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The Impact of Securitization and Bank Liquidity Shocks on Bank Lending: Evidence from the U.S.

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The Impact of Securitization and Bank Liquidity Shocks on Bank Lending: Evidence from the U.S.

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The securitization expansion preceding the 2007-2009 financial crisis introduced alternative liquidity sources and increased bank lending capacity. During the securitization expansion there was a rise and subsequent collapse of the subprime mortgage market. We investigate the impact of securitization and the subprime mortgage collapse on bank lending during the crisis. The results suggest that securitization, for the large and money-center bank, is a cost effective liquidity source since traditional bank funding costs play a diminished role in the supply of bank lending. We find that for the small and medium bank samples increases in REPO rates fostered lending during the crisis period. We show that real estate lending exposure negatively affects bank lending in the sample of small and medium banks suggesting a liquidity building behavior for these banks.

JEL classification: E44; G21
Keywords: Bank Lending, Securitization, Subprime Mortgage Market, Dynamic Panel Data Methods

1. Introduction

The origin of the securitization markets[1] dates to the 1970s with the U.S. economy witnessing explosive growth in this market since its inception until the advent of the 2007-2009 financial crisis. Funds flow account data underscores the significant growth in U.S. securitized home mortgages, which increased from U.S. $27.7 billion as of 1976Q1, a starting period for the home mortgage securitization market, to U.S. $6.4 trillion as of 2007Q4. This represents an average annual growth rate of 18.7% over a time-span of almost thirty-two years. The securitization phenomenon has transformed the way in which financial intermediation takes place. In recent years, the banking model has changed in that banks originate loans that are pooled, tranched, and eventually resold through the securitization process. Under the new banking model, large investors that supply bank funds (e.g. mutual funds,

[1] Securitization is a process of creating and issuing new financial instruments such as debt securities or bonds whose payments of principal and interest derive from cash flows generated by a separate pool of assets. Typically, the pool of assets that are initially owned by commercial banks are transferred to a separate legal entity known as a special purpose vehicle (SPV).

sovereign wealth funds, large cash-rich companies) receive collateral to protect their investments since insured banks cannot offer government-backed deposit insurance to these investors[2].

The stage was set prior to the 2007-2009 financial crisis with historically low interest rates and lax credit markets. This was reminiscent of the first national bubble in U.S. home prices, during the Great Depression of the 1930s. By mid-2007 the correction in the housing market led banks to report substantial losses and to take significant write downs of their real estate mortgage portfolios as a result of rising delinquencies and home-value reductions. The rising loan delinquencies are arguably a consequence of an increase in non-traditional lending characterized by loose requirements on borrowers' income verification to support mortgage repayment ability and minimal down payment requirements. Some claim that the real estate mortgage-backed securities market fueled the housing bubble, providing increased financing of these high-risk non-traditional loans through the securitization process. Others conclude that the housing, securitization, and repo markets were at the nexus of the financial crisis.

Surprisingly, scant literature investigates the impact of securitization on bank lending. Altunbas et al. (2009) draws from a large data set of euro-area banks from 12 countries during 1999-2005, examining the impact of securitization on the effectiveness of the bank lending channel (BLC) and the banks' ability to grant loans. They conclude that securitization shelters banks' loan supply from the effects of monetary policy and strengthen banks' capacity to supply new loans; however, this capacity is conditioned on business cycle conditions and banks' risk positions. Using a data set of U.S. banks and a sample period from 1976Q1 to 2007Q4, Loutskina (2011) introduces a novel bank-level index that estimates bank loan portfolio liquidity to examine the impact of securitization on bank liquidity and lending management. She finds that securitization allows banks to reduce holdings of liquid securities which increases lending ability. Furthermore, securitization offers banks an additional funding source making bank lending less sensitive to cost of funds shocks. Neither of these papers, however, capture the cost of securitization in modeling loan behavior. The above papers imply that the effectiveness of securitization as an alternative funding source for banks hinges on the strength (and liquidity) of the securitization market. While it is well known that the housing bubble and subsequent burst was at the heart of the 2007-2009 financial crisis, the Loutskina (2011) specification does not control for this important variable. Further, the study ends at the early stages of the 2007-2009 financial crisis, and thus the results may not reflect the full impact of the financial crisis.

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[2] In practice this form of collateralized transaction between an investor and the bank is commonly referred to as a repurchase (REPO) agreement. The investor purchases some asset from the bank (i.e. the collateral) at an agreed upon price with the understanding that the bank will repurchase the same asset sometime in the future at a higher pre-established price with the difference representing the investment gains.

This paper expands the literature by investigating the impact of securitization and the subprime mortgage collapse on bank lending in the midst of the 2007-2009 financial crisis employing methodologies from the (BLC) literature. Examining the effect of securitization on bank lending is interesting since active securitization markets represent an important alternative liquidity source that enhances lending capacity as suggested by Loutskina (2011). Researchers including Cornett et al. (2011), however, suggest that in times of crisis, banks tend to build up liquidity reserves, which could infringe on lending, as part of an overall strategy to manage liquidity risk including risk due to a loss of short term financing. An understanding of how the subprime mortgage market collapse affects bank lending is important for policy makers, bank regulators, and investors. Loose monetary policy, cheap money, and aggressive lending contributed to both the boom and subsequent bust of the housing market and the fall of the subprime mortgage market. A deeper understanding of commercial bank behavior, including its lending activities, is driven by their role in stimulating business and economic activity. In times of financial crises, losses tend to spread across financial institutions thus jeopardizing the well-being of the financial system with negative repercussions for the economy and the business community as a whole.

We contribute to the literature in several distinct ways. First, we re-examine empirical models of lending behavior given the securitization phenomena that transformed the bank intermediation process. Our empirical lending models, unlike previous studies, incorporate a REPO spread variable backed by securitized bonds (where the collateral consists mainly of real estate mortgage-backed securities) to assess whether these new channels of bank liquidity represent a sustainable alternative to more traditional sources of bank funding. The work of Gorton and Metrick (2012) implies that traditional bank run on deposits that disrupted the banking system dating back to the days of the banking panic of the early 1930s have been replaced by a run in the REPO markets. Regressing various credit spreads and REPO spreads on a series of control variables including the LIBOR-OIS spread, a measure of counter-party risk which was statistically significant, the authors conclude higher bank solvency uncertainty and lower values of REPO collateral. Second, in contrast to previous studies the sample period from 2005Q1 to 2010Q4 covers economic expansion (including the peak period of the housing bubble), the subsequent bust of the recent U.S. financial crisis, and the following mild recovery. The sample period also covers an important transition the financial industry experienced that deals with a changing banking model that eventually led to new forms of bank runs. Third limited attention has focused on how the subprime mortgage market collapse impacted bank lending. Drawing from rich empirical work on the BLC and employing individual bank-level data and macroeconomic variables, we assess the presence of a BLC incorporating a bank liquidity shock caused by the subprime mortgage market crisis. The subprime mortgage crisis arguably generated an exogenous liquidity supply shock that is uncorrelated with firm loan demand.

We apply dynamic panel data methods to a sample of banks following a four-size classification scheme based on asset size that yields 4,982 small banks, 475 medium banks, 34 large banks, and 14 money-center banks to examine commercial lending behavior over a sample period 2005Q1 to 2010Q4. We show that traditional bank funding costs play a diminished role in the supply of bank lending in the larger bank samples (large banks and money-center banks) and a positive impact of the repurchase agreement (REPO) market rates on bank lending is prevalent in the smaller bank samples (small and medium banks), suggesting increases in REPO rates foster lending during the crisis period. We also find real estate lending exposure negatively affects bank lending in the small and medium bank samples.

The remainder of the paper is organized as follows: Section 2 presents the literature review focusing on bank lending behavior during the crisis, and Section 3 describes the data and sources and presents descriptive statistics. Our methodology and empirical model is presented in Section 4 and Section 5 puts forth our hypotheses. Section 6 discusses the results, and we present the conclusions in Section 7.

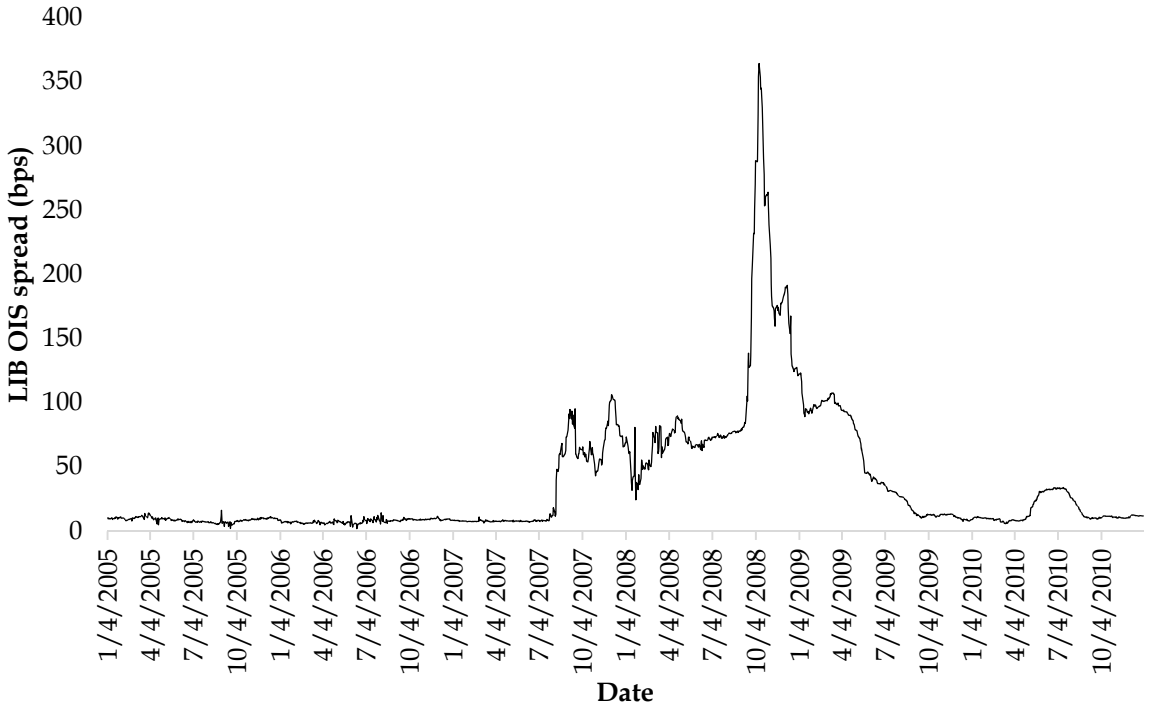
2. Literature Review

Recent literature that examines the securitization market is motivated by its explosive growth, the banks' increased dependency on the financial markets as a source of funding, and the impact that this market had on the U.S. banking system during the 2007-2009 financial crisis. An important implication of the securitization process as suggested by Altunbas et al.(2009) is that while bank-financed projects may be illiquid, the underlying loan, if eligible, may be sold which in turn provides the originating bank with a new source of financing. Researchers including Brunnermeier and Pedersen (2009), Shleifer and Vishny (2010), Brunnermeier and Sannikov (2011) and Korinek (2011) provide the theoretical framework tied to the new securitization-based banking model with emphasis on the measurement of systemic risk and stress testing. Collectively, these studies propose a bidirectional relationship between asset-market liquidity and traders-funding liquidity. They also introduce the phenomena of amplification effects through various channels including the REPO markets and posit a positive relationship between securitization and banks' real investments, concluding that financial markets are pro-cyclical. The implication of amplification effects as posited by theory provides further support for the modeling specifications presented in our research.

Cecchetti (2009) claims that the triggering event of the financial crisis took place in August 2007 when the large French bank BNP Paribas suspended redemptions from three of its investment funds since it could not reliably value the assets backed by U.S. subprime mortgage debt held in those funds. Gorton and Metrick (2012) define the subprime mortgage market as a financial innovation created to provide housing finance to disproportionately poor and minority individuals with some combination of spotty credit histories, a lack of income verification or no money for

a down payment. The symptom of this crisis is also captured through the 3 month LIBOR-OIS spread, which is a common proxy in the literature for counterparty risk (refer to Figure I). We argue that this event introduced a liquidity shock to the banks that was unrelated to business fundamentals while highly related to problems arising from housing mortgages.

Figure I LIBOR-Overnight Index Swap (OIS) Spread

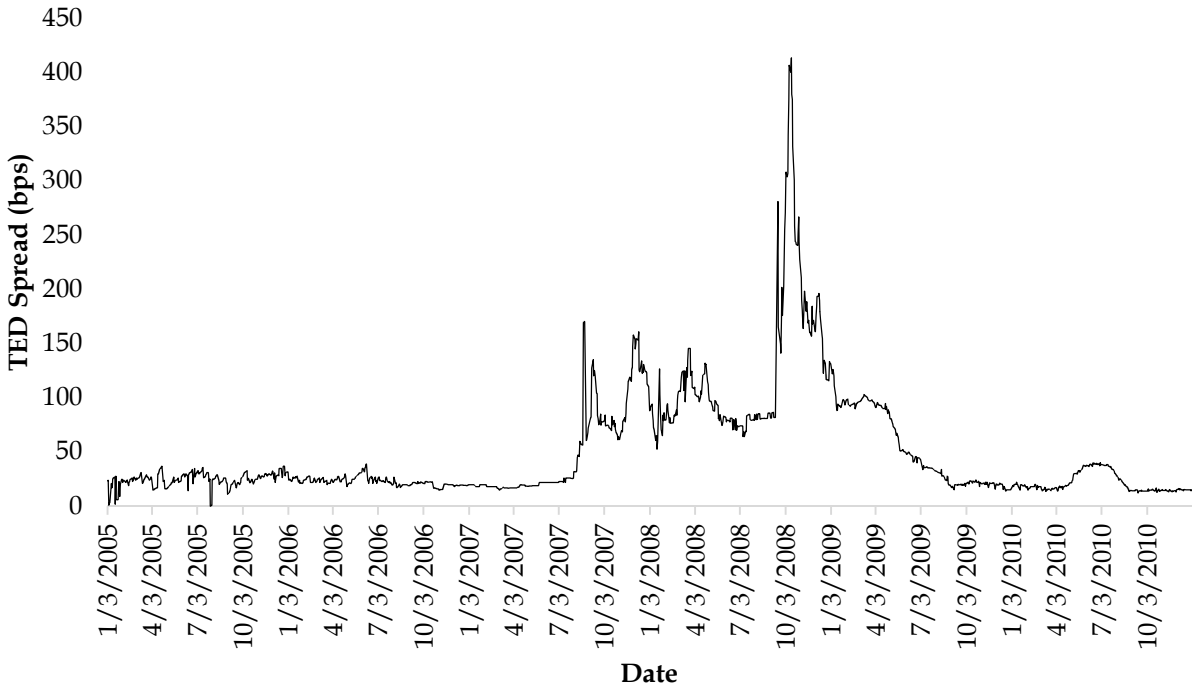


Source: The 90 day London Interbank Offered Rate (LIBOR) series US0003M and the Overnight Index Swap (OIS) series USSOC Curncy are expressed in daily frequency and downloaded from the Bloomberg database http://www.bloomberg.com. The spread was computed by subtracting the OIS series from the LIBOR series. The author computes a quarterly average LIBOR-OIS spread series from the daily data. The quarterly series is used for model purposes. The OIS rate is a commonly used measure of investor expectations of the effective federal funds rate. The LIBOR rate is expected to reflect credit risk and the expectations on future overnight federal funds rates.

Figure II, which depicts the TED spread, provides a similar story to that of Figure I while also capturing the liquidity crunch that evolved during the crisis. Brunnermeier (2009) provides a comprehensive chronology of the 2007-2009 financial crisis and introduces the concept of "amplification effects" in connection with the housing bust through various channels. He points out that prior to the 2007-2009 financial crisis, banks were heavily exposed to maturity mismatch through liquidity backstop credit facilities granted to their off-balance sheet vehicles and through their increased reliance on the REPO markets. By mid-2007 a reduction in

funding liquidity and investors' reluctance to purchase mortgage/asset-backed paper placed enormous pressure on the financial system. Using large syndicated loan data to examine the impact of the financial crisis on bank lending, Ivashina and Scharfstein (2010) point out that the meltdown of the subprime mortgage market in turn raised concerns about the solvency and liquidity of financial institutions. This unfolded into a full-scale banking panic linked to short-term creditors and bank corporate borrowers following the failures of Lehman Brothers' and Washington Mutual, the government takeovers of Fannie Mae and Freddie Mac, and government intervention in AIG during the latter part of 2008Q3.

Figure II TED Spread



Source: The 90 day London Interbank Offered Rate (LIBOR) series USD3MTD156 N and the 90 day U.S. Treasury Bill series DTB3 are expressed in daily frequency and downloaded from the Federal Reserve Economic Data (FRED) database available through the Federal Reserve Bank of Saint Louis http://research.stlouisfed.org/fred2/ The TED spread was computed by subtracting the U.S. Treasury Bill series from the LIBOR series. The author computes a quarterly average TED spread series from the daily data. The quarterly series is used for model purposes. The TED spread is viewed as an indicator of perceived credit risk in the economy.

The focus of our research bears resemblance to the studies by Khwaja and Mian (2008), Paravisini (2008), Cornett et al. (2011) and Egly and Mollick (2013). These authors exploit significant events to determine whether liquidity shocks related to these events impact bank lending. To understand the impact of bank liquidity shocks

on the economy, Khwaja and Mian (2008) apply a fixed-effects methodology to loan-level panel data from 1996-2000 on corporate lending in Pakistan. They find a significant bank-lending channel for all borrowing firms and that larger firms borrow from other unaffected banks, thus are able to attenuate the impact of a supply-side liquidity shock. Examining government allotments granted over the 1993-1999 time-frame to banks in Argentina, Paravisini (2008) finds that banks expand lending in response to the added dollars of external financing. Based on a sample of 111 banks that received the government allotments and loan data for over 220,000 firms and individuals, he also concludes that financial constraints prevent banks from undertaking profitable lending opportunities and that these opportunities are not arbitraged by other competing lenders.

Drawing from the population of insured commercial banks in the U.S. between 2006Q1 and 2009Q2, Cornett et al. (2011) find that banks that relied heavily on core deposits and equity capital continued to lend during the financial crisis relative to other banks while banks that held higher levels of illiquid assets chose to increase asset liquidity and reduce lending. They also find that off-balance sheet liquidity risk materialized onto the banks' balance sheets and curbed new lending since increased takedown demand displaced lending capacity. Egly and Mollick (2013) apply dynamic panel data methods to a subsample of 100 banks that are CPP recipients over a period from 2008Q3 to 2009Q4 and find a modest impact on lending by only the largest banks. They conclude that CPP's business objectives to boost loan growth and stimulate business activity during the financial crisis are unmet.

The modeling of bank-lending behavior would be incomplete if we ignored the credit channel of monetary policy transmission in our empirical framework. The existence of balance sheet and bank-lending channels that are encompassed within the credit channel are captured by Bernanke and Gertler (1995) and Mishkin (1995). The aforementioned authors claim that the balance-sheet channel (BSC) stresses the potential impact of changes in monetary policy on borrower's balance sheets and income statements while the bank-lending channel (BLC) focuses more narrowly on the potential effect of monetary policy on the supply of bank loans. They assert that according to the credit-channel theory, the direct effects of monetary policy actions on interest rates are magnified by endogenous changes in the external finance premium, which is defined as the cost differential arising from funds raised externally (equity or debt issues) compared to internally-generated funds (i.e. retained earnings). The nature and focus of our paper leans towards a detection of a BLC as opposed to a BSC, since the latter would typically require a data set comprised of non-financial firms that is not compiled for purposes of this research. However, as pointed out by Bernanke and Gertler (1995) an increase in bank holdings of volatile securities and derivative instruments may have also increased the sensitivity of bank lending to interest rates via the BSC. Finally, our paper acknowledges that this research indirectly measures the impact of a credit channel on the economy through

our econometric methodology that allows for reverse causation effects from lending to economic output.

3. Data and Descriptive Statistics

The sample draws from the population of commercial banks that are insured through the Federal Deposit Insurance Corporation (FDIC) over the sample time frame 2005Q1 to 2010Q4. The bank information used is originally documented in Consolidated Reports of Condition and Income "call reports" that are submitted by insured banks on a quarterly basis. The call reports that commercial banks file are Federal Financial Institutions Examination Council (FFIEC) forms FFIEC-031 or FFIEC-041. The choice of the FFIEC form is dictated by the geographic scope of the bank's business (i.e. domestic offices only file FFIEC-041 or domestic and foreign offices file FFIEC-031). The bank data employed in our paper is available through Federal Deposit Insurance Corporation statistics on depository institutions (SDI) database at the following website: http://www2.fdic.gov/sdi/index.asp (last accessed on 8/15/2012).

Since our paper works with bank-level data, we used data from the lead bank in the case of multibank holding companies (BHC). In many instances the lead bank commonly represents over 80% of the total insured assets reported by the BHC[3]. Banks with missing balance sheet and/or income information required for this study are excluded from the sample. In keeping with Loutskina (2011), to minimize the impact of outliers we eliminate all bank-quarter data with asset growth over the preceding quarter in excess of 50%, total loan growth exceeding 100%, or total-loans-to-asset ratio less than 10%. Application of the same criteria to the population of FDIC insured commercial banks removes 63,629 bank quarters from the initial data set[4].

The bank information extracted includes loan balances on various loan categories (e.g. total loans, commercial and industrial (C&I) and residential real estate loans), total assets, balance sheet liquidity measures (e.g. securities held to maturity, securities available for sale, cash and balances due, mortgage-backed securities and asset-backed securities, federal funds sold, and reverse REPOs), Tier 1 risk-based capital ratio, cost of deposits (e.g. interest expense on deposits to total deposits), and various bank-deposit measures (e.g. total deposits that include demand deposits, money market accounts, savings accounts and time deposits, and transaction

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[3] To investigate the presence of multibank holding companies (MHC), we extracted a list of the largest 150 financial institutions as of the beginning of the sample. We matched each of these institutions against the FDIC website to determine if they were MHC. The number of banks excluded that formed part of a MHC represent less than 2% of the total sample (lead banks of MHC were retained for this research).

[4] In the initial data set there were 7,895 banks reported per quarter on average vs. 5,259 in the final data set. The maximum (minimum) number of reported banks in the initial data set was 8,215 at 2007Q1and 7,223 at 2010Q4. The maximum (minimum) number of reported banks in the final data set was 5,482 at 20087Q2and 4,781 at 2005Q2.

deposits that include demand deposits and NOW accounts). Appendix A provides further description of the bank variables.

Table 1: Bank Descriptive Statistics - Panels A and B

Panel A (TA < U.S. $1 billion)					
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Asset	114203	222758.20	194982.50	50003.00	2837389.00
Net Loans	114203	151055.20	141077.60	7790.00	1414196.00
Reloans	114203	48802.37	63016.87	0.00	756515.00
Comloansdom	114203	19406.27	28146.41	0.00	1428146.00
Rmbs	114203	15771.88	31819.75	0.00	1050181.00
Abs	103615	106.47	2047.97	0.00	188895.00
Sechmat	114203	6606.14	21999.03	-250952.00	550297.00
Secfsale	114203	37180.44	47433.48	0.00	1082084.00
Depdom	114203	174128.90	158104.90	500.00	2405441.00
Cash	114203	10098.05	14622.51	-178.00	380620.00
Ffsrepo	114203	4537.98	9470.27	0.00	438438.00
Capt1r	114203	15.28	6.56	0.02	50.03
Panel B (TA ≥ U.S. $1 billion and < U.S. $20 billion)					
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Asset	10930	3398152.00	3587482.00	502046.00	32700000.00
Net Loans	10930	2293808.00	2489323.00	127300.00	22300000.00
Reloans	10930	733581.00	1330553.00	0.00	19900000.00
Comloansdom	10930	360635.00	562568.00	0.00	4850149.00
Rmbs	10930	400613.00	716410.00	0.00	17100000.00
Abs	9152	8169.00	74016.00	0.00	2354260.00
Sechmat	10930	122859.00	450698.00	-183326.00	11800000.00
Secfsale	10930	546362.00	801322.00	0.00	8178007.00
Depdom	10930	2442229.00	2509636.00	0.00	30100000.00
Cash	10930	141478.00	276098.00	10.00	4592160.00
Ffsrepo	10930	45343.00	154659.00	0.00	2850000.00
Capt1r	10930	12.30	5.02	0.00	50.00

Notes: All bank variables are expressed in levels and in thousands of dollars with the exception of our Tier 1 risk-based capital variable (capt1r) which is in ratio form. The descriptive detail is on four sub samples of banks (panels A through D) measured by average total assets over the sample period. The sample covers from 2005Q1 to 2010Q4. Bank variable definitions are detailed in Appendix A: Bank Variables. The bank data was downloaded from Federal Deposit Insurance Corporation (FDICs) statistics on depository institutions (SDI) database: http://www2.fdic.gov/sdi/index.asp. The SDI information is extracted from quarterly call reports (FFIEC form FFIEC-031 for banks with domestic and foreign offices or form FFIEC-041 for banks with domestic offices only).

Table 1: Bank Descriptive Statistics – continued - Panels C and D

Panel C (TA ≥ U.S. $20 billion and < U.S. $90 billion)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Asset	779	45900000.00	24800000.00	1582921.00	169000000.00
Net Loans	779	27500000.00	16000000.00	1141757.00	125000000.00
Reloans	779	8770274.00	7697717.00	0.00	39800000.00
Comloansdom	779	5627078.00	5647719.00	0.00	25900000.00
Rmbs	779	5439802.00	7402032.00	0.00	50100000.00
Abs	598	770379.00	2017680.00	0.00	18500000.00
Sechmat	779	1092533.00	2958350.00	-1532625.00	25100000.00
Secfsale	779	7711980.00	8968807.00	0.00	68300000.00
Depdom	779	28700000.00	18800000.00	901085.00	136000000.00
Cash	779	2914472.00	5149576.00	361.00	38800000.00
Ffsrepo	779	1011476.00	2286952.00	0.00	18000000.00
Capt1r	779	12.75	6.78	6.25	47.72

Panel D (TA ≥ U.S. $90 billion)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Asset	322	443000000.00	471000000.00	50900000.00	1770000000.00
Net Loans	322	225000000.00	206000000.00	22400000.00	732000000.00
Reloans	322	84900000.00	92300000.00	3052000.00	377000000.00
Comloansdom	322	48400000.00	45800000.00	1985000.00	182000000.00
Rmbs	322	46000000.00	54500000.00	1903217.00	253000000.00
Abs	322	3743973.00	6136682.00	0.00	29200000.00
Sechmat	322	1701747.00	6204059.00	0.00	47400000.00
Secfsale	322	67100000.00	79100000.00	3430433.00	354000000.00
Depdom	322	205000000.00	201000000.00	26800000.00	838000000.00
Cash	322	27300000.00	40100000.00	1112825.00	228000000.00
Ffsrepo	322	29300000.00	64100000.00	0.00	302000000.00
Capt1r	322	8.76	1.72	6.13	15.17

Notes: All bank variables are expressed in levels and in thousands of dollars with the exception of our Tier 1 risk-based capital variable (capt1r) which is in ratio form. The descriptive detail is on four sub samples of banks (panels A through D) measured by average total assets over the sample period. The sample covers from 2005Q1 to 2010Q4. Bank variable definitions are detailed in Appendix A: Bank Variables. The bank data was downloaded from Federal Deposit Insurance Corporation (FDICs) statistics on depository institutions (SDI) database: http://www2.fdic.gov/sdi/index.asp. The SDI information is extracted from quarterly call reports (FFIEC form FFIEC-031 for banks with domestic and foreign offices or form FFIEC-041 for banks with domestic offices only).

Following the approach used by Verma and Jackson (2008), the bank sample is divided into four groups based on average total asset size as follows: small banks (average total assets < U.S. $1 billion), medium banks (average total assets ≥ U.S. $1 billion and < U.S. $20 billion), large banks (average total assets ≥ U.S. $20 billion and < U.S. $90 billion) and money-center banks (average total assets ≥ U.S. $90

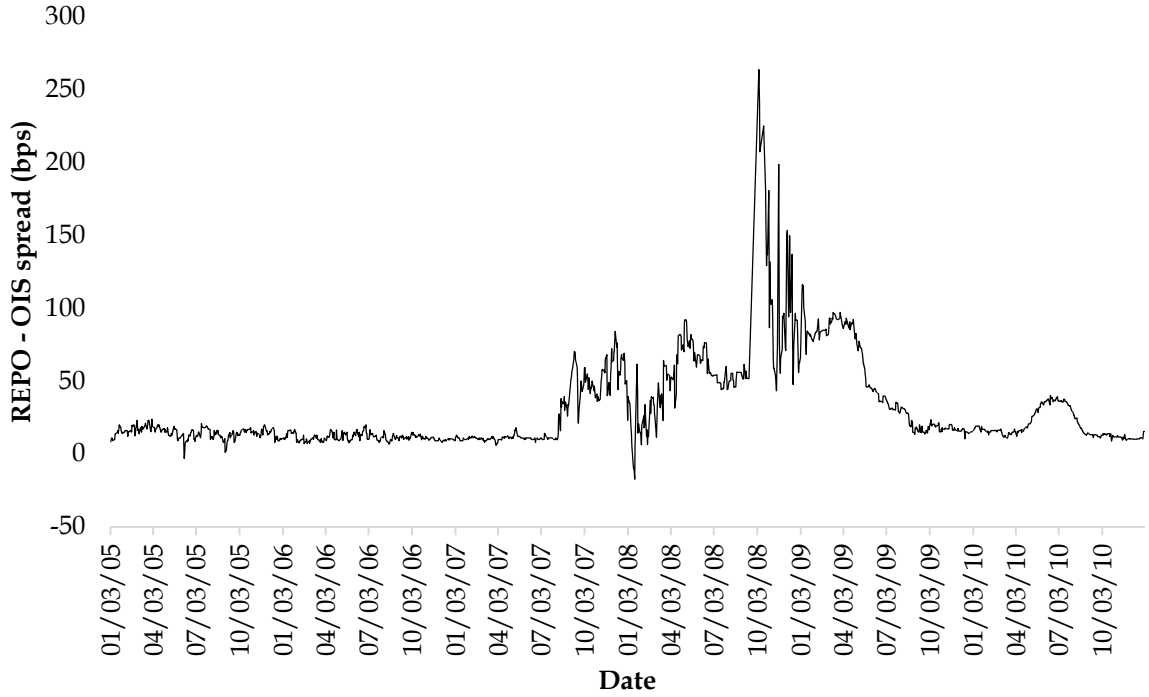
billion).Table 1 presents descriptive information on the banks classified in the four groups following the four-size classification scheme. Some interesting results emerge under this alternative bank classification scheme. When scaled by mean total assets, banks' exposure to total loans (net loans) declines as overall bank size rises. For example, the ratio of total-mean-loans-to-mean-assets is 0.678 for small banks identified in Table 1 Panel A, while this ratio falls to 0.599 for large banks shown in Table 1 Panel C. This finding is consistent with the view that bank size has typically affected the type of activities that banks engage in. For example, small banks generally focus on the retail side of banking, while large banks tend to emphasize wholesale banking. With the exception of the money-center banks (as shown in Table 1 Panel D) it is equally interesting that the exposure to commercial loans, scaled by bank mean total assets, rises as overall bank size increases. The ratio of mean-commercial-loans-to-mean-assets increases from 0.087 for small banks to 0.106 for medium banks and to 0.123 for large banks before dropping to 0.109 for money-center banks. This result is also consistent with the large banks' tendency to focus on wholesale activities that include lending to larger corporations to support their capital expenditure and operating capital requirements, while small banks tend to lend to smaller and less sophisticated customers. The banks' investments in real estate mortgage (rmbs) and asset-backed securities (abs) scaled by total assets increases with bank size. These ratios increase from 0.071 to 0.104 and from 0.000 to 0.008 for rmbs and abs respectively for small banks compared to money-center banks. Analysis of the federal funds sold and securities purchased under agreements to resell (frepo) scaled balances reveals a similar finding: the ratio increases from 0.020 to 0.066 when small banks are compared to money-center banks.

On the balance sheet's liability side the domestic deposits (depdom), scaled by mean total assets, and bank capitalization ratios (capt1r) decline as bank size increases. The ratio of mean-domestic-deposits-to-mean-assets decreases from 0.782 for small banks to 0.463 for money-center banks. This finding supports the view that larger banks have greater access to capital and money markets, including REPOs, compared to their smaller counterparts. The findings suggest that large banks operate with lower equity capital ratios compared to small banks and that large banks tend to rely more on purchased funds such as Federal funds and lower levels of core deposits.

The main variable of interest includes REPO spreads collateralized by real estate mortgage-backed securities. The REPO spread is the difference between the 90-day REPO rate for a given bond class and the Overnight Index Swap (OIS). Figure III portrays a REPO-OIS series with the collateral consisting of real estate mortgage-backed securities (rmbs). This series is based on daily frequency and covers the time frame 12/31/04 to 12/31/10. Brunnermeier (2009) suggests that banks rely on REPO markets in addition to other markets such as the commercial paper, federal funds, and interbank markets to finance their activities. Based on Figure III the REPO-OIS spread is at its widest point during the peak period of the crisis between 2007Q3 and

2008Q4. Gorton and Metrick (2012) suggest that by late summer 2007 an initial shock had occurred that negatively impacted the securitization markets in particular high-grade tranches that commonly served as collateral in the REPO markets. Figure III illustrates the full impact of the crisis during the second half of 2008. This period included events such as the Lehman Brothers and Washington Mutual bankruptcies and AGI's U.S. government bailout in September, as well as the TARP U.S. government bailout in October 2008.

Figure III REPO-(OIS) Spreads R/E Backed Collateral



Source: The 90 day Repurchase Agreement (REPO) series RPMB03M with collateral consisting of real estate mortgage backed (RMBS) and the Overnight Index Swap (OIS) series USSOC Curncy are expressed in daily frequency and are downloaded from the Bloomberg database http://www.bloomberg.com. The spread was computed by subtracting the OIS series from the REPO series. The author computes a quarterly average REPO-OIS spread series from the daily data. The quarterly series is used for model purposes. The REPO markets allow banks and other market participants to obtain collateralized funding by selling owned securities while agreeing to repurchase them at loan maturity.

The REPO spread series and 90-day LIBOR-OIS spread are downloadable from Bloomberg's database: http://www.bloomberg.com (data retrieved on 8/15/2012). The TED spread series are downloadable from the Federal Reserve Economic Data (FRED) database available through the Federal Reserve Bank of Saint Louis: http://research.stlouisfed.org/fred2 (data retrieved on 8/15/2012). To control for loan demand we include a real GDP growth rate (RGDP) variable. The Real Gross

Domestic Product (RGDP) growth rate variable is computed using quarterly data on RGDP expressed in Billions of Chained 2005 Dollars (Series GDPC1), available from the U.S. Department of Commerce: Bureau of Economic Analysis website: http://bea.gov/national/index.htm#gdp (data retrieved on 8/15/2012). To proxy for the stance of monetary policy we incorporate the effective federal funds rate that is available through Federal Reserve Bank of Saint Louis: http://research.stlouisfed.org/fred2 (data retrieved on 8/15/2012) and is measured in monthly frequency. A quarterly FEDFUNDS series is formed from the monthly series since the bank variables are measured in a quarterly frequency.

Table 2 Panels A through D presents contemporaneous bivariate correlations for the independent bank variables and macroeconomic variables that are employed in the lending models for the four subsamples of banks. The bank total assets are presented in log form (lta) while the liquidity (Liq I) and deposit variables (Dep I and Dep II) are scaled by total assets. The liquidity measure includes cash in banks and securities held to maturity and available for sale. Deposit I includes demand deposits, money market deposits, saving deposits, and time deposits. Deposit II is a narrower measure that captures demand deposits and NOW accounts that are collectively considered transaction deposits. Residential real estate loans (reloans) are scaled by total loans. The Tier 1 risk-based capital ratio (capt1r) and deposit cost (depcost) variables are presented in ratio form. The former represents the ratio of bank Tier-1-capital-to-total-risk-weighted-assets while the latter is the ratio of bank interest-expense-on-deposits-to-total-deposits.

Table 2 suggests that bank behavior is not necessarily fully consistent across the bank subsamples. For example, correlation between bank total assets (lta) and residential real estate loan portfolios (reloans) is moderate (0.313) for money-center banks (refer to Table 2 Panel D) yet the correlation turns to a negative for large banks (see Table 2 Panel C) and to negligible correlation coefficients for small and medium banks as shown in Table 2 Panels A and B, respectively. Another interesting correlation pattern emerges between the liquidity variable and total assets in the four bank subsamples. The moderate and negative correlation of -0.156 for the small banks in Table 2 Panel A suggests that increases in liquidity are not accompanied by a contemporaneous increase in balance sheet assets, and thus increases in liquidity may simply have been part of an effort to recapitalize the banks whose balances sheets had been negatively impacted by losses. It is puzzling that the correlation matrix reflects a negative relationship between the deposit variables and total assets. Typically we would expect strong positive correlations between deposit variables and total assets, especially in the case of small to medium banks, given the high degree of leverage that banks typically operate with. Normally, small to medium banks are able to control the size of their balance sheet through their deposit gathering efforts which to some extent are driven by the banks' deposit pricing strategies.

Table 2: Correlation Matrix Independent Variables

Panel A Small Bank Subsample (TA < U.S. $1 billion)										
	Lta	Liq I	Dep I	Dep II	Reloans	Capt1r	Depcost	Repo-Ois	Ffr	Rgdpg
Lta	1.000									
Liq I	-0.156	1.000								
Dep I	-0.252	0.248	1.000							
Dep II	-0.417	0.286	0.636	1.000						
Reloans	0.010	0.098	-0.008	-0.029	1.000					
Capt1r	-0.175	0.324	-0.129	0.015	0.176	1.000				
Depcost	0.044	-0.057	-0.146	-0.118	0.007	-0.074	1.000			
Repo-Ois	0.034	-0.047	-0.041	-0.047	-0.038	-0.050	0.005	1.000		
Ffr	-0.113	-0.035	0.029	0.066	-0.017	0.055	0.073	-0.279	1.000	
Rgdpg	-0.039	0.047	0.042	0.047	0.036	0.053	0.014	-0.793	0.350	1.000
Panel B Medium Bank Subsample (TA ≥ U.S. $1 billion and < U.S. $20 billion)										
	Lta	Liq I	Dep I	Dep II	Reloans	Capt1r	Depcost	Repo-Ois	Ffr	Rgdpg
Lta	1.000									
Liq I	0.119	1.000								
Dep I	-0.231	-0.187	1.000							
Dep II	-0.125	0.069	0.202	1.000						
Reloans	0.004	0.234	-0.073	-0.038	1.000					
Capt1r	-0.045	0.408	-0.245	-0.060	0.168	1.000				
Depcost	-0.070	-0.153	-0.081	-0.138	-0.052	-0.056	1.000			
Repo-Ois	0.053	-0.082	-0.072	-0.108	-0.021	-0.063	0.286	1.000		
Ffr	-0.148	-0.065	-0.034	0.108	-0.008	-0.018	0.243	-0.279	1.000	
Rgdpg	-0.058	0.082	0.065	0.111	0.020	0.070	-0.096	-0.793	0.350	1.000

Panel C Large Bank Subsample (TA ≥U.S. $20 billion and < U.S. $90 billion)										
	Lta	Liq I	Dep I	Dep II	Reloans	Capt1r	Depcost	Repo-Ois	Ffr	Rgdpg
Lta	1.000									
Liq I	0.082	1.000								
Dep I	-0.151	-0.137	1.000							
Dep II	-0.037	0.159	0.067	1.000						
Reloans	-0.101	0.362	0.121	0.208	1.000					
Capt1r	-0.128	0.080	-0.296	-0.011	-0.110	1.000				
Depcost	-0.162	-0.272	0.050	-0.201	-0.120	-0.117	1.000			
Repo-Ois	0.141	-0.029	-0.030	0.000	-0.032	-0.085	0.265	1.000		
Ffr	-0.360	-0.136	-0.034	-0.046	0.011	-0.083	0.349	-0.279	1.000	
Rgdpg	-0.145	0.028	0.017	0.013	0.037	0.078	-0.082	-0.793	0.350	1.000
Panel D Money-center Bank Subsample (TA ≥ U.S. $90 billion)										
	Lta	Liq I	Dep I	Dep II	Reloans	Capt1r	Depcost	Repo-Ois	Ffr	Rgdpg
Lta	1.000									
Liq I	-0.011	1.000								
Dep I	-0.471	-0.385	1.000							
Dep II	-0.187	0.526	0.167	1.000						
Reloans	0.313	-0.443	0.324	-0.036	1.000					
Capt1r	0.116	0.426	-0.113	0.079	-0.028	1.000				
Depcost	-0.079	-0.339	-0.005	-0.279	0.033	-0.320	1.000			
Repo-Ois	0.061	-0.035	-0.035	-0.050	-0.058	-0.144	0.201	1.000		
Ffr	-0.137	-0.226	-0.084	-0.059	0.041	-0.487	0.425	-0.279	1.000	
Rgdpg	-0.061	0.022	0.006	0.049	0.057	0.086	-0.012	-0.793	0.350	1.000

Note: The bank total assets (lta) variable enters in log form. The liquidity (liq I) and deposit (dep I & II) variables are scaled by bank total assets while residential real estate loan (reloans) variable is scaled by bank total loans. Tier1 risk-based capital (capt1r) and deposit cost (depcost) variables are in ratio form. Refer to Appendix A for listing of the bank variable names and codes. Bank data was obtained from FDICs statistics on depository institutions (SDI) website http://www2.fdic.gov/sdi/index.asp last accessed pm 8/15/12. The bivariate correlations cover the entire sample period from 2005Q1 to 2010Q4. The correlation matrix includes the macroeconomic variables used in this study along with the REPO-OIS spread which is a key variable employed in this research. Author's calculations.

With the exception of the money-center bank sample reported in Table 2 Panel D, the correlation between the bank tier1 capital ratio (capt1r) and bank total assets (lta) is negative ranging from -0.045 for the medium banks in Panel B to -0.175 for small bank in Table 2 Panel A. The negative correlations do not support the view that an increase in capitalization is accompanied by a contemporaneous increase in bank lending or some other expansion of the balance sheet such as liquidity build up with a concurrent stabilization of the banks' lending portfolio. This finding also supports the view that the banking system experienced an overall period of recapitalization in part spawned by the effects of the financial crisis. Table 2 also suggests that deposit costs (depcost) and various rate measures such as the REPO-OIS spread (REPO-OIS) and federal funds rates (ffr) have the strongest correlations with bank total assets of large banks as reflected on Panel C. With the exception of the negative correlation between the REPO-OIS spread with the RGDP growth rate variable (rgdpg) of -0.793, all other correlations are either low or moderate as seen in Panels A through D of Table 2. The low to moderate correlations help mitigate any potential collinearity issues that could impact the lending models while in no model do we allow for the REPO-OIS spread and the RGDP variables to enter simultaneously.

4. Methodology

We employ dynamic panel estimation to: 1) model the effect of REPO spreads on bank- lending behavior, and 2) model the effect of bank's exposure in residential real estate portfolios on bank-lending behavior. The model incorporates various control variables including bank-specific variables measuring asset size, balance sheet liquidity, bank capitalization, deposits, and deposit costs as described in the preceding Data Section. The bank-control variables capture supply-side lending constraints that are common to bank lending models (refer to Altunbas et al. (2009) and Cornett et al. (2011)).

We also include macroeconomic variables such as a real GDP growth rate and an effective federal funds rate. The real GDP growth rate controls for loan demand (see Berger and Udell (2004) and Lei (2013)) while the interest rates series is commonly associated with the bank-lending channel (BLC) literature. The BLC posits that monetary policy may be transmitted to the real economy through its effects on bank loans and that a tightening in monetary policy diminishes firm's bank loan supply. The model is expressed as follows:

$$\Delta L_{i,t} = \beta_1 \Delta L_{i,t-1} + \beta_2 bk_{i,t} + \beta_3 RREL_{i,t} + \beta_4 repo_{t} + \beta_5 macro_{t} + \mu_i + \varepsilon_{i,t} \qquad (1)$$

where the Δ prefix indicates the change of the bank loan variable L which is expressed in log form; *bk* represents a vector of the following bank specific variables: 1) bank total assets (TA) expressed in log form, 2) a balance sheet liquidity measure (Liq) that is scaled by total assets and defined as the sum of cash in banks and securities held to maturity and available for sale, 3) bank capitalization (Cap)

measured as the Tier 1 risk-based capital ratio, 4) two deposit measures (Dep I and Dep II) that are scaled by total assets with Deposit I consisting of the sum of demand deposits, money market deposits, saving deposits, and time deposits and Deposit II capturing demand deposits and NOW accounts that are collectively considered transaction deposits, and 5) the cost of deposits (Dc) defined as the ratio of interest-expense-on-deposits-to-total-deposits; *RREL* expresses the banks' residential real estate portfolio scaled by total loans (net loans); *repo* measures the REPO-OIS spread; and *macro* represents a vector of macroeconomic variables. The *macro* vector includes an effective federal funds rate and the real GDP growth rate (RGDP). Finally, μ captures the time-invariant bank-specific effects, while ε denotes the remaining disturbance term.

Equation 1 follows the fixed effects loan specification Cornett et al. (2011) used while introducing some important improvements[5]. First, a fixed effects model assumes that agents (banks in our case) are myopic and that observations in time are independent. Our dynamic approach allows banks to behave dynamically to form expectations about future values of the variables. Moreover, as Arellano and Bond (1991) explain, our estimation is consistent with rational expectation models in which agents use all available information to form expectations. This is important because, for example, bank-specific variable expectations might affect the bank's present strategy on lending decisions. Our dynamic approach is also motivated by the fact that bank lending is a dynamic process that is driven by multiple criteria that takes into account many factors, such as business cycle conditions, bank loan portfolio performance, bank financial attributes and constraints, competition, and loan demand. Second, allowing for dynamics and our choice of estimators also helps us control for potential endogeneity. Third, the above specification introduces the *repo* spread variable which is the main variable of interest for this research. Since traditional funding costs are suspected to have a reduced impact on lending as a result of expanded securitization, equation 1 tests for this transition towards alternative bank funding sources by retaining a deposit cost variable (Dc) that is included in the vector of bank variables *bk*. Fourth, unlike Cornett et al. (2011) who incorporate a TED spread as the only macroeconomic variable, equation 1 incorporates additional *macro* variables that are commonly used in the BLC literature. The bank variables are normalized with respect to their average across all banks in a given sample similar to the specification used by Matousek and Sarantis (2009). The Tier 1 risk-based capital variable (capt1r) and the cost of deposit measure (Dc) are reported in ratio form. The normalization of the bank specific variables takes the following form:

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[5] Altunbas et al. (2009) and Matousek and Sarantis (2009) employ dynamic panel estimation to model bank lending behavior in European Countries; the basis of their models bear resemblance to the model introduced in this paper. Our model also draws from bank lending models proposed by Kishan and Opiela (2000), Ashcraft (2006), and Jayaratne and Morgan (2000) who examine lending behavior by U.S banks.

$$TA_{i,t} = \ln TA_{i,t} - \frac{\sum_i \ln TA_{i,t}}{N_t} \quad (2)$$

$$Liq_{i,t} = \frac{LiqA_{i,t}}{TA_{i,t}} - \frac{\sum_i \frac{LiqA_{i,t}}{TA_{i,t}}}{N_t} \quad (3)$$

$$Cap_{i,t} = \frac{Tier1Cap_{i,t}}{RWA_{i,t}} - \frac{\sum_i \frac{Tier1Cap_{i,t}}{RWA_{i,t}}}{N_t} \quad (4)$$

$$Dep_{i,t} = \frac{Dep_{i,t}}{TA_{i,t}} - \frac{\sum_i \frac{Dep_{i,t}}{TA_{i,t}}}{N_t} \quad (5)$$

$$Dc_{i,t} = \frac{IntE_{i,t}}{TD_{i,t}} - \frac{\sum_i \frac{IntE_{i,t}}{TD_{i,t}}}{N_t} \quad (6)$$

where $i = 1,\ldots..N$; $t = 1,\ldots..T$; and N is the number of banks and T is the time period; $TA_{i,t}$ are the total assets of bank i in quarter t; $Liq_{i,t}$ is the ratio of bank i liquid assets as defined in the data section divided by bank i total assets in quarter t; $Cap_{i,t}$ is the ratio of bank i Tier 1 capital divided by bank i total risk weighted assets (RWA) in quarter t; $Dep_{i,t}$ is the ratio of bank deposits based on various measures as defined in the data section divided by bank i total assets in quarter t; and $Dc_{i,t}$ is the ratio of bank i interest expense on deposits divided by bank i total deposits in quarter t.

While we focus on the impact of REPO spreads on bank lending, the inclusion of FFR in the model aligns with empirical research that investigates the presence of a BLC and with our underlying research purpose. We examine whether the subprime mortgage market crisis (i.e. a bank liquidity shock) impacts the supply of bank lending in a BLC framework. The intent is to capture the impact of the subprime mortgage market crisis through changes in the banks' residential real estate portfolio exposure. Under our securitization theme, *a-priori* we would expect a general tendency for larger banks to be more active in the securitization markets and rely on complex funding sources including greater use of REPO agreements. Moreover, the BLC literature suggests the BLC's effectiveness is impacted by banks' asset size, liquidity, and capital with smaller banks tending to be more responsive to monetary policy changes as measured by FFR.

We employ the system GMM (SGMM) dynamic panel data estimator proposed by Blundell and Bond (1998).[6] This estimator starts by taking first differences in

[6] We also employed the difference GMM (DGMM) dynamic panel estimator as proposed by Arellano and Bond (1991) and the central findings remain qualitatively unchanged. Blundell and Bond

equation 1 to remove the time-invariant bank-specific effects μ. Then a vector of instruments Z is needed to construct moments $E(\Delta\varepsilon Z) = 0$. Under serially uncorrelated ε, lags of the right-hand-side variables in equation 1 are valid instruments. The SGMM augments the moment conditions obtained in the difference equation with moments from the equation in levels, $E[(\mu+\varepsilon)W] = 0$. Blundell and Bond propose using lags of the right-hand-side variables in the equation in differences as instruments W.[7] Altunbas et al. (2009) points out that SGMM is efficient and consistent contingent on the absence of first-order serial correlation and the validity of the instruments. We provide two tests to validate our empirical approach. A second-order serial correlation test on the differenced error term is used to assess whether the assumption of no first-order serial correlation is met. To test the overall validity of the instrument Z and W we use the Hansen test of over-identifying restrictions.

Some of our right-hand side regressors in equation 1 are potentially endogenous. For example, an increase in bank lending funded through increased deposits or other external liabilities, *ceteris paribus*, would lead to an increase in bank total assets. Changes in lending activity may also have an effect on bank total assets because loans from an accounting perspective are included in banks' total assets. Also, findings are mixed on the causation relationship between bank lending and output. The direction of the causation between bank lending and output is based on the idea that many small bank-dependent firms are unable to access alternative forms of financing which leads to economic fluctuations. Another example deals with lending and balance sheet liquidity which might be jointly determined because banks have managerial discretion to choose both, lending and liquidity, levels simultaneously during the same period. Banks need to choose an optimal level of liquid assets to meet demands from depositors and borrowers. Based on this analysis, we model bank total assets, liquidity, and real GDP growth rate as endogenous.

To investigate the impact of the financial crisis on bank lending, we propose several specifications that expand the benchmark model. First, following Kishan and Opiela (2000) and Cornett et al. (2011), the bank sample is divided into four asset size classes to better isolate the impact of the various financial constraints on bank loan supply. Second, given the relatively high correlation of -0.793 between the REPO-OIS spread and the RGDP growth rate variable as reported in Table 2, we replace the REPO-OIS spread with the RGDP growth rate variable under alternative specifications that model bank lending behavior. Third, similar to Cornett et al. (2011), we allow for the interaction between an indicator variable identified as a *Crisis* variable to capture the impact of the financial crisis and certain bank variables such as residential real estate portfolio, bank deposits, and Tier 1 risk-based capital ratio.

(1998) point out that when the series are persistent over time, the instruments in the DGMM are weak. Hence our focus on our preferred estimator, the SGMM.

[7] We use the two-step method of moments estimator.

The *Crisis* dummy variable is assigned a value of one during the crisis period from 2007Q3 to 2008Q4 and zero otherwise. The idea behind the interaction terms is to determine whether the effects of the crisis, measured through the crisis indicator variable, operate through the bank variables. For example, banks with high risk exposure in their residential real estate portfolios would be expected to reduce new lending activity more than banks with lower risk exposure in their residential real estate portfolios during the crisis period. Fourth, we explore the asymmetric effects of the REPO-OIS spread on bank lending through its interaction with the Crisis variable. *A priori*, we would expect that during the crisis period, rising REPO-OIS spreads would have served to discourage banks from granting new bank credit, to the extent that REPO financing represents an important source of bank financing.

Since the Sargan test on the validity of over-identifying restrictions is not robust to heteroskedasticity or autocorrelation in the error terms, for model diagnostic purposes we choose to apply and report the Hansen J statistic which is a well-accepted standard specification check used with two-step SGMM. Roodman (2009b) explains that the J-test is a test of instrument validity but it can also be viewed as a structural specification test. The Hansen test is robust to the presence of heteroskedasticity and autocorrelation, but is usually weakened in the presence of a high instrument count. The number of instruments in this model is relatively low, thus deemed to not be a matter of concern. Using system GMM estimation, we have between 16 and 20 instruments depending on the model specification after imposing restrictions on the instrument matrix[8].

5. Hypotheses

We identify four testable hypotheses regarding the impact of securitization on bank lending during the 2007-2009 financial crisis. The literature proposes that development of the securitization market offers an important alternative funding source for banks, especially for the larger banks. Loutskina (2011) claims that the securitization process not only represents a substitute for on balance sheet liquidity but also serves as a mechanism to finance loans when the absence of available external financing constrains funds . The idea is that if banks can liquidate their loans to support their liquidity needs, they can also do so to supply new credit thereby making banks less dependent on the traditional funding sources. It follows that the change in the intermediation process brought upon by securitization, whereby funds

[8] The SGMM estimation was performed on STATA software using xtabond2 program code written by Roodman (2009a). Under this program code, "gmmstyle" variable list includes endogenous variables while "ivstyle" variable list includes exogenous variables. In our model, gmmstyle variables include bank total assets, liquidity, and real GDP growth. All other model variables are ivstyle variables. The collapse command restricts the number of instruments in a manner that a single instrument is created for each variable and lag distance rather than an instrument for each time period, variable, and lag distance. This is useful to support our choice of the Hansen statistic to validate the instrument list.

from ultimate suppliers (households/lenders) are channeled to the ultimate borrowers, should lead to changes in bank funding costs to the extent that banks can access this new funding source. For those banks that cannot readily access securitization markets in a cost effective manner, we expect an inverse relationship between rising bank deposit costs and bank lending. The empirical literature that explores the bank-lending channel (BLC) finds that securitization has impacted the effectiveness of monetary policy to influence the supply of bank loans. The implication is that securitization enhances bank liquidity and reduces banks' funding needs in the event of monetary tightening. This leads to our first hypothesis:

H_1: Traditional bank funding costs measured through established monetary rates play a diminished role in the supply of bank lending for larger banks. Since traditional bank funding costs are proxied by (Dc), a variable included in the vector of bank variables in equation 1, bank funding costs have a negative effect on bank lending. We hypothesize $\beta_2 \leq 0$ in equation 1with respect to (Dc) for the smaller bank samples.

Altunbas et al. (2009) suggests that the advent of securitization has likely altered bank characteristics such as size, on balance sheet liquidity ratios, and capital requirements that are usually emphasized in the literature to identify shifts in loan supply. The literature suggests that the securitization process serves to reduce regulatory capital requirements by offloading credit risk from the loan portfolio. The capital relief resulting from securitization may lead to, *ceteris paribus,* a bank loan supply increase. Therefore, an active securitization market provides banks with an additional source of both loan funding and liquidity. Loutskina (2011) suggests that as the banks' ability to securitize loans increases, their balance sheet's liquid assets holdings decreases. She also claims that since liquid funds and loans are two core components of bank assets, a decrease in liquid funds leads to an offsetting increase in lending. The literature suggests that business-cycle conditions increase securitization during economic expansion periods due to lower investor uncertainty regarding the securitized asset valuation. At the same time, banks with heavy reliance on securitization for liquidity and loan funding needs are more vulnerable to economic shocks when the market for securitized assets is disrupted. This implies that in the absence of a strong market for securitized assets, banks must hold enough liquid funds to provide liquidity to borrowers and depositors on demand. Hence, we hypothesize that:

H_2: REPO spreads narrow (widen) in times of economic expansion (contraction) and its effects on bank loan supply attenuate (intensify) during expansionary (contractionary) periods. We hypothesize asymmetric REPO effects on bank lending captured in β_4 in equation 1.

The banks' residential real estate loans are the key asset that allowed for the development of the securitization process. During the pre-financial crisis period, banks were able to sell loans to either finance their liquidity needs or fund new lending. During the financial crisis when funding liquidity dried up the residential real estate portfolio became an illiquid asset held by banks. It is plausible the subprime mortgage market collapse generated a negative liquidity shock to the banks that recorded large losses and significant write-downs in their real estate mortgage portfolios. It is also conceivable the degree of the liquidity shock would be directly related to the level of concentration in the lending portfolio tied to real estate mortgage lending and related mortgage-backed securities. Additionally, we expect that an increase in liquidity risk exposure, captured by the level of the banks' residential real estate portfolio, would hinder the banks' capacity to generate new lending. We argue that banks that are relatively illiquid during financial crises and would need to increase liquid assets holdings which would in turn restrict bank lending. Since banks choose liquidity levels and lending jointly this leads to the third hypothesis:

H_3: During the financial crisis a bank's exposure in its residential real estate lending portfolio, *RREL* scaled by total loans has a negative effect on overall bank lending. We hypothesize $\beta_3 < 0$ in equation 1.

Cornett et al. (2011) show that banks that are more exposed to liquidity risk stemming from exposure to unfunded loan commitments, the withdrawal of wholesale deposits, or the loss of other sources of short term financing tend to hoard cash and other liquid assets in times of crisis. It is expected that during recessionary periods, and certainly during a financial crisis, that non- financial firms' increased reliance on bank funding would be inversely related to their balance sheet strength measured in terms of internal liquidity. On this premise, the composition of the banks' lending portfolio would reflect the banks' degree of liquidity risk as noted above. It follows that a bank's capacity to generate new loans diminishes as its exposure to liquidity risk rises. Banks may respond by rationing credit if anticipated liquidity needs are likely to be high. Cornett et al. (2011) also point out that, based on explicit and implicit government backing, transaction deposits (a.k.a. core deposits) consisting of demand deposit accounts, NOW accounts, and certificates of deposit under the FDIC coverage threshold are unlikely to leave the banking system during a crisis. Cornett et al. (2011) find that banks with stable sources of funding (i.e. higher reliance on core deposits and equity capital) are less constrained by the financial crisis and therefore are able to continue to lend. They also suggest that during the 2007-2009 financial crisis funds were leaving the securities market and flowing into the banking system, with most of these funds going into deposit accounts. If transaction deposits, along with bank capital, represent stable sources of financing during the 2007-2009 financial crisis, then banks with higher levels of deposits and capital would

be more willing to roll down their liquidity cushions to support bank lending. This argument leads to the fourth hypothesis:

H_4: During the financial crisis bank deposits scaled by total asset have a positive effect on overall bank lending. Since bank transaction deposits are proxied by (Dep II), a variable included in the vector of bank variables in equation 1, we hypothesize $\beta_2 > 0$ in equation 1 with respect to (Dep II).

6. Results

Tables 3 through 6 present model specifications using the system GMM estimator applied to the small, medium, large, and money center bank samples respectively. The dependent variable in all models is the one period change in bank net loans and leases that enters the model in log form. These tables introduce various model specifications with Model 1 representing the benchmark model for this research. Under these specifications we allow for feedback effects from bank lending to total assets, liquidity, and real GDP growth rate variables.

Overall we find empirical support for hypothesis H_1 which suggests that traditional bank funding costs play a diminished role in the supply of bank lending for the larger banks (i.e. $\beta_2 \leq 0$ in equation 1). The negative effect of bank funding costs on bank lending is well captured in the medium bank sample under the dynamic panel specifications as reported in Table 4. Contrary to expectations, we find a positive significant relationship between bank funding costs and bank lending in the small bank sample as reported in several model specifications in Table 3. Our results are consistent with Loutskina and Strahan (2009) who point out that strong loan demand may spur an increased appetite for deposits required to fund new loans that potentially may lead to higher deposit yields (i.e. a positive relationship between deposit costs and loan growth). The fact that variability in deposit costs does not explain bank lending growth in the large and money-center samples is also consistent with H_1 since the larger banks should have greater access to the securitization markets which has become an important alternative funding source.

Evidence supports hypothesis H_2 which posits asymmetric effects of the REPO-OIS spread on bank lending (i.e. β_4 in equation 1 interacted with the crisis dummy variable). However, the results suggest the presence of asymmetric affects that are limited to the small and medium-bank samples. Since the REPO-OIS spread can be viewed as a funding cost we expect that its impact permeates across all banks that use this type of funding source that is commonly associated with larger banks. While asymmetry that is detected in the small and medium-bank samples is an interesting finding, the absence of asymmetry in the remaining bank samples is somewhat surprising. It is possible that bank lending by the larger banks is not impacted by an increase in the REPO-OIS spread due to offsetting income generated from securitization activities which include underwriting and sale of securities as mentioned by Shleifer and Vishny (2010).

Table 3: Dynamic panel models. Dependent variable: Bank lending growth, small bank sample

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Loan growth (1-lag)	0.035	0.012	0.321***	0.329***	0.311***	0.321***	0.311***	0.018
Bank Total Assets normalized	0.033***	0.035***	0.018**	0.021***	0.019**	0.021***	0.017**	0.033***
Bank Liquidity-I normalized	-0.204***	-0.169***	-0.143***	-0.112***	-0.145***	-0.114***	-0.147***	-0.206***
Bank Tier 1 Capital normalized	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bank Deposits- I normalized	0.012***		0.008***		0.008***		0.009***	0.012***
Bank Deposits- II normalized		0.015***		0.021***		0.022***		
Bank Deposit Costs normalized	0.004*	0.002	0.005*	0.002	0.005*	0.002	0.005*	0.004*
Real Estate Loans normalized	-0.254***	-0.312***	-0.182***	-0.188***	-0.187***	-0.190***	-0.182***	-0.258***
REPO-OIS Spread	0.010***	0.010***						0.000
Federal funds Rate	0.003***	0.003***	0.006***	0.006***	0.006***	0.006***	0.006***	0.003***
Real GDP Growth Rate			-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	
Crisis dummy					-0.002*	0.000	0.000	-0.004***
Real Estate Loans normalized*crisis					0.008***			
Bank Deposits- II normalized*crisis						-0.011		
Bank Tier 1 Capital normalized*crisis							-0.001***	
REPO-OIS Spread * crisis								0.012***
Hansen Test-Chi square	89.090	87.480	307.300	315.960	308.030	317.260	308.220	87.490
Prob > Chi-square	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AB(1) z	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AB(2) z	0.028	0.005	0.350	0.303	0.415	0.353	0.422	0.017

Notes: Sample period 2005Q1-2010Q4. The dependent variable net loans and leases, and bank total assets enter the models in log form. The liquidity and bank deposit measures are scaled by bank total assets while the residential real estate loan variable is scaled by bank total loans. Liquidity I includes cash in banks and securities held to maturity and available for sale. Deposit I measures domestic deposits consisting of the sum of demand deposits, money market deposits, saving deposits and time deposits. Deposit II captures demand deposits and NOW accounts aka transaction deposits. The bank Tier 1 capital and the bank deposit cost variables are expressed in ratio form. All right hand side bank variables are normalized with respect to their averages across all banks in a given sample. The models employ the Blundell-Bond (1998) two-step estimator. The Hansen tests report the orthogonal conditions of over-identifying restrictions of the instruments as a group under the null that over-identifying restrictions are valid, i.e. exogeneity of instruments. AB (1) and AB (2) refer to Arellano-Bond serial correlation tests under the null of no autocorrelation in the first differenced error terms. Corrected standard errors are reported in parentheses. The symbols *, **, and *** refer to levels of significance of 10, 5, and 1% respectively. Bank total assets, liquidity and real GDP growth are treated as endogenous in all models. The sample size of small banks is 4,982. Small banks are defined as those banks with total assets less than U.S. $1 billion as of the beginning of the sample period. There are 95,421 observations in each model run. Models 1 and 2 employ 16 instruments, Models 3, 4, and 8 use 18 instruments while Models 5, 6, and 7 use 20 instruments.

Table 4: Dynamic panel models. Dependent variable: Bank lending growth, medium bank sample

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Loan growth (1-lag)	0.200	0.351*	0.391***	0.371***	0.371***	0.351***	0.369***	0.174
Bank Total Assets normalized	0.016	0.035	0.025	0.043*	0.025	0.041*	-0.024	0.019
Bank Liquidity-I normalized	-0.213**	-0.190*	-0.124	-0.142*	-0.139*	-0.153*	-0.138*	-0.227**
Bank Tier 1 Capital normalized	-0.007***	-0.007***	-0.007***	-0.006***	-0.007***	-0.006***	-0.007***	-0.007***
Bank Deposits- I normalized	-0.230***		-0.238***		-0.237***		-0.237***	-0.227***
Bank Deposits- II normalized		0.021		0.058		0.074		
Bank Deposit Costs normalized	1.193***	-0.849***	-1.096**	-0.886**	-1.093**	-0.953**	-1.088**	-1.170***
Real Estate Loans normalized	-0.148**	-0.099	-0.122*	-0.136**	-0.133**	-0.141**	-0.131**	-0.149**
REPO-OIS Spread	0.015***	0.015***						0.000
Federal Funds Rate	0.004***	0.005***	0.004***	0.004***	0.005***	0.005***	0.005***	0.004***
Real GDP Growth Rate			0.000	0.000	0.000	0.000	0.000	
Crisis dummy					0.004	0.008***	0.008***	-0.002
Real Estate Loans normalized*crisis					0.015			
Bank Deposits-II normalized*crisis						-0.101**		
Bank Tier 1 Capital normalized*crisis							0.000	
REPO-OIS Spread * crisis								0.016***
Hansen Test-Chi square	12.600	8.380	14.710	1.670	14.020	9.960	14.060	12.900
Prob > Chi-square	0.050	0.211	0.065	0.221	0.081	0.268	0.080	0.045
AB(1) z	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.002
AB(2) z	0.884	0.115	0.248	0.286	0.285	0.329	0.287	0.958

Notes: Sample period 2005Q1-2010Q4. The dependent variable net loans and leases, and bank total assets enter the models in log form. The liquidity and bank deposit measures are scaled by bank total assets while the residential real estate loan variable is scaled by bank total loans. Liquidity I includes cash in banks and securities held to maturity and available for sale. Deposit I measures domestic deposits consisting of the sum of demand deposits, money market deposits, saving deposits and time deposits. Deposit II captures demand deposits and NOW accounts aka transaction deposits. The bank Tier 1 capital and the bank deposit cost variables are expressed in ratio form. All right hand side bank variables are normalized with respect to their averages across all banks in a given sample. The models employ the Blundell-Bond (1998) two-step estimator. The Hansen tests report the orthogonal conditions of over-identifying restrictions of the instruments as a group under the null that over-identifying restrictions are valid, i.e. exogeneity of instruments. AB (1) and AB (2) refer to Arellano-Bond serial correlation tests under the null of no autocorrelation in the first differenced error terms. Corrected standard errors are reported in parentheses. The symbols *, **, and *** refer to levels of significance of 10, 5, and 1% respectively. Bank total assets, liquidity and real GDP growth are treated as endogenous in all models. There are 475 banks in the sample of medium banks defined as those banks with total assets ranging between U.S. $1 billion and $20 billion as of the beginning of the sample period. There are 9,353 observations in each model run. Models 1 and 2 employ 16 instruments, Models 3, 4, and 8 use 18 instruments while Models 5, 6, and 7 use 20 instruments.

Table 5: Dynamic panel models. Dependent variable: Bank lending growth, large bank sample

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Loan growth (1-lag)	0.099	-0.149	-0.285	-0.247	-0.178	-0.176	-0.246	0.105
Bank Total Assets normalized	-0.019	-0.062	-0.069	-0.065	-0.056	-0.047	-0.057	-0.018
Bank Liquidity-I normalized	0.529**	0.180	0.450***	0.305	0.455**	0.351	0.443**	0.513**
Bank Tier 1 Capital normalized	-0.012**	-0.008	-0.010***	-0.008**	-0.009**	-0.008**	-0.009**	-0.011**
Bank Deposits- I normalized	-0.171		-0.267		-0.190		-0.198	-0.160
Bank Deposits- II normalized		-0.092		-0.252		-0.139		
Bank Deposit Costs normalized	1.943	1.328	1.809	1.649	1.774	1.546	1.960	1.901
Real Estate Loans normalized	0.105	0.258	0.147	0.128	0.183	0.146	0.169	0.108
REPO-OIS Spread	0.020	0.021						0.001
Federal Funds Rate	0.007	0.004	0.001	0.001	0.003	0.003	0.003	0.008
Real GDP Growth Rate			0.001	0.001	0.001	0.001	0.001	
Crisis dummy					0.047	0.024	0.025	0.006
Real Estate Loans normalized*crisis					-0.071			
Bank Deposits- II normalized*crisis						-0.173		
Bank Tier 1 Capital normalized*crisis							-0.002	
REPO-OIS Spread * crisis								0.015
Hansen Test-Chi square	2.120	2.220	3.410	4.840	4.320	5.270	3.980	2.070
Prob > Chi-square	0.908	0.898	0.906	0.775	0.827	0.729	0.859	0.913
AB(1) z	0.156	0.581	0.317	0.367	0.168	0.243	0.237	0.131
AB(2) z	0.805	0.897	0.411	0.584	0.636	0.694	0.472	0.750

Notes: Sample period 2005Q1-2010Q4. The dependent variable net loans and leases, and bank total assets enter the models in log form. The liquidity and bank deposit measures are scaled by bank total assets while the residential real estate loan variable is scaled by bank total loans. Liquidity I includes cash in banks and securities held to maturity and available for sale. Deposit I measures domestic deposits consisting of the sum of demand deposits, money market deposits, saving deposits and time deposits. Deposit II captures demand deposits and NOW accounts aka transaction deposits. The bank Tier 1 capital and the bank deposit cost variables are expressed in ratio form. All right hand side bank variables are normalized with respect to their averages across all banks in a given sample. The models employ the Blundell-Bond (1998) two-step estimator. The Hansen tests report the orthogonal conditions of over-identifying restrictions of the instruments as a group under the null that over-identifying restrictions are valid, i.e. exogeneity of instruments. AB (1) and AB (2) refer to Arellano-Bond serial correlation tests under the null of no autocorrelation in the first differenced error terms. Corrected standard errors are reported in parentheses. The symbols *, **, and *** refer to levels of significance of 10, 5, and 1% respectively. Bank total assets, liquidity and real GDP growth are treated as endogenous in all models. There are 34 banks in the sample of large banks defined as those banks with total assets ranging between U.S. $20 billion and $90 billion as of the beginning of the sample period. There are 650 observations in each model run. Models 1 and 2 employ 16 instruments, Models 3, 4, and 8 use 18 instruments while Models 5, 6,and 7 use 20 instruments.

Table 6: Dynamic panel models. Dependent variable: Bank lending growth, money-center bank sample

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Loan growth (1-lag)	-0.474	-0.523**	-0.643	-0.532	-0.727	-0.751)	-0.608	-0.628
Bank Total Assets normalized	0.044)	0.075*	0.015	0.153	-0.023	0.020	0.038	0.001
Bank Liquidity-I normalized	1.058	-0.167	1.992	-0.746	2.008	-0.355	0.092	1.366
Bank Tier 1 Capital normalized	-0.023	-0.004	-0.019	0.001	-0.024	-0.010	-0.011	-0.032
Bank Deposits- I normalized	0.849		2.242		2.289		0.798	1.161
Bank Deposits- II normalized		0.253		1.200		3.459		
Bank Deposit Costs normalized	8.473	-7.296	-5.615	-8.702	-2.496	-4.012	0.531	16.462
Real Estate Loans normalized	0.510	0.295	0.383	0.150	0.429	0.334	0.422	0.647
REPO-OIS Spread	-0.023	-0.031						-0.003
Federal Funds Rate	-0.009**	-0.009*	-0.002	0.002	0.002	0.006	-0.003	-0.005
Real GDP Growth Rate			-0.002	-0.002	-0.003	-0.003	-0.001	
Crisis dummy					-0.091	0.036	0.039	0.057***
Real Estate Loans normalized*crisis					0.380			
Bank Deposits- II normalized*crisis						-1.780		
Bank Tier 1 Capital normalized*crisis							-0.003	
REPO-OIS Spread * crisis								-0.019
Hansen Test-Chi square	1.120	1.940	2.350	6.220	2.600	6.330	2.660	1.430
Prob>Chi-square	0.980	0.925	0.969	0.622	0.957	0.611	0.616	0.964
AB(1) z	0.742	0.433	0.866	0.462	0.972	0.914	0.790	0.691
AB(2) z	0.490	0.387	0.020	0.389	0.153	0.553	0.389	0.471

Notes: Sample period 2005Q1-2010Q4. The dependent variable net loans and leases, and bank total assets enter the models in log form. The liquidity and bank deposit measures are scaled by bank total assets while the residential real estate loan variable is scaled by bank total loans. Liquidity I includes cash in banks and securities held to maturity and available for sale. Deposit I measures domestic deposits consisting of the sum of demand deposits, money market deposits, saving deposits and time deposits. Deposit II captures demand deposits and NOW accounts aka transaction deposits. The bank Tier 1 capital and the bank deposit cost variables are expressed in ratio form. All right hand side bank variables are normalized with respect to their averages across all banks in a given sample. The models employ the Blundell-Bond (1998) two-step estimator. The Hansen tests report the orthogonal conditions of over-identifying restrictions of the instruments as a group under the null that over-identifying restrictions are valid, i.e. exogeneity of instruments. AB (1) and AB (2) refer to Arellano-Bond serial correlation tests under the null of no autocorrelation in the first differenced error terms. Corrected standard errors are reported in parentheses. The symbols *, **, and *** refer to levels of significance of 10, 5, and 1% respectively. Bank total assets, liquidity and real GDP growth are treated as endogenous in all models. There are 14 banks in the sample of money-center banks defined as those banks with total assets greater than U.S. $90 billion as of the beginning of the sample period. There are 267 observations in each model run. Models 1 and 2 employ 16 instruments, Models 3, 4, and 8 use 18 instruments while Models 5, 6, and 7 use 20 instruments.

The positive and statistically significant coefficient on the interaction term reported in Model 8 (Table 3 and Table 4) suggests that during the crisis period, as the REPO-OIS spread rises, so does bank lending for the small and medium banks. This is an interesting result as our finding provides support to the theoretical model of financial intermediation proposed by Shleifer and Vishny (2010). They incorporate the effects of investor sentiment in the markets which suggests that banks have an incentive to securitize loans as long as the fees generated from loans are higher than potential losses if securitized asset prices fall. The securitization process in and of itself is fueled by loan production and, primarily in the case of investment banks, is commonly funded through REPO arrangements.

Evidence supports H_3, which states that bank's residential real estate portfolio exposure has a negative effect on overall bank lending (i.e. $\beta_3 < 0$ in equation 1). This is particularly evident in the small-bank and medium-bank sample as reported in Tables 3 and 4. . It is possible that larger banks are not subject to a reduction in lending due to benefits associated with geographical dispersion in their residential real estate portfolios that would not be evident in the small and medium bank samples. In the small-bank sample, banks with high risk exposure in their residential real estate portfolios increase new lending activity by a greater amount compared to banks with relatively lower risk exposure during the crisis period, which is contrary to expectations. The finding in the small-bank sample is in step with the institutional memory hypothesis problem proposed by Berger and Udell (2004). Under this hypothesis credit risk rises during expansionary periods since bankers have a short memory and failed to recognize prior economic slowdowns. The increased credit risk leads to eventual loan performance issues that further spiral into an economic downturn which leads banks to raise credit standards and lower credit risk accordingly.

The evidence to support H_4 that asserts a positive effect of transaction deposits on bank lending is mixed (.i.e. $\beta_2 > 0$ in equation 1). The positive effect between transaction deposits (Deposits II variable) and bank lending is well captured in the small bank sample (Table 4). The evidence that transaction deposits seem to lose importance as bank size increases is also expected since the banks' balance sheet composition, including funding sources, typically changes with bank size. An interesting finding that goes against the hypothesis is that banks with higher levels of transaction deposits reduce new lending activity by a greater amount compared to their counterparts with lower levels of transactions deposits during the crisis period. This finding is statistically significant in the medium-bank sample as shown in Model 6 (Table 4). It is important to keep in mind that, while banks with stable financing sources may be better positioned from a liquidity standpoint to support lending activity compared to less liquid and weaker capitalized banks, other factors influence lending activity such as banks' unique credit cultures, credit policy changes, evolving loan demand, banks' liquidity-risk preferences, and business sentiment. However, these factors extend beyond our paper's scope.

7. Conclusion

The 2007- 2009 financial crisis, while unfortunate, has spawned a new wave of research opportunities that are of interest to academicians, economic policy makers, regulators, bank managers, investors, and other affected parties including households and businesses. The 2007-2009 financial crisis, like previous crises, was rooted in lax monetary policy with interest rates at historic lows and was accompanied by a housing market boom and bust. What is unique to this latest financial crisis is the banking system's transformation to one of heavy dependence on securitized banking, and the ensuing Federal Reserve and U.S. Treasury intervention in an attempt to revive the frail U.S. economy.

We apply dynamic panel data methods to a sample of banks following a four-size classification scheme based on asset size that yields 4,982 small banks, 475 medium banks, 34 large banks and 14 money-center banks to assess the impact of securitization and the subprime mortgage collapse on bank lending over a sample period 2005Q1 to 2010Q4. We conclude that securitization is a cost effective liquidity source for the large and money-center banks. Contrary to initial expectations, we find that increases in the repurchase agreement (REPO) markets rates had a positive impact on bank lending during the crisis period in the small and medium bank samples. This finding suggests that banks were able to pass on rising funding costs and/or generate offsetting fee income. Consistent with our expectations, we also find that increases in bank liquidity risk exposure, captured by changes in the level of banks residential real estate portfolio, curbed banks new lending.

The findings in our paper have important implications. First, we find that banks of varying sizes do not behave in the same manner and therefore strong consideration should be given to re-assessing the existing pre-established guidelines that are used in determining a bank's level of safety and soundness. Second, even though the evidence of asymmetric effects of the REPO-OIS spread on bank lending is not common across all bank samples, the results from the small and medium-bank samples provide an important signal that merits attention. The securitization process is a lucrative venture that fueled bank lending in the pre-crisis period and that if left unmonitored by regulators can result in significant negative consequences. As Loutskina (2011) explained, the securitization process jeopardized banks' fundamental screening and monitoring roles, effectively allowing them to easily move assets off their balance sheets. Depending on the severity of the potential negative outcomes the implication of this finding extends beyond bank regulators to policy makers and investors. Furthermore, if we accept that bank losses have been adequately recognized and that banks have been appropriately recapitalized, then the stage has been set for business recovery.

Our findings lead us to contemplate the following questions: will we witness a loosening of bank credit standards to promote bank lending to help revive the

economy? Have lessons been learned from the 2007-2009 financial crisis, and are bank regulators prepared to handle the new challenges in the post-crisis era? How will an eventual contraction of the Federal Reserve's balance sheet which should hypothetically have a negative impact on liquidity in the financial system impact bank lending? These questions and many others become the springboard for ongoing research in this interesting field of study.

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