New Evidence on Procyclical Bank Capital Regulation: The Role of Bank Loan Commitments*

Ki Young Park†

September 28, 2018

Abstract

Previous research on procyclical bank capital regulation has largely focused on the role of increased loan losses and deteriorated credit ratings in economic downturns. We focus on the role of bank loan commitments, which have been increasingly popular from the 2000s, on the procyclicality of bank capital regulation. Using the bank-level data of U.S. commercial banks, we present another independent source of procyclicality working through bank loan commitments, which we call "loan commitments channel." We find that, as firms draw down more from their pre-existing credit lines when credit market conditions are tighter, this increased takedown raises bank risk-weighted assets via involuntary lending and thus lowers capital adequacy ratios of commercial banks, making them more procyclical. Our empirical results suggest that this loan commitments channel is quantitatively important and needs to be addressed in designing the regulatory framework for reducing credit procyclicality.

Keywords: bank loan commitments, capital adequacy ratio (CAR), procyclical bank capital regulation
JEL classification: E44, G21, G32

*I thank Randall Kroszner, Skander J. Van den Heuvel, Yongsung Chang, Mathias Hoffmann, Nobuhiro Kiyotaki, Kei-Mu Yi, Fabrizio Perri, Ramon Marimon, Sunghoon Cho, Jinook Jung, Jinil Kim and Frank Song for their helpful suggestions and discussions. I also thank seminar participants at the University of Zurich, University of Tokyo, the Bank of Korea, Yonsei University, 2017 IFABS (International Finance and Banking Society) Asia Conference. This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government. All remaining errors are mine. The usual disclaimers apply.

†kypark@yonsei.ac.kr, School of Economics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul, 120-749, South Korea.

1. Introduction

After the onset of the recent financial crisis, financial innovation, once hailed as a tool for bringing both stability and growth, has been severely criticized. Among its products, CDO (Collateralized Debt Obligations), SIV (Structured Investment Vehilce), and CDS (credit default swap) are criticized for their poor design and misuse. Meanwhile, bank loan commitments, which are a result of financial innovation and has become popular from 1990s, has received much academic attention for its role in providing additional liquidity during the financial turmoil of 2007–2009. Studies by Ivashina and Scharfstein (2010), Cornett et al. (2011), Cornett et al. (2011), Acharya and Mora (2015), and Berger et al. (2017) show that bank loan commitment play a role of additional funding source. While recent studies on loan commitments focus mainly on corporate liquidity management and banks' liquidity risk exposure, the purpose of our study is to examine the role of loan commitment in making bank capital ratio more procyclical. It is important in at least two respects. First, as figure 1 shows, the use of bank loan commitments has been increasingly popular and the amount of total unused commitments in off-balance sheet has already exceeded the amount of total loans around the year of 2000. Second, addressing the procyclical effect of bank capital regulation and stabilizing credit cycles is essential for stable economic growth.

The procyclicality of bank capital requirements has been much discussed in academic and supervisory community and it becomes one of the top agenda for financial reforms following the recent financial crisis. Widely-discussed sources of procyclicality are related to realized loan losses or capital charges. These two effects are clearly summarized in Kashyap and Stein (2004):

> The recession will have two effects. First, it will naturally lead to loan losses, thereby eroding banks' capital positions. Second, existing non-defaulted loans are likely to become significantly riskier . . . the capital charges for banks' existing portfolios will go up.

As a bank's capital base is likely to be eroded by increased loan losses in bad times, its capital adequacy ratio becomes lower, which forces a bank to hold more capital when capital is most needed and most expensive. We will call this procyclical effect that works through increased loan losses "equity erosion channel" henceforth. If a bank responds by cutting down new loans in this situation to avoid the binding capital requirement, this response will exacerbate credit cycles and thus magnify macroeconomic fluctuations. Another popular source of procyclicality is the Basel II capital requirements, which make a bank's capital holdings proportional to its potential credit losses.[1] As non-defaulted borrowers will be downgraded by the relevant credit-risk models more often in bad times, the capital charges for a bank's existing portfolio will go up. Again, to the extent that a bank finds it difficult to raise new equity in bad times, its capital ratio becomes procyclical. We will call this channel that works through changing risk weights over business cycles "Basel II channel."

In addition to these widely-discussed channels, equity erosion channel and Basel II channel, we propose another channel by providing new evidence on the role of bank loan commitments that makes bank capital requirements more procyclical.[2] We find that, as firms draw down more from their credit lines in economic downturns, CAR tends to be lower. It is because the part of off-balance sheet loan commitments materialize on on-balance sheet in bad times and it raises a bank's risk-weighted assets (denominator of CAR) and thus lowers its CAR. We will explain more and provide empirical evidence in the following sections.

Our identification strategy is based on the following premises: (1) firms draw down more from their preexisting credit lines as liquidity conditions tighten, and (2) this increased takedown pushes banks to make 'involuntary lending' and raises their assets, even though banks cut back on new term loan origination. The first premise is strongly supported by previous empirical studies. Following an early study by Morgan (1998) showing that firms tend to rely more on their loan commitments after contractionary monetary shocks, studies by Jimenez et al. (2009), Ivashina and Scharfstein (2010), Cornett et al. (2011), Berrospide (2013), Acharya and Mora (2015), and Berger et al. (2017) document that firms draw down their unused commitments in response to negative liquidity shocks. For the second premise, the following conditions should be met; (i) as firms take down more in bad times, bank risk-weighted assets should increase, even though banks cut back on new term loan origination, and (ii) CCF (credit conversion

[1] See Kashyap and Stein (2004), Heid (2007), and Repullo et al. (2010) on the procyclical effect of the Basel II standard and possible remedies.

[2] We use the term, bank loan commitments and lines of credit (or credit lines), interchangeably.

factor) on the unused loan commitments is not 100% in average.[3] And (iii) banks do not often limit access of firms to existing lines of credit until they rate them as high risk or firms have already used much of their credit limit. We will explain more about these and show that these conditions are met in the following section.

This new source of procyclicality, which we will call "loan commitments channel (henceforth, LC channel)," is distinctive from equity erosion channel because the former works through larger bank balance sheet due to increased takedown, while the latter works through increased equity erosion and reduced assets. Alternatively, loan commitment channel raises the denominator of CAR while equity erosion channel reduces both the denominator and the numerator.[4] We also present evidence that our suggested channel is distinct from Basel II channel. According to Basel II channel, a bank's risk-weighted assets tend to increase as the average risk weights rise in bad times, all other things being equal.[5] However, there are many difficulties in empirically making distinction between two channels. For example, Basel II became effective for U.S. banks in April 2008, too late in our sample period. And concurrent events such as the financial crisis and a change in loan loss provisioning rule makes it harder. In this regard, rather than directly making distinction between our proposed LC channel and Basel II channel, we focus on testing if our suggested LC channel still works even when we consider changes in credit quality, which are a proxy for risk weights used in Basel II regulation.

We confirm the procyclical effect of loan takedown on CAR in various ways. First, we examine not only total loan commitments but also "other commitments," which are a

[3]CCF translates an off balance sheet exposure to its credit exposure equivalent. For example, it is 50% for long-term loan commitments and 20% for short-term loan commitments whose maturity is less than one year. If it can be unconditionally cancellable by an issuing bank, 0% of weights can be applied.

[4]Distinguishing the numerator and the denominator of bank capital ratio can be important for financial regulation. For example, Hanson et al. (2010) explain that "the basic critique of microprudential regulation can be understood as follows. When a microprudentially oriented regulator pushes a troubled bank to restore its capital ratio, *the regulator does not care whether the bank adjusts via the numerator or via the denominator– that is, by raising new capital or by shrinking assets.* Either way, the bank's own probability of failure is brought back to a tolerable level, which is all that a microprudential regulator cares about."

[5]Heid (2007) suggests that, facing higher capital charges during an economic downturn, banks have some leeway to accommodate higher credit risk by actively managing their portfolio. Thus, changes in actual capital ratios may turn out to be far smaller than those without portfolio adjustments. However, with regard to the cyclicality of lending, he finds that the capital buffers will only partially mitigate the impact of changes in capital charges. A significant procyclical effect may exist even if banks are not capital constrained. Under Basel II, the capital buffer will actually decrease, because the rise in the average risk weights will usually overcompensate the reduction in lending.

subset of total loan commitment and mainly obligations to supply C&I loans. Since these commitments are more intensively used for commercial and industrial firms, we find a stronger effect of LC channel in case of other commitments. Second, we use a rule of loan loss provisioning and compare banks that have leeway to adjust their regulatory capital through loss provisioning and banks that do not. We find that the latter group, who have less leeway to adjust their regulatory capital, exhibit stronger effect of bank loan commitment channel. In addition, we perform additional robustness tests in terms of (1) alternative measure of market liquidity and business cycles, (2) using GMM-IV, (3) outliers, (4) sample period and others.

Our finding can be important for policy discussion given the increasing significance of bank loan commitments and bank capital regulation to the macroeconomy. According to FDIC (Federal Deposit Insurance Corporation) Quarterly Bank Profile, the share of total unused loan commitments remaining on off-balance sheet to assets of all commercial banks in the U.S. amounts to 43.0% as of 2017Q2. For C&I loans, the percentages of amount of loans made under loan commitments are 81.7% as of 2017 May, according to Federal Reserve statistical release E.2. Given the popular usage of loan commitments, understanding the behavior of unused loan commitments (or takedown) over business cycles will shed some light on bank capital regulation and lending channel of monetary policy.[6] After presenting our empirical evidence below, we also discuss our finding's policy implications in relation to regulatory capital reforms under Basel III.

The rest of the paper is structured as follows. Section 2. starts with explaining our empirical strategy with referring to related studies on loan commitments, explains our data and key variables, and provides the main results. Section 3. perform various robustness tests and Section 4. discuss policy implications. The last section concludes with summary.

2. Empirical Analysis

[6] Gersbach and Rochet (2017) provide a theoretical rationale for counter-cyclical capital requirements on banks. They show that stabilization of credit cycles not only reduce the amplitude of credit cycles but also correct capital misallocation, enhancing long-term growth. In this regard, it is important to identify the sources of procyclical bank capital ratios.

2.1. Empirical Strategy

Our main conjecture is that, as firms take down more from their pre-existing credit lines in bad times, a bank's assets rise and its CAR thus decline, generating the procyclical effect. To observe this effect, we need the following preconditions to be met: (1) firms take down more in economic downturns, (2) risk-weighted assets rise with this increased loan takedown, (3) this effect is distinguishable from equity erosion channel and Basel II channel.

First, for increased takedown in bad times, we have ample empirical evidence. Morgan (1998) shows that firms tend to rely more on their loan commitments after contractionary monetary shocks. Jimenez et al. (2009) show that firms in danger of default draw down more funds from their lines and Ivashina and Scharfstein (2010) show that firms with low credit ratings take out more money from their lines during the financial crisis. Cornett et al. (2011) show that, as TED spread widens during the financial crisis, increased takedown moves funds from off-balance sheet to on-balance sheet. According to Berrospide (2013), firms take down from loan commitments and hoard liquidity for precautionary motives.[7] Park and Lee (2017) show that firms with low credit ratings draw down more when credit spreads widen, but firms with high credit ratings draw down more when market interest rates are low.[8]

Second, risk-weighted assets need to rise with increased loan takedown in bad times. We illustrate this precondition using the laws of motion for loans and commitments. Table 1 shows a bank's balance sheet (B/S) at time $(t-1)$ and t. For simplicity, assume that there is no consideration of risk weights and that the asset side consists of liquid assets such as cash and securities (S) and loans (L) only. And the only off-B/S item is unused commitment (UC).

We can express the behaviour of unused loan commitments of a bank i:

$$UC_{it} = (1 - z_{it})UC_{i,t-1} + NC_{it} \tag{1}$$

where UC_{it} is the unused loan commitments of bank i's off-balance sheet at time t, z_{it} is a takedown shock, whose range is $[0, 1]$, and NC_{it} is the amount of new loan com-

[7] See Berrospide and Meisenzahl (2015) for the real effect of loan commitment drawdowns.

[8] Sufi (2009) poses a related but a different question. He empirically investigate the factors to determine firms' decision to use between two substitutes, loan commitments and cash.

mitments issued by a bank at time t.[9] As long as a bank does not rely on the Material Adverse Change (MAC) clause to avoid its obligation to provide liquidity, z_{it} will be determined by borrower side. While a bank has a right to re-evaluate the borrower and repudiate the contract, courts have often obstructed the right to invoke the MAC clause (Edelstein (1991)). Boot et al. (1993) also show that a bank makes reputational consideration when exercising the MAC clause.[10] The following equation is a simplified law of motion for bank loans:

$$L_{it} = (1 - \delta_{it} - \rho_{it})L_{it-1} + N_{it} + z_{it}UC_{i,t-1} \tag{2}$$

where L_{it} is the amount of loans outstanding for a bank i at time t, δ_{it} is the fraction of outstanding loans that becomes due in this period (thus, $1/\delta$ is the average maturity), ρ_{it} is default ratio, and N_{it} is the amount of new term loans issued at time t. Rewriting (1) and (2) in terms of changes gives

$$\Delta UC_{it} = -z_{it}UC_{i,t-1} + NC_{it}, \tag{3}$$

$$\Delta L_{it} = -(\delta_{it} + \rho_{it})L_{i,t-1} + N_{it} + z_{it}UC_{i,t-1} \tag{4}$$

Equation (3) shows that a change in the amount of loan commitments on off-B/S depends on two terms, loan takedown and new loan commitment contract. Equation (4) clearly states that a change in loans results from amount of matured and defaulted loans, new term loan origination, and loan drawdown. In order to observe an increase in assets, we need:

$$\begin{aligned} \Delta A_t &\equiv \Delta S_t + \Delta L_t \\ &= \Delta S_t - (\delta_{it} + \rho_{it})L_{i,t-1} + N_{it} + z_{it}UC_{i,t-1} > 0 \end{aligned} \tag{5}$$

In order to meet the increased loan drawdown in economic downturns, a bank would reduce its holdings of liquid assets ($\Delta S_t < 0$) and cut down on its new credit ($N_{it} < 0$), let alone more frequent defaults in bad times (higher ρ_{it}). Whether ΔA_t is positive or

[9] We use the term 'shock' for z because, in the viewpoint of issuing banks, how much of funds will be drawn down is a kind of random shock, on which banks should make a guess.

[10] However, a bank has more discretion over the size of new commitments, NC_{it}.

not is an empirical question. As shown in the following section, we find that increased loan drawdown in economic downturns actually increase banks' total assets and risk-weight assets. It suggests that the denominator of CAR (risk-weighted assets) is affected by loan drawdown and the total volume of loans increases even though banks attempt to cut back on its new term loans.[11]

Third, even though LC channel exists, we need to identify it against equity erosion channel and Basel II channel. To differentiate it from equity erosion channel, we examine the directions of bank assets. A typical and established source of bank capital procyclicality is ρ_{it}, which is related to equity erosion channel. In economic downturns, default ratio (ρ_{it}) tends to increase and the amount of loan charge-off increases. Then, in a simplest setting, the amount of loan charge-off are valued at zero and written off, and then bank equity fall in bad times. It will reduce the same amount from the denominator and numerator of the following definition of CAR:

$$\text{CAR} = \frac{\text{Bank Equity (E)}}{\text{Risk-Weighted Assets (RWA)}} \tag{6}$$

Meanwhile, according to LC channel, risk-weighted assets should increase with increased loan takedown. As the term zUC in equation (2) shows, if firms draw down more funds from their credit lines, it is counted as loans, which raise bank assets and thus lower bank capital ratio.[12] We expect the high correlation between loan charge-offs and loan takedown because both are likely to happen more often in bad times. However, the key identification is that the former (ρ_{it}) reduces bank assets while the latter (zUC) raises bank assets. We will use this difference to make a distinction between equity erosion channel and loan commitments channel.

Lastly, it is not easy to identify LC channel against Basel II channel.[13] There are sev-

[11] Recent studies define 'total credit' or 'credit' as the sum of loans and unused commitments, which is $(L_{it} + UC_{it})$ in our notation. And some studies define a bank's liquidity risk exposure as $UC_{it}/(L_{it} + UC_{it})$ or $UC_{it}/(A_{it} + UC_{it})$. Cornett et al. (2011) show that, during the financial crisis of 2007-2009, increased takedown displaced lending capacity. In our notation, an increase in $z_{it}UC_{i,t-1}$ partially crowds out N_{it}. Kim and Sohn (2017) find that the effect of an increase in bank capital on 'credit' growth is positively associated with the level of bank liquidity only for large banks and that this positive relationship has been more substantial during the recent financial crisis period.

[12] To be precise, we should add $(1 - \text{CCF})$ in front of zUC. We assume that CCF is zero for simplicity. As long as CCF is not 100%, our argument still holds.

[13] In related to our study, the logic of Basel II channel is simple. Firms' profitability tend to decline in bad times and their risk-weights evaluated by lenders tend to increase. Then, even for a fixed portfolio, bank risk-weighted assets, the denominator of equation (6), will increase because of higher risk-weights,

eral reasons. First, there are so many concurrent events around the timing of Basel II regulation implementation. While our sample period is 2001Q2−2009Q4, Basel II regulation framework for U.S. banks became fully effective in April 2008.[14] There is the financial crisis period of 2007−2009. And there is a change in loan loss provisioning rule. In response to bank lobbying at the time of the issuance of Financial Accounting Standards (FAS) 166 and 167 in late 2009, regulators allowed transitional relief for banks from the 1.25% limit.[15] Additionally, call reports do not report risk weights for individual borrowers. Given these difficulties, we test if our proposed LC channel still works even when we consider the changes in credit quality. We run a horse race with adding both level and interaction variables that reflect loan takedown and credit quality.

2.2. Data and Variable Description

For our empirical analysis, we use the Report of Condition and Income, often called the call report. It provides detailed information on on- and off-balance sheets and income statements of all commercial banks in the U.S. on quarterly basis. Our sample period is from 2001:I to 2009:IV.[16]

Initially, we obtain 301,246 bank-quarter observations from 2001:I to 2009:IV. Following Kashyap and Stein (2000) and Ashcraft (2006), we apply exclusion criteria for several reasons. For avoiding inconsistency that resulted from possible mergers, bank-quarter observations are dropped if their growth rates of bank assets are greater than 50% in absolute value or growth rates of total loans or C&I loans is greater than 100%. For ensuring consistency and excluding mis-reported ones, if the amount of C&I loans are greater than that of total loans or the amount of total unused loan commitments is smaller than the amount of unused loan commitments whose maturity is greater than

leading to lower CAR. Though the logic is simple, making a distinction between Basel II channel and LC channel is not clearcut because downgrading of firms and loan takedown tend to take place at the same time, especially in bad times.

[14] Refer to Getter (2014) for U.S. experience of adopting Basel capital regulatory reforms.

[15] The new rule, effective from 1 January, 2010, is aimed at bringing off-balance sheet items back on on-balance sheet, which would raise banks' risk-weighted assets and hence lower the CARs. In the first two quarters after the implementation of SFAS (Statement of Financial Accounting Standards) 166 and 167 in November 2009, a banking organization, under certain conditions, was permitted to include the full amount of the loan loss reserves in Tier 2 capital beyond the 1.25% of risk-weighted assets. If banks move early in anticipation of the new rule, it will be captured partially by time fixed effect of 2009:IV.

[16] One reason for not extending the analysis before 2001 is inconsistency of time-series because of changes in reporting forms.

1 year, then those observations are removed. In addition, we drop observations if the share of non-performing loans is greater than 50%, ratio of loan commitments to assets is zero or greater than 500%, or share of total loans to assets is less than 10%. After applying exclusion criteria, we have 262,663 bank-quarter observations.

Considering the considerable skewness of bank assets, we split the sample by bank size, measured by their assets. Large banks are the top 1 percent in terms of average assets during the sample period and small banks refer to ones in the bottom 99 percent.[17] Another reason to run regressions by bank sizes is the different behaviors of CARs by bank sizes. Figure 2 shows that the capital adequacy ratio (CAR, henceforth) and Tier 1 capital ratio of commercial banks sharply decline from 2007:III.[18] Interestingly, those ratios of large banks rise from 2009. There can be at least two reasons for this pattern. One might conjecture that large banks, whose agency costs are lower in financial markets, were easier to get external funds and inject more capital, compared to small banks. Another is the CPP (Capital Purchase Program), the central piece of the TARP. During the crisis period, the CPP program required the top 20 largest banks to receive the fund in order to minimize the signalling effect.

Table 2 shows the summary statistics of key variables used in our regression analysis. As expected, small banks hold more liquidity and rely more on transaction deposits. They hold more equity capital, measured by CAR. For example, during the period of 2001Q2−2009Q4, the average value of CAR for large banks is 12.8% while that of small banks amounts to 16.6%. For loan commitments, large banks issue more loan commitments. For large banks, the shares of total unused loan commitments and other commitments to assets are 41.3% and 19.4%. The same measures for small banks are 11.3% and 6.1%, respectively. In terms of maturity, large banks issue more long-term loan commitments. The reason for different patterns across bank sizes is due to agency cost. Loan commitments, which can be taken down any time during the contract period by borrowers' discretion, impose additional liquidity management on issuing banks and thus banks with high agency costs such as small banks and stand-alone banks can

[17]We also divide banks into three groups: large (top 1%), medium (top 1−5%), and small (bottom 95%). We find that medium banks behave more like small banks.

[18]This can happen for increased loan charge-offs, dividend payouts, and many other things. Acharya et al. (2011) emphasize that dividend payout during the Financial Crisis exacerbate the erosion of common equity.

be reluctant to issue loan commitments.[19]

For a measure of business cycles, we need a statistical measure which reflects both real economic activity and financial market conditions since we investigate the relationship between business cycles and bank capital ratio. For this purpose, we mainly use TED spread, difference between the interest rates on interbank loans and on short-term U.S. government debt (”T-bills”). We also use credit spread between Baa and Aaa corporate bond yields for checking robustness. Figure 3 shows the trends of two variables, along with the growth rate of quarterly real GDP. The correlation coefficient of TED spread with credit spread and real GDP growth rate are 0.66 and -068, respectively. And the correlation between credit spread and real GDP growth is -0.79. All these suggests that TED and credit spread serves well for our purposes as a measure of market liquidity and business cycles.

As a measure related to loan commitments, we use COM_{it}, defined as (total unused loan commitments/total assets). ΔCOM_{it} is the change in the ratio of unused amount of loan commitments to assets, $COM_{it} - COM_{i,t-1}$. If unused amount of loan commitments declines, there are two possibilities. One is that firms take down more and the other is that a bank reduces the amount of credit lines, worrying about its own liquidity management problem. However, as mentioned above, the former is more likely to happen and to be larger in magnitude. If banks reduce credit lines in bad times, their assets should decrease in bad times (periods of high TED spread), which is not found in our empirical analysis. Figure 4 shows the average values and medians of COM and $CICOM$ over time, in which $CICOM$ is defined as (other unused loan commitments/total assets). “other commitments” is the obligation mainly for C&I (commercial and industrial) loans. It clearly shows that both COM and $CICOM$ increase before the financial crisis reflecting their popularity and decline after the onset of financial crisis reflecting the increased loan takedown. We interpret COM as size-adjusted loan commitments and use ΔCOM_{it} to capture changes in unused loan commitments.

Before going into our empirical analysis, we need to mention the potential bias from incomplete dataset. Since the call report does not contain the information on individual borrowers, it is not feasible to address the survivorship bias. Given that a bank's loan portfolio in the data consists of non-defaulting borrowers during the sample period, we

[19] For the link between loan commitments and agency cost, see Kashyap et al. (2002) and Park (2012).

will understate the effects of equity erosion channel and Basel II channel. In addition, as Kashyap and Stein (2004) emphasize, a bank's loan portfolio will change in response to external shocks. It is safe to assume that we observe an *actively managed* portfolio and its resulting capital requirement, rather than a *fixed* portfolio. This possibility also underestimate the effects of three channels.

2.3. Empirical Results

2.3.1. Baseline Regression

Our hypothesis is if increased loan drawdown in economic downturns exerts downward pressure on CAR, making CAR more procyclical. If firms increase takedown from their credit line as credit market conditions deteriorate, ΔCOM_{it} is likely to be negative. Note that, if a firm draws down its credit line from a bank, the amount of being drawn down is captured as loans, which will raise the denominator of bank regulatory capital ratio as long as the condition of equation (5) is met.[20] This logic implies that the effect of increasing TED on CAR, $\partial \text{CAR}_{it}/\partial TED_{t-1}$, is a function of ΔCOM_{it}:

$$\frac{\partial CAR_{it}}{\partial TED_{t-1}} = \beta_1 + \beta_2 \Delta COM_{it}$$

In this case, β_1 measures the procyclicality that has been much talked about and β_2 measures the additional procyclicality associated with increased loan takedown in bad times.[21] However, it can be positive or negative. As Heid (2007) well points out, a bank's actual capital ratio may not move in parallel with capital requirements since banks are likely to hold a certain capital buffer. For example, it can be negative if a bank experiences increased loan charge-off in bad times. And it can be positive if banks make more capital injection facing tightened capital market conditions, though raising equity in bad times can be very costly. Figure 2 clearly shows this point. While CARs and Tier 1 capital ratios of small banks tend to decline during the financial crisis, those of large banks actually increase. In this regard, we focus on β_2 and expect $\beta_2 > 0$. In addition, we expect $\beta_2^{\text{large banks}} > \beta_2^{\text{small banks}}$, considering that large banks issues more loan commitments and they would face more takedown in bad times.

[20] We will examine this possibility in the following section.

[21] Ayuso et al. (2004) show that, using Spanish data of 1986-2000, an increase of 1 percentage point in GDP growth might reduce capital buffers by 17% and the interaction with size not that strong.

Our baseline regression equation takes the following form:

$$\begin{aligned} CAR_{it} &= c + \beta_1 TED_{t-1} + \beta_2 TED_{t-1}\Delta COM_{it} \\ &\quad + (\text{bank balance sheet variables})_{i,t-1} \\ &\quad + (\text{dummy variables}) + (\text{time fixed effect}) + \alpha_i + u_{it}, \end{aligned} \tag{7}$$

The dependent variable is CAR_{it}, defined as (bank's total risk-based capital/risk-weighted assets) for bank i at time t. To control for the effect of other bank balance sheet variables, we include log of assets, share of liquid assets to assets, share of non-performing loans to total loans, ratio of unused commitments to assets (COM), share of transaction deposits to asset, and share of loans to assets.[22] In addition, we include dummies for Federal Reserve districts and BHC-affiliation. Since controlling for time effects common to all banks is important, we include time fixed effects. The term α_i captures bank-level fixed effects. In the following, we will add additional interaction variables.

Table 3 shows the estimation results of fixed effects panel regression of equation (7).[23] Results for all banks in column (1) is very similar to one in column (3) because the number of small banks dominate that of large banks. According to column (2) and (3), we obtain $\hat{\beta}_2 > 0$ both for large and small banks. As expected, the effect of a change in unused loan commitments is much stronger for large banks. $\hat{\beta}_2$ for large banks is 0.074 while it is 0.006 for small banks. These results confirm our prediction: as market liquidity dries up, proxied by an increasing TED, firms draw down more from their credit lines and this increased takedown contributes to lowering capital ratio, making it more procyclical.

2.3.2. Loan Commitments Channel vs. Equity Erosion Channel

We emphasize that procyclicality can be strengthened by increased loan takedown. It is different from the equity erosion channel because increased loan takedown in bad times raises bank assets (denominator of equation (6)) and thus lower the capital ratio, while the traditional channel focuses on increased loan charge-off in bad times, which

[22] We define liquid asset as the sum of securities and cash and non-performing loans as the sum of loans late over 90 days and loans not accruing. See the appendix for more on variable definitions.

[23] Some specifications fail to meet the asymptotic assumptions of the Hausman test. However, in other cases including robustness tests to be followed, fixed effects model is preferred in many cases reported here. Thus we report the results of fixed effects regressions.

reduce bank assets. If our conjecture is correct, we should see bank assets rise with increased loan takedown in bad times.[24] To see this, we replace the dependent variable in equation (7) with the level term, log of risk-weighted assets (RWA) or log of total assets:

$$\begin{aligned}\ln(\text{RWA})_{it} &= c + \beta_1 TED_{t-1} + \beta_2 TED_{t-1}\Delta COM_{it} \\ &+ (\text{bank balance sheet variables})_{t-1} \\ &+ (\text{dummy variables}) + \alpha_i + u_{it}\end{aligned}$$

We expect to see $\beta_2 < 0$, which implies that bank assets rise with increased loan takedown in bad times. Estimation results in table 4 confirm our conjecture. In columns (1) and (2) in which log of risk-weighted assets is used as dependent variable, β_2's are -0.223 for large banks and -0.174 for small banks.

Columns (3) and (4) show that our conjecture still holds when log of bank total assets, which is not risk-weighted, is used as dependent variable. We can see that the absolute values of estimates becomes larger compared to the case of risk-weighted assets (from -0.233 to -0.549 and from -0.174 to -0.297) and the estimate of β_2 is larger for large banks. Given that Heid (2007) uses the ratio of risk-weighted assets to non-adjusted assets as the average risk weight, this result suggests that the average risk weight of borrowers under commitments are lower than that of borrowers using term loans.

Regardless of whether a measure of bank assets is risk-weighted or not, estimation results in table 4 tell us that, as firms draw down more from their credit lines when market liquidity becomes scarce, banks face upward pressure on bank assets, lowering their capital ratio and potentially strengthening the procyclicality. Considering the condition of (5), our result also suggests that, even though banks may cut down on its new loan origination, the amount of total loans (sum of term loans and loans under commitments) increases. It is noteworthy because our suggested source of procyclicality comes from increased bank assets in bad times, not from shrunk bank assets in bad times.

[24] Cornett et al. (2011) show that banks with higher levels of unused loan commitments increased their holdings of liquid assets in preparation for increased takedown during the financial crisis.

2.3.3. Loan Commitments Channel vs. Basel II channel

We argue that the role of increased takedown for making bank capital ratio procyclical is distinct from the channel working through degrading of credit ratings or increased risk weights in bad times, which has been much discussed in the context of the Basel II standard. As mentioned above, there are many difficulties in empirically making distinction between two channels. For example, Basel II became effective too late in our sample period. And concurrent events such as the financial crisis and a change in loan loss provisioning rule makes it harder. In this regard, we focus on testing if our suggested LC channel still works even when we consider changes in credit quality, which is a proxy for risk weights used in Basel II regulation. This test is also necessary given that the possibility of positive correlation between degradation and loan takedown because both take place more often in bad times, suggesting that the empirical results above might be driven by deteriorated credit quality.

As a proxy for credit rating or loan quality, we use the variables of loan charge-off and non-performing loans. While loan charge-off is more related to equity erosion, two variables move in the same direction. We estimate the following form:

$$\frac{\partial CAR_{it}}{\partial spread_{t-1}} = \beta_1 + \beta_2 \Delta COM_{it} + \beta_3 \Delta X_{it}, \tag{8}$$

where X is the share of loan charge-off to total loans or the share of non-performing loans. We also interact all other control variables with TED spread. Columns (1) and (2) in table 5 show the estimates of β_1 and β_2 when the interaction variable associated with a change in the share of loan charge-off and non-performing loans is included. We obtain $\hat{\beta}_2 = 0.081$ for large banks and $\hat{\beta}_2 = 0.010$ for small banks, which are statistically significant. Note that they are larger compared to those from the baseline regression, which are 0.074 and 0.006. We also obtain much higher statistical significance. It suggests that adding additional interaction variables reduces variations in error terms, enhancing the accuracy. Columns (3) and (4) show the result when we add more interaction variables. Even with more interaction variables, the estimates of β_2 does not change much. The results in table 5 strongly suggest that our main result is not driven by changes associated with credit ratings or loan quality, a potential mechanism surmised in Basel II channel.

2.3.4. Evidence from Other Commitments

Next, we examine if a subcategory of loan commitments can produce the same result. Among the loan categories such as real estate loans, agricultural loans, and so on, commercial and industrial loans (C&I loans) are known as the loan category in which loan commitments are most heavily used. As mentioned above, the share of amount of C&I loans made under loan commitments is around 80%. In the call report, the item of 'other loan commitments' is mainly for C&I loans. Given that the majority of C&I loans are made under commitments, we expect the effect of increased takedown to be larger for other loan commitments.

Table 6 shows the estimation results. For the sample period of 2001:I to 2009:IV, $\hat{\beta}_2$, the estimated coefficients for $TED_{t-1}\Delta CICOM_{it}$, are 0.213 and 0.012 for large and small banks. Even with other interaction variables, they are 0.239 and 0.014 as shown in column (3) and (4). As expected, the estimates are larger compared to the case of total commitments.

3. Robustness Tests

In this section, we perform robustness tests. We report the estimation results when we consider (1) loan loss provisioning, (2) different measure of business cycles, (3) first-difference GMM with instrumental variables, (4) using only non-positive ΔCOM variable, (6) only banks that are present more than 8 quarters in the sample, (7) excluding outlier states such as Delaware, New York, and South Dakota, and (8) only the pre-crisis period.

3.1. Loan Loss Reserves and Loan Loss Provision

Under FAS 5, a bank is supposed to make loan loss provision if a loss is "probable" and can be "reasonably estimated." There is a degree of inherent management discretion in interpreting "probable" and "reasonably estimated" loss estimates. In addition, the accounting rule before the late 2009 treats the allowance for loan losses taken out from Tier 1 capital on an after-tax basis and this allowance added to Tier 2 capital on a pre-tax basis up to the 1.25% of risk-weighted assets. For example, if a bank takes $X out of retained earnings and adds it to loan loss reserves, this transaction reduces Tier 1 capital by $\$(1-\tau)X$ with the statutory tax rate τ and raises Tier 2 capital by $\$X$. That is, $(1-\tau)$ dollar of Tier 1 capital can be converted into one dollar of Tier 2 capital as long as loan loss reserves prior to provisioning is less than 1.25% of risk-weighted assets.[25] Bikker and Metzemakers (2005) and Beatty and Liao (2011) document that provisioning behavior of banks is largely procyclical. Berger et al. (2008) report that bank holding companies actively manage regulatory capital ratios rather than use the earnings to build up bank capital.

Related to our discussion, Bushman and Williams (2009) report that greater discretion in loan loss provisioning weakens regulators' ability to monitor and discipline banks. Though procyclical provisioning may make bank capital ratio look less procyclical, it is worthwhile to check the effect of loan loss provision on our empirical results because the changes in unused loan commitments (ΔCOM) and the changes in loan loss reserves can be negatively correlated. Borrowing the specification of equation (8), we test if the changes in loan loss affect the estimates of our interest. Table 7 shows the results. In column (1) and (2), the estimates of $\hat{\beta}_2$ are positive and statistically significant when we add the interaction terms related to changes in (loan loss provision/loans). They are 0.076 and 0.011 for large and small banks, which are not much different from those in table 5. For banks whose loan loss reserves are greater than 1.25% of risk-weighted assets, they cannot move funds from Tier 1 capital to Tier 2 capital to raise their capital ratio. To account for this effect, we run the same regression based on those banks. Column (3) and (4) show that the estimates of $\hat{\beta}_2$ are 0.225 and 0.016, respectively, which are much larger than 0.076 and 0.011 in column (1) and (2). This result show not only that our empirical result is robust to the inclusion of procyclical loan loss provisioning but also that increased loan takedown in bad times urges bank to adjust regulatory capital.

3.2. Different Measure of Business Cycles and Market Liquidity

We use TED spread as a measure of business cycles and market liquidity. Just like TED spread, we can use other measures that reflect macroeconomic conditions. One candidate is credit spreads between Baa and Aaa corporate bond yields, well-known mea-

[25] See Ng and Roychowdhury (2011) for a more detailed exposition on the accounting principle.

sure that has predictive power for business cycle fluctuations (Gertler and Lown (1999), Gilchrist et al. (2009), Gilchrist and Zakrajšek (2012), Giovanni et al. (2016)).

Table 8 shows the results of fixed effects panel regression of equation (8). The signs and statistical significance of $\hat{\beta}_2$ confirm our prediction again. The estimates are 0.044 and 0.007, respectively for bank sizes. Even when we include all interaction variables, the estimates do not change much and they are statistically significant. Increased loan takedown imposes downward pressure on CAR as credit spread widens. And this effect is more pronounced for large banks.

3.3. First-Difference GMM with Instrumental Variables

One common problem of estimating panel data with rational agents (banks in our context) is that those agents respond to past and current shocks and thereby change future values of dependent variables. Letting x be explanatory variables in equation (7), it implies that $E(u_{it}|x_i^T) = 0$ no long holds, making fixed effects panel estimator inconsistent.[26] One way to fix this endogeneity problem is to use the first-difference GMM with instrumental variables, suggested in Arellano and Bond (1991). Assuming that TED spread is predetermined, we use the moment conditions $E_t[TED_{t-3}\Delta u_{it}] = 0$ to estimate the coefficient of our interest, β_2. Note that these orthogonal conditions still hold with the lagged dependent variable. Columns (1) and (2) in table 9 show the estimates using the first-difference GMM. Like the result in table 3, the signs of $\hat{\beta}_2$ in columns (1) and (2) are positive and their statistical significance is valid. The estimates become smaller from 0.074 and 0.006 in table 3 to 0.061 and 0.016 in table 9 for large firms and small firms, respectively.[27] Columns (3) and (4) show the result when we include the lagged dependent variable.[28]

Though we can be relieved by these results, first-difference GMM is not a cure-all. Since we use the differenced error term, $\Delta u_{it} = u_{it} - u_{i,t-1}$, related test statistics must suggest strong $AR(1)$ structure in error terms, but not higher order than $AR(1)$.[29] In this

[26]We use the superscript notation $x_i^T = (x_{i1}, ..., x_{iT})$.

[27]Technically, we can add more instruments and stack more moment conditions. However, only with TED_{t-3} or $spread_{t-3}$, we use 876 instruments, too many for the sample size of 1,895 for the case of large firms. In addition, using too many instruments make the test statistics of overidentifying restrictions less robust.

[28]We also obtain the similar result by using the moment conditions $E_t[spread_{t-3}\Delta u_{it}] = 0$.

[29]If Δu_{it} follows $AR(2)$ process, then it implies that u_{it} is likely to follow $AR(1)$, suggesting that u_{it} violates the classical assumptions.

regard, Arellano-Bond test statistics in table 9 is disappointing for small firms in column (2) and (4). The test statistics strongly suggest the $AR(2)$ or higher order structure of the differenced error term, Δu_{it}. However, Sargan test statistics of overidentifying restrictions suggests that the moment conditions are zero in a statistical sense.

In sum, even if we treat our key variables are predetermined and estimate using GMM-IV method, we still obtain positive estimates of β_2, which are statistically significant.

3.4. Other Robustness Tests

To check the statistical validity of our empirical results, we perform various robustness tests. Since the key mechanism of LC channel is increased loan takedown in bad times, we conjecture that negative ΔCOM is more important for the procyclicality of BC channel compared to positive ΔCOM. If an increase in COM (that is, positive ΔCOM) is made by more issuance of loan commitment (an increase in NC in equation (1)), positive ΔCOM will not affect a bank's risk weighted assets much as long as CCF for this commitment is not large. In this regard, we estimate with replacing positive values of ΔCOM with zero. If our conjecture is correct, the estimated coefficients would not change much. Columns (1) and (2) in table 10 show that the estimated $\hat{\beta}_2$'s are 0.086 and 0.005 for large and small banks. These are not much different from ones we obtain in table 5, 0.081 and 0.010. This result supports our conjecture on the main mechanism of BC channel.

In column (3) and (4), we estimate using the banks that are present longer than 8 quarters. By doing so, we would like to reduce the effect of outlier banks caused by mergers or bankruptcy. We also check the effect of outlier states such as Alaska, California, Colorado, New York, and South Dakota. For example, South Dakota is specialized in credit card business. Since the item of total unused loan commitments in the call report includes credit card lines, we need to check if our result is not driven by South Dakota. We run the same regression with and without the combinations of these states. We report the result when Delaware, New York, and South Dakota are excluded in column (5) and (6). As discussed above, figure 2 shows the different patterns of CARs and Tier 1 capital ratios during the financial crisis. To check the effect of this period, we estimate for the sample period of 2001Q2$-$2007Q2 and report the result in column (7) and (8). Results in column (3)-(8) confirm that our main result is still maintained. One notable result is found in column (7) and (8). The estimates are larger when we exclude the period of the financial crisis. Yet, without further data, we cannot evaluate the relative importance of Basel II implementation, Fed's large-scale asset purchase, or other events or policies during the period of the financial crisis.

4. Discussion

4.1. Is It Quantitatively Important?

Our empirical analysis provides new evidence that increased loan takedown with widening credit spreads lowers a bank's CAR, strengthening the already existing procyclicality. Is this effect quantitatively important? Our back-of-envelope calculation suggests that it can be so. Based on the estimate for large banks in table 5, changes in TED spread and COM, we provide a rough estimate. Between 2007Q3 and 2008Q4, the average value of COM among large banks declines by 3.1 percentage point (from 0.431 to 0.400). Then it implies that CAR of large banks gets lower by 0.251 percentage point ($= \hat{\beta}_2 \times \Delta COM$ $= 0.081 \times (-3.1)$) with one percent increase in TED spread. Considering that the average CAR of large banks during the sample period is 12.8% and the minimum for well-capitalized banks is 10.0%, a change of 0.251 percentage point in a bank's CAR associated with increased loan takedown cannot be ignored given the capital buffer over the regulatory minimum is only 2.8 percentage point ($= 12.8\% - 10.0\%$).[30] As TED spread increases by 1.32 percentage point (from 1.13% to 2.45%), our calculation suggests that increased loan takedown during this period can explain 11.8% ($= (0.251 \times 1.32)/2.8$) of variation in bank capital buffer.

While our results show an additional channel that makes bank capital ratio more binding in bad times, it is not an easy task to quantify its impact on the real economy. It is related to responses of banks and firms in economic downturns. When banks cut down new loans (N in equation (2)), some borrowers will be credit-rationed while other

[30]To be well-capitalized under federal bank regulatory agency definitions, a bank holding company must have a Tier 1 capital ratio of at least 6%, a combined Tier 1 and Tier 2 capital ratio of at least 10%, and a leverage ratio of at least 5%, and not be subject to a directive, order, or written agreement to meet and maintain specific capital levels. See the following link, http://www.fdic.gov/deposit/insurance/risk/rrps_ovr.html.

borrowers that have loan commitments will draw down from their credit lines. Thus, overall effect depends on the relative importance of these two groups to the real economy.

4.2. Policy Implications

A report from the U.S. Treasury also emphasize that efforts to reduce the procyclicality of the regulatory capital regime, which not only has great appeal from a macro-prudential perspective, but also possibly contribute to the narrower micro-prudential goal of making individual banking firms less likely to fail.[31] According to the report, the principal options for implementing such an approach include adopting (i) fixed, time-invariant target capital ratio(s) above the minimums, with capital distribution restrictions as the penalty for falling below the target ratios; and (ii) time-varying minimum capital ratio(s), where the applicable minimum capital ratio for banking firms at a particular time is a function of one or more contemporaneous macroeconomic indicators.

In line with the second option, Gordy and Howells (2006) suggest two basic alternatives to mitigate the procyclicality of Basel II. One is to smooth the inputs of the Basel II formula by using some through-the-cycle adjustment of the default probabilities and the other is to smooth the outputs by using some adjustments of the Basel II capital requirements computed from the point-in-time default probabilities.[32]

Though our empirical results show that loan commitment channel is distinct from the Basel II capital requirements (that is, credit rating channel), both channel share a common feature that they tend to lower CAR by raising its denominator in bad times. It implies that any measures to mitigate the procyclical property embedded in the Basel II capital requirements might also work for loan commitment channel. However, one cannot conclude that measures for the Basel II standard is sufficient for loan commitment channel. Firstly, given the empirical fact that firms take down more in bad times, one might underestimate the degree of procyclicality without proper consideration of loan commitments. Secondly, all banks might not exhibit the same degree of procycli-

[31] See the U.S. Treasury (2009), "Principles for Reforming the U.S. and International Regulatory Capital Framework for Banking Firms."

[32] Using Spanish data, Repullo et al. (2010) show that output adjustment is better than input adjustment in terms of simplicity and transparency. In addition, they recommend using GDP growth as a multiplier for output adjustment.

cality. They can differ depending on their liquidity risk exposure, as suggested in Cornett et al. (2011) and Acharya and Mora (2015). For policy implication, our empirical finding suggests that banks need to consider the possibility of increased loan takedown when market conditions deteriorate and should hold additional capital buffer on top of the regulatory minimum, as emphasized by Heid (2007), or more liquid assets in order to meet the increased loan takedown. In this regard, Basel III regulation moves in the right direction because it stipulates capital conservation and countercyclical buffers. It explicitly addresses liquidity risk by 30-day liquidity coverage ratio (LCR) and one-year net stable funding ratio (NSFR).

In addition, as shown in the explanatory power of COM variables in our regression analysis, supervisory authority should closely monitor the behaviour of unused loan commitments and other off-balance sheet variables.[33] Monitoring the volume of bank loans may not be sufficiently informative and can be misleading. A more explicit treatment of variables related to loan commitment is necessary.

5. Conclusion

Previous discussion on the source of bank capital procyclicality has focused on the increased loan charge-off and degradation of credit ratings in economic downturns. Apart from the traditional sources of this procyclicality, based on the empirical fact that firms draw down more from their credit lines in bad times, we investigate how their takedown behaviours affect bank assets and capital adequacy ratios.

We find new evidence that increased loan takedown, which takes place more frequently in economic downturns, make bank capital ratio more procyclical by raising the denominator of capital adequacy ratio. We also show that this channel working through loan commitments is distinct from the traditional sources of procyclicality.

Considering the increased significance of loan commitments and their behaviour in economic downturns, this channel that strengthens the procyclicality through loan commitments should be explicitly taken into consideration. More specifically, supervisory institutions need to more actively and explicitly use the unused amount of loan commitments and the amount of takedown as additional information variables for

[33] For objectives of reducing procyclicality and promoting countercyclical buffers, addressed by the Basel committee, see the BIS consultative document available at http://www.bis.org/publ/bcbs164.htm.

monitoring future loan growth and capital adequacy in banking industry.

A Appendix: Definition of Variables

This appendix explains how the bank balance sheet variables are constructed from the Report of Condition and Income, which is available at the Federal Reserve Bank of Chicago website.

Assets: total assets (RCFD2170)
Liquid assets: cash (RCFD0010) + securities (RCDF1754 + RCFD1773)
Loans: total loans, net of unearned income (RCFD2122)
Transaction deposits: transaction deposits (RCON2215)
Equity: total equity capital (RCFD3210)
Total Loan Commitments: unused commitments, total (RCFD3423)
Loan commitments whose maturity is greater than 1 year: total unused commitments, original maturity greater than 1 year (RCFD3833)
Other loan commitments: other loan commitments (RCFD3818). This is usually for C&I loans.
Non-performing loans: loans 90+ days late (RCFD1407) + toal loans not accruing (RCFD1403)
Risk-weighted capital: total risk-based capital (RCFD3792). This is equal to the sum of tier 1 capital (RCFD8274) and tier 2 capital (RCFD8275) for most banks
Risk-weighed assets: net risk-weighted assets (RCFDa223)
Average assets: average total assets, denominator of the bank's tier 1 leverage capital ratio (RCFDa224)
Market risk assets: amount of the bank's market risk equivalent assets (RCFD1651)

References

ACHARYA, V. AND N. MORA (2015): "A Crisis of Banks as Liquidity Providers," *The Journal of Finance*, 70, 1–43.

ACHARYA, V. V., I. GUJRAL, N. KULKARNI, AND H. S. SHIN (2011): "Dividends and Bank

Capital in the Financial Crisis of 2007-2009," *National Bureau of Economic Research Working Paper Series*, No. 16896.

ARELLANO, M. AND S. BOND (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, 58, 277–297.

ASHCRAFT, A. (2006): "New Evidence on the Lending Channel," *Journal of Money, Credit and Banking*, 38.

AYUSO, J., D. PÉREZ, AND J. SAURINA (2004): "Are Capital Buffers Pro-Cyclical?: Evidence from Spanish Panel Data," *Journal of Financial Intermediation*, 13, 249–264.

BEATTY, A. AND S. LIAO (2011): "Do delays in expected loss recognition affect banks' willingness to lend?" *Journal of Accounting and Economics*, 52, 1 – 20.

BERGER, A., R. DEYOUNG, M. FLANNERY, D. LEE, AND Ö. ÖZTEKIN (2008): "How Do Large Banking Organizations Manage Their Capital Ratios?" *Journal of Financial Services Research*, 34, 123–149.

BERGER, A. N., L. K. BLACK, C. H. BOUWMAN, AND J. DLUGOSZ (2017): "Bank loan supply responses to Federal Reserve emergency liquidity facilities," *Journal of Financial Intermediation*, 32, 1 – 15.

BERROSPIDE, J. M. (2013): "Bank liquidity hoarding and the financial crisis: an empirical evaluation," *Finance and Economics Discussion Series 2013-03, Board of Governors of the Federal Reserve System (U.S.)*.

BERROSPIDE, J. M. AND R. MEISENZAHL (2015): "The Real Effects of Credit Line Drawdowns," *Finance and Economic Discussion Series, FEDS Working Paper*, 2015, 1–53.

BIKKER, J. A. AND P. A. J. METZEMAKERS (2005): "Bank Provisioning Behaviour and Procyclicality," *Journal of International Financial Markets, Institutions and Money*, 15, 141–157.

BOOT, A. W. A., S. I. GREENBAUM, AND A. V. THAKOR (1993): "Reputation and Discretion in Financial Contracting," *American Economic Review*, 83, 1165–1183.

BUSHMAN, R. M. AND C. D. WILLIAMS (2009): "Accounting Discretion, Loan Loss Provisioning and Discipline of Banks' Risk-Taking," *SSRN eLibrary*.

CORNETT, M. M., J. J. MCNUTT, P. E. STRAHAN, AND H. TEHRANIAN (2011): "Liquidity Risk Management and Credit Supply in the Financial Crisis," *Journal of Financial Economics*, 101, 297–312.

EDELSTEIN, P. M. (1991): "Effective Letters of Intnent and Commitment Letters," *Journal of Commercial Bank Leding*, 73.

GERSBACH, H. AND J.-C. ROCHET (2017): "Capital Regulation and Credit Fluctuations," *Journal of Monetary Economics*, 90, 113–124.

GERTLER, M. AND C. S. LOWN (1999): "The Information in the High Yield Bond Spread for the Business Cycle: Evidence and Some Implications," *Oxford Review of Economic Policy*, 15, 132–50.

GETTER, D. E. (2014): "U.S. Implementation of the Basel Capital Regulatory Framework," *Congressional Research Service Report*, 1–33.

GILCHRIST, S., V. YANKOV, E. ZAKRAJŠEK, AND E. ZAKRAJSEK (2009): "Credit market shocks and economic fluctuations: Evidence from corporate bond and stock markets," *Journal of Monetary Economics*, 56, 471–493.

GILCHRIST, S. AND E. ZAKRAJŠEK (2012): "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, 102, 1692–1720.

GIOVANNI, F., S. GILCHRIST, K. F. LEWIS, E. ZAKRAJSEK, G. FAVARA, S. GILCHRIST, K. F. LEWIS, AND E. ZAKRAJŠEK (2016): "Recession Risk and the Excess Bond Premium," *FEDS Notes*.

GORDY, M. B. AND B. HOWELLS (2006): "Procyclicality in Basel II: Can we treat the disease without killing the patient?" *Journal of Financial Intermediation*, 15, 395–417.

HANSON, S. G., A. K. KASHYAP, AND J. C. STEIN (2010): "A Macroprudential Approach to Financial Regulation," *SSRN eLibrary*.

HEID, F. (2007): "The Cyclical Effects of the Basel II Capital Requirements," *Journal of Banking and Finance*, 31, 3885–3990.

IVASHINA, V. AND D. S. SCHARFSTEIN (2010): “Bank Lending During the Financial Crisis of 2008,” *Journal of Financial Economics*, 97.

JIMENEZ, G., J. A. LOPEZ, AND J. SAURINA (2009): “Empirical Analysis of Corporate Credit Lines,” *Review of Financial Studies*, 22, 5069–5098.

KASHYAP, A. K., R. RAJAN, AND J. C. STEIN (2002): “Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-Taking,” *Journal of Finance*.

KASHYAP, A. K. AND J. C. STEIN (2000): “What Do a Million Observations on Banks Say About the Transmission of Monetary Policy?” *American Economic Review*, 90, 407–428.

——— (2004): “Cyclical Implications of the Basel II Capital Standard,” *Economic Perspectives*, 18–31.

KIM, D. AND W. SOHN (2017): “The effect of bank capital on lending: Does liquidity matter?” *Journal of Banking and Finance*, 77, 95–107.

MORGAN, D. P. (1998): “The Credit Effects of Monetary Policy: Evidence Using Loan Commitments,” *Journal of Money, Credit and Banking*, 30, 102–118.

NG, J. AND S. ROYCHOWDHURY (2011): “Do Loan Loss Reserves Behave like Capital? Evidence from Recent Bank Failures,” *SSRN eLibrary*.

PARK, K. Y. (2012): “Interstate Banking Deregulation and Bank Loan Commitments,” *The B.E. Journal of Macroeconomics (Advances tier)*, 12.

PARK, K. Y. AND D. LEE (2017): “Bank Loan CommitmentUsage and the Flight toQuality during the Financial Crisis,” *SSRN eLibrary*.

REPULLO, R., J. SAURINA, AND C. TRUCHARTE (2010): “Mitigating the Pro-Cyclicality of Basel II,” *Economic Policy*, 25, 659–702.

SUFI, A. (2009): “Bank Lines of Credit in Corporate Finance: An Empirical Analysis,” *Review of Financial Studies*.

Table 1: Bank Balance Sheet at time $(t-1)$ and t

This table shows a simple version of a bank's balance sheet at time $(t-1)$ and t with laws of motion for loans (L) and unused commitment (UC).

B/S at time $(t-1)$		B/S at time t	
Assets	Liabilities	Assets	Liabilities
S_{t-1}		$S_t \equiv S_{t-1} + \Delta S_t$	
L_{t-1}		$L_t = (1-\delta_{it}-\rho_{it})L_{it-1} + N_{it} + z_{it}UC_{i,t-1}$	

off B/S: UC_{t-1}

off B/S: $UC_t = (1-z_{it})UC_{i,t-1} + NC_{it}$

Table 2: Descriptive statistics

All the variables are defined as the ratio to bank total assets, except capital adequacy ratio (CAR) and non-performing loans (NPL). Nonperforming loans are defined as the ratio of loans over 90 days late, plus loans not accruing, to total loans. COM is the ratio of total unused loan commitments to total assets and CICOM is other unused loan commitments to total assets. 'COM, $>$ 1yr' is total unused loan commitment whose maturity is longer than one year, divided by total assets. The numbers are average values in each size categories. Large banks are the top 1 percent in terms of average assets during 2001:II-2009:IV and small banks refer to ones in the bottom 99 percent. Panel (a) is for the whole sample period, panel (b) is for the pre-crisis period, and panel (c) is for the Great Recession period based on NBER's business cycle dating. Some exclusion criteria, discussed in the text, are applied to remove outliers in the sample. Source: authors' calculation based on the call report.

	total loan	(cash+security)	COM	CICOM	COM, $>$ 1yr	CAR	NPL	core deposit	N
(a) sample period: 2001Q1 - 2009Q4									
small	0.626	0.235	0.413	0.194	0.135	0.128	0.013	0.13	2,638
large	0.65	0.27	0.113	0.061	0.027	0.166	0.013	0.215	259,934
all	0.65	0.27	0.116	0.062	0.028	0.165	0.013	0.214	262,572
(b) sample period: 2001Q1 - 2007Q3									
small	0.627	0.238	0.401	0.201	0.138	0.128	0.01	0.131	2,081
large	0.644	0.276	0.115	0.06	0.026	0.167	0.01	0.222	196,797
all	0.644	0.276	0.118	0.062	0.027	0.166	0.01	0.221	198,878
(c) sample period: 2007Q4 - 2009Q2									
small	0.627	0.211	0.435	0.172	0.129	0.125	0.021	0.125	440
large	0.673	0.248	0.113	0.063	0.031	0.163	0.019	0.193	49,396
all	0.673	0.248	0.116	0.064	0.031	0.163	0.019	0.192	49,836

Table 3: **Fixed effects regression using TED spread**

This table reports estimation results of equation (7) by groups: whole sample, large banks, and small banks from 2001:II to 2009:IV. The dependent variable is bank capital adequacy ratio (CAR). TED is the difference between the interest rates on interbank loans and on T-bills. COM_{it} is the share of unused amount of total loan commitments to assets of a bank i at time t. Time fixed effects and Fed district dummies are included. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value$<$0.10, p-value$<$0.05, and p-value$<$0.01, respectively.

	(1)	(2)	(3)
Dependent variable:	All	Large	Small
capital adequacy ratio (CAR)	banks	banks	banks
TED_{t-1}	0.004***	-0.005	0.004***
	(6.42)	(-1.02)	(6.51)
$TED_{t-1}\Delta COM_{it}$	0.006**	0.074*	0.006*
	(1.97)	(1.75)	(1.87)
$COM_{i,t-1}$	-0.008	-0.03	-0.006
	(-1.55)	(-1.11)	(-1.19)
share of nonperforming loans	-0.097***	0.046	-0.097***
	(-8.26)	(0.301)	(-8.23)
log(assets)	-0.034***	-0.027*	-0.034***
	(-26.33)	(-1.69)	(-26.37)
(cash+securities)/assets	-0.016***	0.113	-0.017***
	(-3.11)	(1.47)	(-3.40)
transaction deposits/assets	-0.209***	-0.107*	-0.212***
	(-29.48)	(-1.88)	(-29.67)
loans/assets	-0.172***	0.018	-0.173***
	(-34.90)	(0.29)	(-35.74)
BHC-affiliation	-0.006***	-0.013	-0.006***
	(-3.80)	(-0.75)	(-3.73)
R^2	0.301	0.302	0.304
N	251,249	2,493	248,756

Table 4: **Responses of bank assets to increased loan takedown**

This table reports fixed effects panel regression results based on two groups from 2001:II to 2009:IV: large banks and small banks. Time fixed effects and Fed district dummies are included. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.

	Dependent variable			
	$\ln$(risk-weighted assets)		$\ln$(total assets)	
	(1)	(2)	(3)	(4)
	Large banks	Small banks	Large banks	Small banks
TED_{t-1}	0.067	-0.025***	0.031	-0.040***
	(1.44)	(-8.91)	(-0.69)	(-15.43)
$TED_{t-1}\Delta COM_{it}$	-0.233**	-0.174***	-0.549**	-0.297***
	(-2.05)	(-4.31)	(-2.45)	(-5.35)
$COM_{i,t-1}$	-0.140	0.015	-0.318***	-0.134***
	(-1.55)	(0.44)	(-3.42)	(-4.06)
share of nonperforming loans	2.511	-0.042	2.249	0.086
	(1.28)	(-0.44)	(1.35)	-0.91
(cash+securities)/assets	0.315	-0.158***	0.256	0.047
	(0.82)	(-4.09)	-0.71	-1.22
transaction deposits/assets	-0.225	-0.824***	-0.233	-0.685***
	(-1.02)	(-16.86)	(-0.98)	(-13.88)
loans/assets	0.251	0.612***	-0.399	0.057
	(0.82)	(15.76)	(-1.37)	(1.47)
CAR	-3.115***	-2.482***	-2.915***	-2.067***
	(-5.55)	(-40.51)	(-4.72)	(-33.33)
BHC-affiliation	0.162	0.192***	0.165	0.198***
	(0.98)	(12.33)	(0.69)	(13.22)
R^2	0.626	0.614	0.627	0.540
N	2,493	248,756	2,493	248,756

Table 5: **Regressions with other interacted variables**

This table reports fixed effects panel regression results with other interacted variables from 2001:II to 2009:IV. Results of other control variables that are not interacted with TED spread are included (but not reported). Time fixed effects and Fed district dummies are included. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value$<$0.10, p-value$<$0.05, and p-value$<$0.01, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	Large	Small	Large	Small
bank capital ratio (CAR)	Banks	banks	Banks	banks
TED_{t-1}	-0.006	0.005***	-0.005	0.005***
	(-0.61)	(5.22)	(-0.50)	(4.75)
$TED_{t-1}\Delta COM_{it}$	0.081***	0.010***	0.080***	0.017***
	(6.26)	(6.44)	(6.06)	(10.38)
$TED_{t-1}\times$	-0.038	-0.064***	-0.038	-0.070***
Δ(share of loan charge-offs)$_{it}$	(-0.46)	(-7.37)	(-0.46)	(-8.14)
$TED_{t-1}\times$	-0.002	-0.069***	-0.015	-0.058***
Δ(share of nonperforming loans)$_{it}$	(-0.02)	(-12.58)	(-0.16)	(-10.70)
$TED_{t-1}\times$			-0.057***	-0.105***
Δ(share of transaction deposit)$_{it}$			(-3.14)	(-40.07)
$TED_{t-1}\times$			0.087***	-0.003
Δ(share of (cash+securities))$_{it}$			(5.76)	(-1.53)
$TED_{t-1}\times$			0.046**	-0.088***
Δ(share of loans)$_{it}$			(2.48)	(-39.08)
R^2	0.249	0.248	0.262	0.258
N	2,493	248,756	2,493	248,756

Table 6: **Effect of other loan commitments**

This table reports estimation results of equation (7) using other loan commitment. $CICOM_{it}$ is the share of unused amount of other loan commitments to assets of a bank i at time t. Time fixed effects and Fed district dummies are included. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	Large	Small	Large	Small
capital adequacy ratio (CAR)	banks	banks	banks	banks
TED_{t-1}	-0.007	0.004***	-0.008	0.005***
	(-1.40)	(6.51)	(-0.85)	(4.96)
$TED_{t-1}\Delta CICOM_{it}$	0.213***	0.012***	0.239***	0.014***
	(3.41)	(2.73)	(11.4)	(6.85)
$TED_{t-1}\times$			-0.056	-0.062***
Δ(share of loan charge-offs)$_{it}$			(-0.69)	(-7.25)
$TED_{t-1}\times$			0.013	-0.066***
Δ(share of nonperforming loans)$_{it}$			(0.14)	(-11.96)
$COM_{i,t-1}$	-0.029	-0.005	-0.021***	0.001
	(-1.14)	(-1.16)	(-7.08)	-0.85
share of nonperforming loans	0.022	-0.097***	-0.066	-0.119***
	(0.16)	(-8.24)	(-1.26)	(-32.44)
log(assets)	-0.025*	-0.034***	0.000*	-0.000***
	(-1.72)	(-26.38)	(1.65)	(-24.76)
(cash+securities)/assets	0.101	-0.017***	0.103***	-0.021***
	(1.45)	(-3.40)	(9.75)	(-15.02)
transaction deposits/assets	-0.098*	-0.212***	-0.096***	-0.215***
	(-1.92)	(-29.67)	(-11.71)	(-151.43)
loans/assets	0.011	-0.174***	0.025**	-0.188***
	(0.19)	(-35.76)	(2.43)	(-139.87)
BHC-affiliation	-0.017	-0.006***	-0.023***	-0.014***
	(-0.90)	(-3.73)	(-3.16)	(-37.42)
R^2	0.324	0.304	0.277	0.250
N	2,493	248,756	2,493	248,756

Table 7: **Effects of changes in loan loss provision**

This table reports fixed effects panel regression results with considering loan loss provisioning from 2001:II to 2009:IV. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value$<$0.10, p-value$<$0.05, and p-value$<$0.01, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	Large	Small	Large	Small
capital adequacy ratio (CAR)	banks	banks	banks	banks
TED_{t-1}	-0.005**	0.000	-0.003	0.000
	(-2.46)	(-1.01)	(-0.96)	(-1.15)
$TED_{t-1}\Delta COM_{it}$	0.076***	0.011***	0.225***	0.016***
	(5.99)	(6.27)	(9.64)	(6.89)
$TED_{t-1}\times$	-0.051	-0.093***	-0.469	-0.201***
Δ(share of loan loss provision)$_{it}$	(-0.38)	(-6.87)	(-1.53)	(-5.66)
$TED_{t-1}\times$	0.050	0.017	-0.141	0.069*
Δ(share of loan charge-offs)$_{it}$	(0.29)	(1.14)	(-0.25)	(1.95)
$TED_{t-1}\times$	0.014	-0.063***	0.357*	-0.015
Δ(share of nonperforming loans)$_{it}$	(0.15)	(-11.39)	(1.75)	(-1.44)
loan loss reserve $\geq$ 1.25% of RWA	No	No	Yes	Yes
R^2	0.244	0.250	0.379	0.248
N	2,493	248,756	1,616	143,501

Table 8: **Fixed effects regression using credit spread**

This table reports estimation results of equation (8) using the alternative measure. $Spread$ is the credit spread between Baa and Aaa corporate bond yields. Time fixed effects and Fed district dummies are included. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.

	(1)	(2)	(3)	(4)
Dependent variable:	Large	Small	Large	Small
capital adequacy ratio (CAR)	banks	banks	banks	banks
$Spread_{t-1}$	-0.001	0.003***	0.000	0.003***
	(-0.15)	(5.13)	(0.08)	(4.55)
$Spread_{t-1}\Delta COM_{it}$	0.044***	0.007***	0.040***	0.013***
	(9.23)	(6.94)	(8.25)	(11.93)
$Spread_{t-1}\times$	-0.004	-0.070***	0.000	-0.073***
Δ(share of loan loss provision)$_{it}$	(-0.11)	(-12.94)	(0.01)	(-13.63)
$Spread_{t-1}\times$	-0.126**	-0.054***	-0.104*	-0.045***
Δ(share of nonperforming loans)$_{it}$	(-2.15)	(-16.18)	(-1.78)	(-13.60)
$Spread_{t-1}\times$			-0.039***	-0.088***
Δ(share of transaction deposit)$_{it}$			(-3.93)	(-52.72)
$Spread_{t-1}\times$			0.053***	-0.006***
Δ(share of (cash+securities))$_{it}$			(5.74)	(-4.53)
$Spread_{t-1}\times$			0.043***	-0.074***
Δ(share of loans)$_{it}$			(3.54)	(-54.27)
R^2	0.264	0.251	0.279	0.268
N	2,493	248,756	2,493	248,756

Table 9: **First-difference GMM with instrumental variables**

This table reports the result of first-difference GMM with instrumental variables. Columns (1) and (2) reports the estimates from using the moment condition $E_t[TED_{t-3}\Delta u_{it}] = 0$ and columns (3) and (4) uses the moment condition $E_t[TED_{t-3}\Delta u_{it}] = 0$ with the lagged dependent variable. Time fixed effects and dummies for Fed district and BHC-affiliation are included.

	(1)	(2)	(3)	(4)
Dependent variable:	Large	Small	Large	Small
bank capital ratio (CAR)	banks	banks	banks	banks
$CAR_{i,t-1}$			0.801***	0.727***
			(68.14)	(152.48)
TED_{t-1}	0.003***	-0.002***	0.000	0.000
	(5.84)	(-28.15)	(0.75)	(0.83)
$TED_{t-1}\Delta COM_{it}$	0.061***	0.016***	0.020***	0.000
	(11.97)	(14.33)	(3.39)	(-0.31)
$COM_{i,t-1}$	-0.020***	0.009***	-0.007***	-0.018***
	(-11.55)	(7.98)	(-3.79)	(-16.20)
share of nonperforming loans	0.340***	-0.287***	0.115***	-0.171***
	-16.11	(-41.17)	(5.55)	(-26.95)
log(assets)	-0.028***	-0.017***	0.000	0.003***
	(-19.44)	(-38.21)	(0.26)	-8.08
(cash+securities)/assets	0.100***	-0.116***	0.001	0.030***
	(15.89)	(-28.80)	(0.15)	(8.14)
transaction deposits/assets	-0.112***	-0.429***	-0.019***	-0.045***
	(-20.65)	(-86.63)	(-3.61)	(-8.34)
loans/assets	0.015**	-0.272***	0.001	-0.034***
	(2.02)	(-70.95)	(0.11)	(-8.35)
Number of instruments	876	1,054	1,276	1,612
Arellano-Bond test for $AR(1)$	0.00	0.00	0.00	0.00
Arellano-Bond test for $AR(2)$	0.62	0.00	0.98	0.00
Sargan overidentifying test	0.00	0.00	0.00	0.00

Table 10: **Other Robustness Tests**

This table reports various FE estimation results for checking robustness. For columns (1) and (2), we use the non-positive values of ΔCOM. Columns (3) and (4) shows the estimation results based on banks that present in the sample more than 8 quarters. Columns (5) and (6) provide estimates when states of Delaware, New York, and South Dakota are excluded. For columns (6) and (7), we excldue the period of the recent financial crisis. The sample period is 2001Q2-2007Q2. t-values based on robust standard errors are reported in parenthesis. *, **, *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	non-positive ΔCOM		more than 8 quarters		without some states		before GFC	
capital adequacy ratio (CAR)	large	small	large	small	large	small		
TED_{t-1}	-0.006	0.005***	-0.003	0.004***	-0.002	0.005***	-0.006	0.011***
	(-0.61)	(4.97)	(-0.26)	(4.16)	(-0.20)	(5.11)	(-0.14)	(2.73)
$TED_{t-1}\Delta COM_{it}$	0.086***	0.005**	0.078***	0.009***	0.081***	0.010***	0.178***	0.015***
	(4.98)	(2.43)	(5.97)	(5.54)	(6.02)	(5.81)	(8.71)	(3.13)
$TED_{t-1}\times$	-0.023	-0.062***	-0.139	-0.065***	-0.005	-0.060***	-0.370*	-0.219***
Δ(share of loan charge-offs)$_{it}$	(-0.28)	(-7.18)	(-1.51)	(-7.46)	(-0.06)	(-6.84)	(-1.87)	(-6.06)
$TED_{t-1}\times$	-0.008	-0.065***	-0.034	-0.062***	0.262*	-0.066***	-2.708***	-0.061***
Δ(share of nonperforming loans)$_{it}$	(-0.09)	(-11.91)	(-0.35)	(-11.24)	(1.73)	(-12.07)	(-4.77)	(-2.68)
R^2	0.244	0.250	0.251	0.247	0.302	0.252	0.329	0.19 0
N	2,493	248,756	2,448	246,461	2,110	241,354	1,893	179,434

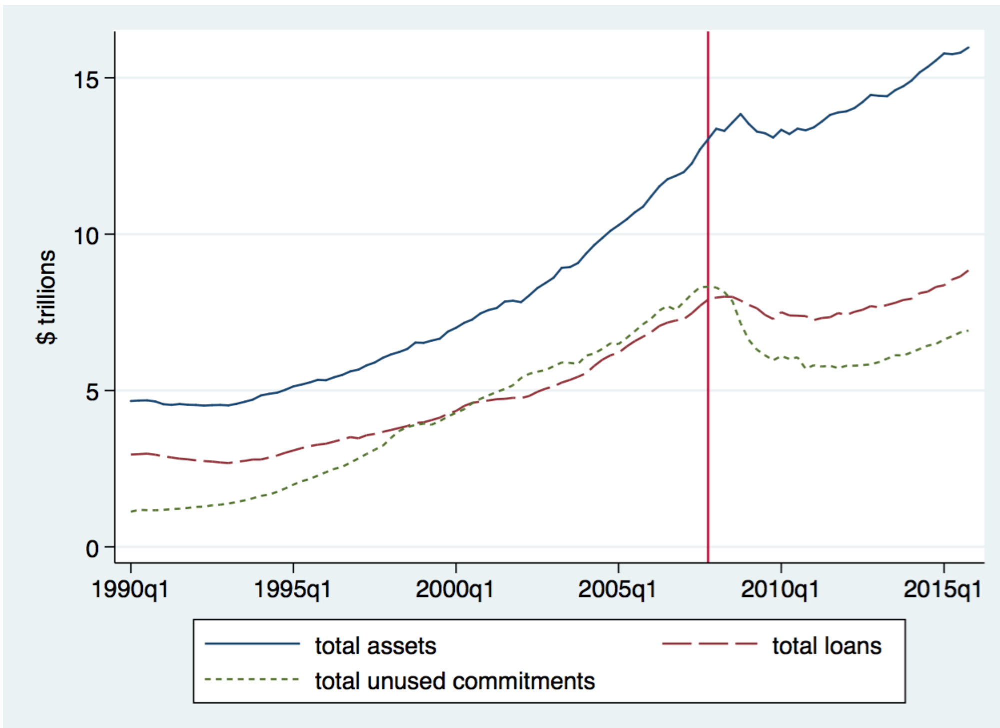

Figure 1: **Increased Use of Loan Commitments**

This figure shows the time trends of total assets, total loans and leases, and total unused amount of bank loan commitments of all U.S. banks. Source: FDIC Quarterly Bank Profile (https://www.fdic.gov/bank/analytical/qbp/)

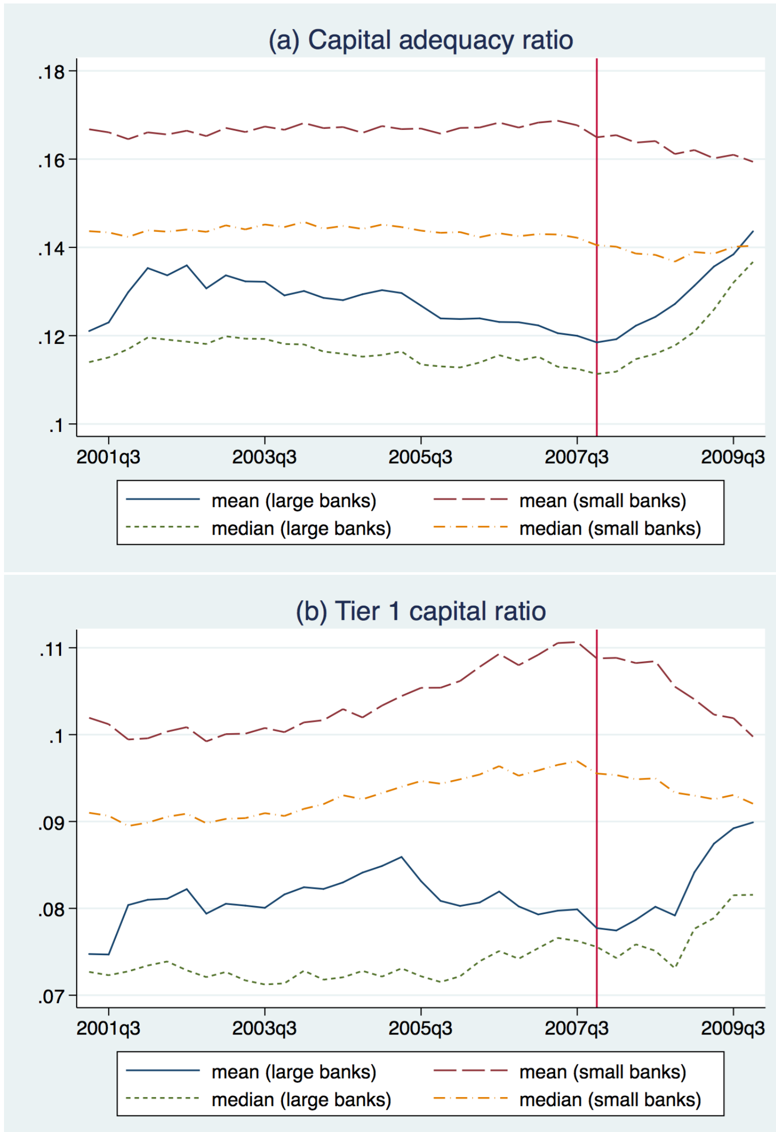

Figure 2: **Capital Adequacy Ratio and Tier 1 Captial Ratio**

This figure shows the time trends of CAR (capital adequacy ratio) and tier 1 capital ratio from 2001:II to 2009:IV. CAR is defined as (total risk-based capital/net risk-weighted assets) and tier 1 capital ratio is the ratio of tier 1 capital to bank assets. Total risk-based capital equals the sum of tier 1 and tier 2 capital for most banks. Large banks are the top 1% banks in terms of average assets during the sample period. Source: authors' calculation based on the call report.

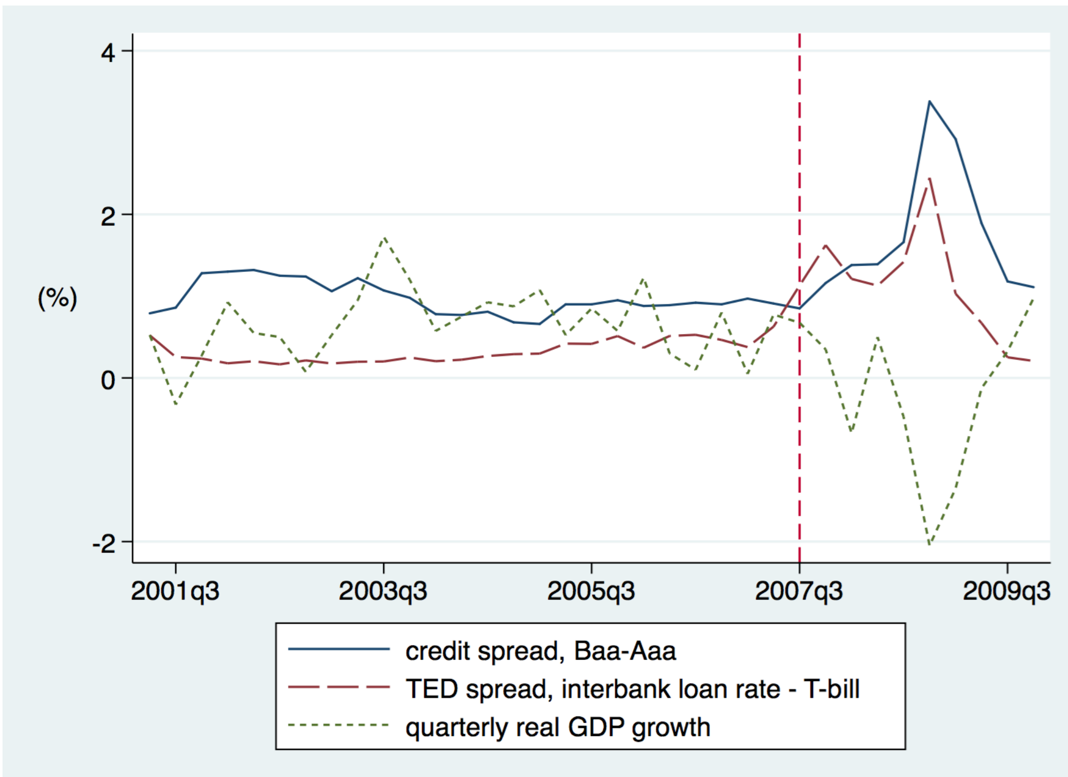

Figure 3: **Credit Spread and Paper-Bill Spread**

This figure shows the time-series of TED spread and credit spread between Baa and Aaa corporate bond yields from 2001:II to 2009:IV. Source: Federal Reserve Economic Data (http://research.stlouisfed.org/fred2/)

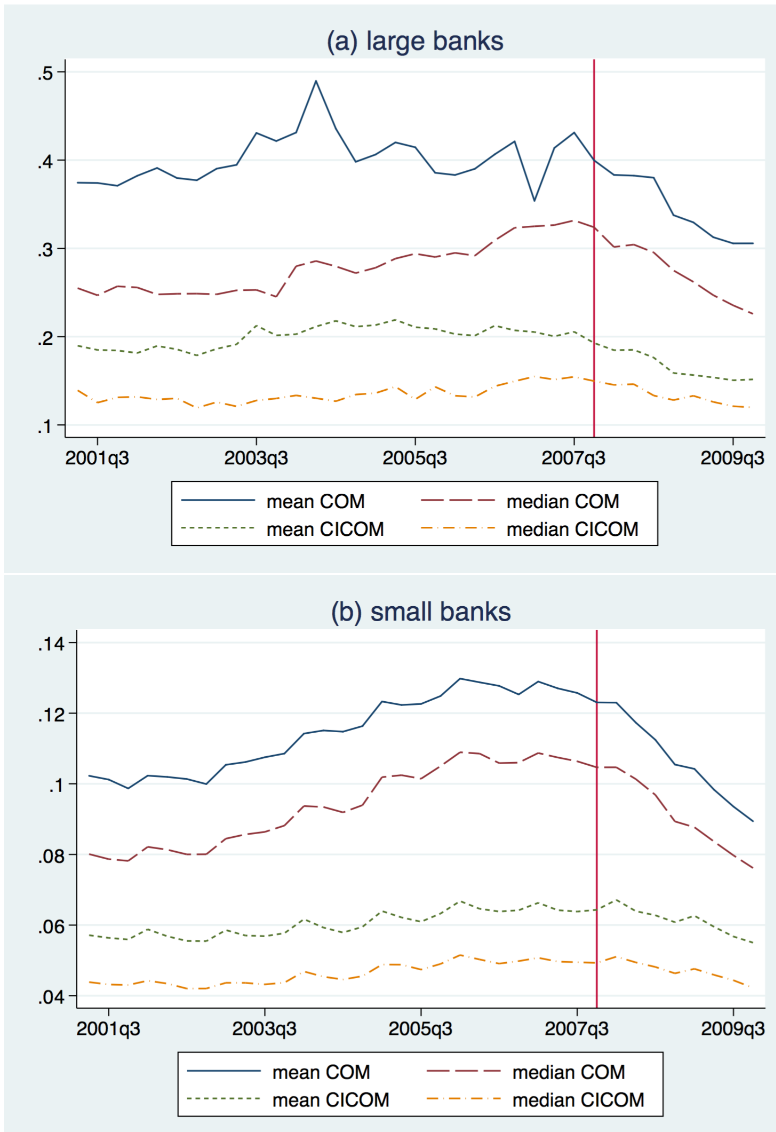

Figure 4: **Ratios of Total and Other Loan Commitments to Assets**

This figure shows the time trends of COM and CICOM variables. COM is defiend as the share of total unused loan commitments to assets. CICOM is defined as the share of other unused loan commitments to assets.Large banks are the top 1% banks in terms of average assets during the sample period. Source: authors' calculation based on the call report.