Herding Behavior in Bank Lending: Evidence from U.S. Commercial Banks

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Abstract

While numerous theories exist to explain the motivations behind herding, little empirical work has been done to document the extent that herding exists in the banks or link different hypotheses to actual bank herding behavior. This paper aims to fill the gap by applying the Lakonishock, Shleifer and Vishny (LSV) and Frey, Herbst and Walter (FHW) herding measures to the Call Report data of U.S. commercial banks during the period from 1976 to 2010 to document bank herding behavior across the various categories of loans. I find that significant herding exists and that herding level increased dramatically during the last financial crisis, which was part of an ongoing trend in increasing herding behavior witnessed since the 1970s. I then examine how herding has changed in response to changes in macroeconomic conditions and bank financial health over the past 20 year period. While clearly bank health and macroeconomic conditions are related, I find that even after controlling for macroeconomic conditions, banks tend to herd more when they are struggling. I also find that big banks tend to herd more than the small ones. This result is driven mainly by each size groups' different herding behavior in each loan categories. Overall, the results suggest that herding is motivated by declining bank performance, and are consistent with the information asymmetry and regulatory arbitrage hypothesis.

***Key words*:** Financial Institution; U.S. Commercial Bank; Bank Lending; Herding.

JEL codes : G01; G21; E32

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[1] Queen's School of Business, Queen's University, cliu@business.queensu.ca. I am grateful to Prof. Lynnette Purda for comments that helped to substantially improve the paper. I thank participants in the EFA 2012 meeting for their comments. I am responsible for all remaining errors.

1. Introduction

There has been a growing interest in the literature on herding behavior. The theoretical works try to explain the motivations behind the herding behaviors (for example, Banerjee, 1992; Birhchandani, Hirshleifer and Welch, 1992, 1998; Scharfstein and Stein, 1990; Borio, Furfine and Lowe, 2001; Acharya and Yorulmazer, 2008). Most of the empirical studies are focused on herding in the capital markets (Chang, Cheng, and Khorana, 2000), among the mutual fund managers (Wermers, 1999), hedge fund managers (Boyson, 2010), and the stock analysts (Hong & Kubik, 2004). Little empirical work[2] has been done to examine the extent that herding exists in the banking industry, in particular, in banks' lending decisions, and try to link different theoretical explanations to the actual bank herding behavior. This paper fills the gap and documents U.S. commercial banks' herding behavior across the various categories of loans that banks can choose to extend during the period from 1976 to 2010. It then examines how herding has changed in response to changes in macroeconomic conditions and bank financial health over the past 30 year period. It also studies the herding patterns among banks of different sizes.

Herding, in this paper, refers to the cases where banks make the same or similar risk-taking, management, and asset holding decisions. Herding can occur either when banks sharing the same information or facing similar circumstances rationally make similar decisions, or when banks intentionally mimic the lending behavior of each other. Herding among banks should receive explicit attention in academics and regulations. First, compared with other industries, the very industry-specific characteristics of the banking sector and regulations make it more likely for banks to herd. Changing characteristics of the banking industry, such as the shrinking number of financial institutions, the widespread reliance on short-term market instruments other than deposits to fund loan expansion, and the increasing popularity of off-balance-sheet activities could all possibly lead banks to behave similarly simultaneously or follow each other's behavior in order to take advantage of the financial innovation or the favorable market conditions. Also, the market microstructure of banks, mainly, the information asymmetries between lenders and borrowers or among banks of different types, may force the uninformed banks to follow the decisions of informed ones. In addition, the banking industry is highly regulated, compared with

[2] Exceptions are Jain and Gupta (1987), Chang, Chaudhuri, and Jayaratne (1997), Barron and Valev (2000), and Stever and Wilcox (2007).

other industries, and there are opportunities for regulatory arbitrage. As a result, banks may not optimize their decisions individually but take into account other banks' choices. Goodhart and Schoenmaker (1995) provides evidence that banks are more often rescued than liquidated in case of distress. When banks believe that they may be bailed out in case of severe financial distress, they may actually have incentives to herd, engaging in collective risk-taking and management strategies. Also, certain regulatory and governance rules such as the capital adequacy requirement that imposes boundaries on what banks can do and limits banks' decision possibilities may lead banks into similar decisions.

A second reason as to why it is important to study herding is that herding among banks may create or facilitate a number of potential problems, given the important role of banks in the economy. These problems include deterioration of lending standards, misallocation of lending resources, asset price bubbles, increased systemic risks, and exacerbation of the business cycle. For example, one of the major causes of the 2007-09 financial crisis was that financial institutions' all over the globe had been holding and trading on subprime mortgage backed securities. Bank herding behavior is one of the factors that led banks' underestimate of risk and overinvestment in mortgage lending. Bank managers revised their own forecasts on the risks and returns of a mortgage loan based on their peers' strategy. Even if some bank managers had a pessimistic view of the market and did not invest in the mortgage loan market, their shareholders may hold them responsible for lower profits in the short run; while they would not be penalized if they did invest in the market and the whole banking industry underestimated the risk level of the investment.

This paper studies banks' herding behavior in their domestic lending decisions. Specifically, I look at the five loan categories (commercial real estate loans, residential real estate loans, consumer and industrial loans, individual loans, and all remaining loans) and examine the extent to which banks deviate from the average lending decision of the banking industry and collectively increase or decrease loans to certain categories in each quarter. To test the existence of herding behavior, I apply the traditional herding measure of Lakonishok, Shleifer and Vishny (1992) (the LSV measure) and a more recent measure by Frey, Herbst and Walter (2007) (the FHW measure) to quarterly data on bank loans in the five different categories from the regulatory Call Report of all U.S. commercial banks during the period of 1976-2010. The LSV herding measure has been extensively used as a standard method in studying herding

behavior among fund managers in their equity investment decisions and the FHW measure has gained popularity since 2007. I find evidence of significant herding during the sample periods and an increasing trend of herding, especially during the 2007-09 financial crisis. The LSV and FHW measures follow similar patterns across time. The scaled FHW herding measure is always larger than the LSV measure, confirming the result of Bellando (2010) that the true herding values can be bounded by both indicators, with LSV as the minimum value and FHW as the maximum value.

Literature provides several hypotheses as to why herding occurs in the financial market. I apply these the theories in banks' lending decisions and it can be summarized as the following. First, uninformed banks—banks with inadequate wealth or having disadvantages to acquire information—tend to follow the lending behavior of informed banks (the information asymmetry hypothesis of Banerjee, 1992; Bikhchandani, Hirshleifer, and Welch, 1992, 1998). Second, the agency problem and the performance-based reward structure that limits blame in the case of collective, as opposed to individual failure of bank managers, can lead to herding behavior (Scharfstein and Stein, 1990). Third, when the overall banking system is weak or when the number of banks failing is large, banks can take advantage of the regulatory arbitrage by having more discretion in reporting loan qualities or being bailed out by regulators (Stever and Wilcox, 2007; Archaya and Yorulmazer, 2008). Therefore, banks have incentives to engage in similar lending and other operation strategies that allow banks to increase profitability without increasing the likelihood of bankruptcy, due to the explicit or implicit commitment of the lender of last resort. Forth, there is spurious herding, which argues that the changing regulatory environment or characteristics of banks over time lead to correlated behaviors of banks. If banks are more alike, they tend to make similar decisions.

In this paper, while I cannot disentangle the determining factors for banks' herding behavior, I find that the time series patterns of herding are related to macroeconomic conditions, market factors, monetary policies, and the time-variant bank characteristics, suggesting some linkages between herding and some of the proposed explanations. Regression results show that herding measures are positively related with the unemployment rate, inflation, and interest spreads that measure risk premium in the economy and in the banking system, and negatively related to banks' costs of external financing. The results indicate that banks tend to herd more during the time when economic conditions are worse or when there are more uncertainties in the

market. Herding is positively related with banks' equity ratio, a proxy for regulation on capital requirement, suggesting the possibility that regulatory approach reduces the available action space (containing potentially optimal actions) for banks where there "is always a positive probability of herding in a non-optimal action since agents cannot fine-tune their actions to their information" (Vives, 1996). Herding is negatively related to the deposits ratio, the ratio of liquid assets over total assets, banks' overall profitability, profitability from loans, and efficiency in operation, indicating that banks tend to herd more when the condition of the banking systems is less favorable. Herding is also positively related to banks' off-balance-sheet activities, which can be explained by the fact that when banks can generate more income from fees rather than interest from loans, they tend to allocate less resource to obtain information related to the traditional lending business, and therefore herd out of information concerns.

Looking at herding measures for banks of different sizes, I find a higher and more volatile level of herding among large banks. Among the large bank groups, the largest 5% of banks have the highest level of herding; and among the small bank groups, the smallest 5% of banks tend to herd more than other small bank groups. The difference in the time series behavior of herding behavior is due to the fact that banks of different sizes tend to herd in different loan categories.

Contributions of this paper will be threefold. First, herding behaviors have been modeled in theoretical works and well-documented for capital market herding; however, only a few studies have empirically investigated herding among banks[3]. This paper is the first study[4] that examines herding behavior in domestic lending decisions of all U.S. commercial banks using the most recent data. Second, this paper documents the changing characteristics of the banking industry and investigates the relationship between herding measures and macroeconomic and bank-specific variables and compares herding patterns among banks of different sizes. In doing so, this paper helps to understand the relative importance of the competing explanations of herding behavior and draws important policy implications. Third, the LSV indicator has been extensively used in the study of fund manager behaviors. This paper is one of the first studies[5] that uses the LSV measure in the setting of banks and is among the few studies that use both LSV and FHW indicators. In this sense, this paper serves as an empirical test and comparison of the LSV and FHW herding measures in the setting of the banking industry.

[3] See Section 2 for a literature review on theoretical and empirical works on bank herding.
[4] Stever and Wilcox (2007) detect herding among 30 largest bank holding companies using stock market data.
[5] Uchida and Nakagawa (2007) studies herding of Japanese banks using the LSV measure.

The remainder of the paper is structured as follows. Section 2 reviews literature. Section 3 provides detailed descriptions of data and an overview of the changing characteristics of the banking industry during the period of 1976-2010. Section 4 describes methodologies and provides evidence of herding among all banks in the sample. Section 5 examines the relations between banks' herding behavior, the macroeconomic and market factors, and banks' characteristics. Section 6 studies herding measures of banks in different size groups. Section 7 concludes.

2. Literature review

Theories provide three basic explanations for herding: the information cascade hypothesis, the reputation/compensation hypothesis, and the regulatory arbitrage hypothesis. First, information cascades arise when there is uncertainty about the accuracy of information and market participants incorporate information contained in earlier actions into their decisions (Banerjee, 1992; Birhchandani, Hirshleifer and Welch, 1992, 1998; Avery and Zemsky, 1998). For banks, Barron and Valev (2000) show that banks with less wealth tend to avoid information gathering and follow banks with more wealth that can easily get information. Therefore, smaller banks have an incentive to follow the behavior of (presumably better informed) larger banks, and banks are endogenously separated into leaders and followers.

An alternative explanation is the reputation/compensation model (Scharfstein and Stein, 1990; Devenov and Welch, 1996; Borio, Furfine and Lowe, 2001). Applying the model in the setting of banks, the reward structure of bank managers (1) limits blame in the case of collective, as opposed to individual failure and (2) gives bank managers an incentive to imitate the benchmark manager and make their optimal decisions move closer to the benchmark decision. As suggested by Kirkpatrick (2009), as commercial bank managers' remuneration systems become increasingly performance-based, banks become more susceptible to herding.

The third view is based on the regulatory arbitrage hypothesis. The model of Acharya and Yorulmazer (2008) shows that when the number of bank failures is large, the regulators find it ex-post optimal to bail out failed banks, whereas when the number of bank failures is small, surviving banks have to acquire the failed banks, increasing the possibility that the surviving ones could also fail. Therefore, banks find it optimal to herd so they can survive or fail together since surviving alone means taking the risk to acquire failed banks. Stever and Wilcox (2007)

proposes another channel through which regulations can lead to herding behaviors. They argue that bank regulators grant banks more discretion in reporting loan charge-offs and provisions when the whole banking system is weak. By being similar to each other, banks could benefit from reporting discretion when all other banks are in trouble.

Although theories provide various explanations for herding, several issues make empirical work on herding particularly difficult. First, detecting herding ideally requires the observation of actions and potentially private information—a challenge for data collection, particularly when herding is used to hide relevant information. Second, even when one does detect herding, the statistical measures document correlated behavior without regard to the underlying reasons and therefore are not able to directly test any of the suggested theoretical models.

Due to these difficulties, there are only a few papers that study herding behavior in the banking industry. In banks' lending decisions, Uchida and Nakagawa (2007) is the first study to use the LSV herding measure and is closest to this paper. They apply the LSV measure to individual Japanese banks' loans outstanding to eleven different industries during the period of 1975 to 2003 and find evidence of herding. Jain and Gupta (1987) and Barron and Valev (2000) use the Granger-causality test and find that small U.S. banks replicate the lending behavior of large U.S. banks in lending to developing countries during the 1980s and 1990s. Nakagawa (2008) finds leader-follower relationships between lending behavior of different types of Japanese banks—local banks follow major banks in urban cities and local banks follow each other in regional cities.

In a more general study of herding behavior among banks, Stever and Wilcox (2007) develop herding measures based on stock price and loan data and find evidence of herding among the 30 largest U.S. bank holding companies during the 1976 to 2005 period. In another area of banks' activities, Rajan (1994) finds evidence of herding in banks' decisions to write down assets and set aside loan loss reserves. Chang, Chaudhuri, and Jayaratne (1997) detects herding by U.S. banks in branch location decisions—new branch openings tend to follow those of other banks even after controlling for factors affecting expected profitability and such herding behavior reduces branch profits. My paper will contribute to the literature by providing empirical evidence of herding in domestic lending decisions of all U.S. commercial banks and relating herding to macroeconomic variables and bank characteristics.

3. Data and an overview of the banking industry over time

In this section I provide a detailed description of data and an overview of the banking industry over time.

3.1 Bank-level data

The primary data source I use for the bank-level data is the Federal Reserve's *Report of Condition and Income* ("call reports"). The call reports, available quarterly from 1976, contain data of all commercial banks that are regulated by the Federal Reserve System, Federal Deposit Insurance Corporation (FDIC), and the Comptroller of the Currency. Previous studies have used the loan information from the call reports to study banks' lending decisions (e.g. Berger and Udell, 2002; Stever and Wilcox, 2007; Contessi and Francis, 2009) and the balance sheet and income statement data to examine banks' conditions (e.g. Huang, 2010; Bassett et al., 2010).

Within the call report files, banks report their individual-entity lending activities. I compile a data set with quarterly balance sheet information, income statements, and risk-based capital measures for all reporting banks over the period of 1976:Q1 through 2010:Q4, covering all sample periods available in the database at the time of the writing and encompassing the 2007-09 financial crisis. I exclude all the bank-quarters with missing information on total assets and total loans. The final data set contains 1,674,392 bank-quarters. The Data Appendix contains the detailed description of the construction of the key series.

3.2 Bank conditions

In this subsection, I look at the changing characteristics of the banking industry over time. Understanding how the banking industry has changed over time is important-- it is possible that the changes in market conditions, regulatory environment, and/or characteristics of banks over time lead to correlated behaviors of banks. For example, after the deregulation of banks in the 1980s, there was a historic wave of commercial bank mergers and acquisitions that changed the composition of the banking industry and affected the way banks operate their business. There is possibility that banks have become more similar to each other after the consolidation. Under the spurious herding hypothesis, if banks are more alike, they tend to make similar decisions. Another example is banks' involvement in the off-balance sheet activities during the recent years. If banks are more involved in the off-balance sheet activities and generate more income from fees than from interest income, they may allocate less resource to the traditional lending business.

As a result, they may not be able to get enough borrowers' information by themselves or monitor the borrowers afterwards, so they follow each others' lending decisions, assuming other banks have better information.

Table 1 provides summary statistics on the changing characteristics of banks from 1976 to 2010. Panel A reports the mean[6] value for each five-year period and Panel B concentrates on the 2006-2010 period for a close look at the banking industry around the 2007-09 crisis. Part I of Panel A and B shows the number of U.S. commercial banks filing the call reports. The number of banks has dropped by almost half, from a plateau of approximately 14,400 banks that had remained stable from 1976 to 1985, to about 9,900 banks by 1995. The number further declined to about 6,500 at the end of the sample period. To further understand this decreasing trend of the number of banks, I use the Federal Deposit Insurance Corporation data to examine the details of bank mergers, failures, and new charters. The sharp decline in the number of banks starting in 1986 corresponds to a significant rise in bank mergers and failures and decline in new charters. During the period from 1976 to 2006, over 11,000 bank charters were merged out of existence, over 1,900 insolvent banks were shut down, and over 5,600 new bank charters were granted. Around the 2007-09 financial crisis (Panel B), bank failures increased significantly from the lowest historical level in 2006 of only one failure to 134 in 2009. Bank mergers also declined during the financial crisis, and the number of new charters decreased sharply from 178 in 2006 to 5 in 2010.

Part II of Panel A shows the inflation-adjusted levels of banks' total assets, total loans, total deposits, and total equity[7] with a base year of 1983. These variables had an increasing trend over the sample periods. In Panel B, I observe a drop in the total loans, from $3,217 billion in 2008 to $2,985 billion in 2009 and $2,951 billion in 2010. This is the credit crunch in the 2007-09 financial crisis, when banks held liquidity and credit were less available for borrowers.

Part III shows the asset side of the U.S. commercial banks' aggregated balance sheet. Total bank loans as a proportion of total assets increased in the late 1970s and early 1980s and kept steady around 60% until the year 2007. Banks' holding of securities over total assets fluctuated around 18% during the sample periods. The ratio of cash holdings to total assets has been trending down, which can be related to the implementation of better techniques for cash

[6] The median values and their significance are similar to the mean values.

[7] Each variable is calculated as the sum of the variable for all banks in each quarter. For example, total loans for each quarter is calculated as the sum of all loans aggregated over all banks in the sample for the quarter.

management in banks. The proportion of other earning assets has been increasing consistently. As shown in Panel B, during the 2007-09 crisis, the loan ratio decreased from about 60% in 2007 to 55% in 2010. Bank's proportion of cash holding increased as a result of the cash hoarding during the credit crunch, it then decreased slightly in 2010 as the economy began to recover.

Part IV shows the liability side[8] of banks' balance sheets. One of the most important components on banks' liability side is the equity capital. The Basel Accord in 1988 is a move toward increasing holdings of capital as a way of limiting the risk exposure of banks. The equity ratio of the banking system as a whole has been increasing through time, from 6% in late 1970s to 8% in 1993, and it experienced a further jump in 2004 to around 10% as a result of the enforcement of Basel II. It dropped slightly to 9.38% in 2008 during the recession and then increased to 11.09% in 2010 as the economy began to recover. It is also shown in the table that deposits have been losing ground to borrowed funds as a source of funding for banks. Banks rely more on market sources of funding and less on deposits to expand their loan base. The deposits ratio decreased from about 82% in the late 1970s to around 78% in 1980s, then to its historic low of 65% in 2007. Borrowed funds as a proportion of total assets have increased over time, corresponding to financial innovations and the development of the short-term money market. Borrowed funds are mainly composed of banks' off-balance sheet vehicles that raise funds by selling short-term asset-backed commercial papers (ABCP), funds raised through the short-term repurchase agreements (repo), and loans from interbank markets. The proportion of borrowed funds has increased from 6.8% in 1976 to 17% in 2007, and this ratio experienced a slight decrease in each of the 1981-82, 1990-1991 and 2001 recessions when credit market conditions were less favorable. During the most recent 2007-09 recession, the proportion of borrowed funds in total assets decreased by 5% to 12% and deposits ratio increased by 5% to 70%. This is due to the difficulties in the short-term money market, and banks having to resort to the more traditional funding method.

[8] All variables on the liability side are calculated as a proportion of total assets. This is because equity ratio is calculated as equity over total assets in the literature. Therefore, other variables are scaled by total assets as well to allow consistency. I also calculate the ratio over total liabilities, and the results are robust.

Part V shows the time series of banks' income statement variables[9]. Return on assets (ROA)[10] takes into account all banks' sources of income and therefore is used to measure the overall profitability of the banking industry. ROA increased from 0.71% in 1970s to about 1.2% in 2005. It decreased substantially in 2006, reaching a historic low of -0.10% in 2009, as a result of banks' profitability cut during the financial crisis. Net interest margin (NIM)[11] is an indicator of banks' profitability from traditional banking activities (i.e., holding deposits and lending). Banks experienced an increase in NIM before 1992 and a steady decrease thereafter until 2007. Non-interest income as a proportion of total assets is used as a proxy for banks' profitability from the off-balance-sheet activities. The ratio has increased substantially in the 1980s and 1990s, from 0.6% in 1976 to its historic high of 2.52% in 1999, and stayed steady in the early 2000s, suggesting a growing importance of off-balance-sheet activities at banks. I also look at the non-interest income as a proportion of total operating income. The ratio shows a similar increasing trend until the 2007-09 crisis, when it decreased from 28.04% to 25.66% from 2007 to 2008, then it recovered gradually. As a measure for banks' efficiency in operation, the ratio of non-interest expense to average assets decreased steadily since the beginning of the 1990s, indicating that banks are moving toward increasing efficiency with new operating technologies and financial innovations.

Part VI presents two measures for banks' loan quality—the proportion of nonperforming loans in total loans and the ratio of loan loss allowance over total loans. Nonperforming loan ratio records actual bad loans in banks and loan loss allowance ratio reflects banks' expected loss from bad loans. The nonperforming loan ratio fluctuated between 2% and 3% in the 1980s and early 1990s. It decreased to around 1% in the late 1990s and early 2000s, corresponding to favorable market conditions during the time. The ratio then increased to its historical high of 5.67% in the fourth quarter of 2009 during the 2007-09 crisis. The loan loss allowance ratio followed a similar trend over time but was more stable.

[9] All income statement variables are reported as a proportion of banks' total assets. A robustness check that looks at the ratio over banks' average assets shows no significant difference. Therefore, for easy comparison with other variables, I report the ratio over total assets in the summary statistics table.

[10] ROA is calculated as the ratio of net income over banks' average assets for each quarter. A robustness check with return on equity (ROE) shows similar results.

[11] NIM is calculated as the net interest income over banks' average assets for each quarter.

Figure 1 and Part VII of Table 1 present the composition of total loans. Figure 1 Panel A shows the proportion[12] of loans in each category and Panel B presents the inflation-adjusted real level of loans with the base year of 1983. I divide bank loans into five main categories: (1) commercial real estate loans, (2) residential real estate loans, (3) commercial and industrial loans (hereafter C&I loans), (4) individual loans, and (5) all remaining loans. The Data Appendix contains the detailed description of the definition and construction of each loan category. Panel A of Figure 1 shows that total real estate loans (the sum of commercial real estate loans and residential real estate loans) have been gaining ground. On average, 84% of real estate loans were residential real estate loans and 16% were commercial real estate loans. As a proportion of total loans, residential real estate loans have been increasing since 1985, and commercial real estate loans have remained relatively stable with a slightly increasing trend. The proportion of C&I loans has decreased significantly during the sample period, from around 38.83% in the early 1980s to 17% in 2010. C&I loans were the only loan category whose real level decreased around the early 2000s (Panel B of Figure 1), as a result of the increasing off-balance-sheet activities of banks in the 2000s. Individual loans remained steady at around 14% of total loans during the entire sample period. Panel B of Figure 1 shows that around the 2007-09 credit crunch, the inflation-adjusted real levels of loans decreased in the commercial real estate loans and C&I loans; the pattern regarding residential real estate loans and all other loans was less distinct. However, individual loans still increased during that period. Panel C-G plot the proportions of different loan categories by bank size; this is will be further discussed in Section 6 of the paper.

3.3 Macroeconomic data and monetary policy proxies

I include three standard macroeconomic variables: real GDP growth, inflation rate, and unemployment rate. The data for each of these measures were collected from the U.S. Bureau of Economic Analysis. These macroeconomic variables control for valuation in economic growth and the business cycle. Since banks' lending decisions and funds they use to support their loan expansions are affected by credit market conditions, I examine the time series pattern of different interest rates and spreads as measure for credit availability and risks.

[12] The ratios are calculated as the total loans in each category aggregated across all banks in each quarter divided by the aggregated total loans across all banks in the quarter.

To proxy the central bank's monetary policy and the cost of external financing for banks, I use the federal funds rate provided by the Board of Governors Release H.15. This proxy is advocated by Bernanke and Blinder (1992), who show that the federal funds rate captures the stance of monetary policy well because it is sensitive to shocks to the supply of bank reserves. The federal funds rate is the prevalent measure of monetary policy in empirical work. The solid line in Figure 2 shows the time series pattern of the federal funds rate. The rate increased in the late 1970s and became very volatile during the early 1980s recession; it then followed a decreasing trend. The rate increased in the favorable market conditions from 2004 to 2007. During the 2007-09 recession, the rate decreased from 5% to around 0.15% and remained at a low level in the end of the sample period.

The Libor-OIS spread[13] reflects what banks believe is the risk of default associated with lending to other banks. An increase in the Libor-OIS spread indicates the risk premium that generally increases in an environment of increased uncertainty, such as periods of financial turmoil and recession. Using the spread as a proxy for the level of the banking system's stress and uncertainties, I can relate the changes of herding behavior to market uncertainties. The dashed line in Figure 2 plots the 3-month Libor-OIS spread. The spread was quite volatile in the 1970s and 1980s. After a lengthy period of being small and relatively constant since the early 2000s, there was a sharp rise in the spread in late 2007; this is associated with market concerns that problems in the subprime mortgage market were spreading to the broader mortgage market. The spread narrowed and went back to the pre-recession level when the economy started to recover.

Another indicator of financial stress is Moody's spread between corporate bonds with Baa and Aaa ratings (the Baa-Aaa spread). Compared with Libor-OIS spread that focuses on the banking industry alone, the Baa-Aaa spread measures default risk in a more general sense. The dotted line in Figure 2 shows the time series of the Baa-Aaa spread. The Baa-Aaa spread and Libor-OIS follow a similar pattern, with the former being wider than the latter during most of the sample period, indicating a higher risk in the whole economy than on the banking industry alone.

[13] Libor (London interbank offer rate) is the rate at which banks indicate they are willing to lend to other banks for a specified term of the loan. OIS (overnight index swap) is an interest rate swap in which the floating rate is tied to an index of overnight rates and the fixed rate is a proxy for market expectations of future overnight rates, with minimal credit risk (due to the short maturity of the claim). The spread provides a measure of credit risk in the interbank market.

Both spreads, and therefore their corresponding risk premiums, increased dramatically in early August 2007, showing that the subprime mortgage problems affect risk premiums not only in the banking industry, but also the whole economy. The fact that the Libor-OIS spread was higher than the Baa-Aaa spread in the first quarter of 2008 suggests that the risks were somewhat higher in banking than in the general economy. The Baa-Aaa spread later became wider than the Libor-OIS spread, suggesting that the concerns in the real economy became more serious.

4. Measuring bank herding behavior: methodology and results

4.1 Methodology: the LSV and FHW herding measure

In this paper, I use the LSV indicator to measure banks' herding behavior as excessive concentration on increasing or decreasing bank loans to certain loan categories. The LSV indicator is considered the standard device for empirical investigations of herding behavior and has been applied to investigate herding in different contexts by numerous studies[14].

Adapting the LSV measure for bank loan decisions requires that in each quarter indexed by t, bank i has loans outstanding to category j. Let $X_{j,t}$ be the number of banks that increased loans outstanding to loan category j at quarter t and $N_{j,t}$ the number of banks that were active in category j at quarter t. If J categories of loans exist, then the LSV herding measure for a particular category j at time t is defined as:

$$LSV_{j,t} = \left|p_{j,t} - E\left[p_{j,t}\right]\right| - E\left|p_{j,t} - E\left[p_{j,t}\right]\right|$$

$$= \left|\frac{X_{j,t}}{N_{j,t}} - \frac{\sum_{j=1}^{J} X_{j,t}}{\sum_{j=1}^{J} N_{j,t}}\right| - E\left[\left|\frac{\tilde{X}_{j,t}}{N_{j,t}} - p_t\right|;\ \tilde{X}_{j,t} \sim B\left(p_t, N_{j,t}\right)\right]; \quad (1)$$

Where $p_{j,t}$ is the proportion of banks that increased loan outstanding to loan category j at quarter t. The first term in equation (1) quantifies the extent to which banks' lending policies to category j in quarter t deviates from the overall lending policy in quarter t, $E\left[p_{j,t}\right]$. The adjustment factor, $E\left|p_{j,t} - E\left[p_{j,t}\right]\right|$, is subtracted to account for the natural dispersion of banks' lending decisions and normalizes the measure to zero under the null hypothesis of no herding. The adjustment factor is defined as the outcome of a binomial distribution with X_{jt} (loan increase, with

[14] For example, Grinballatt, Titman and Wermer(1995), Oehler (1998), Choe, Kho and Stulz (1999), Wermers (1999), Gelos and Wei (2003), Oehler and Chao (2003), Voronkova and Bohl (2005), Wylie (2005), Walter and Weber (2006), Lobao and Serra (2007), Do, Tan, and Westerholm (2008), Puckett and Yan (2008), Boyed, Buyuksahin, Harris, and Haigh (2009), Arouri, Bellando, Ringuede, and Vanbourg (2010).

probability p_t) and $1 - X_{jt}$ (loan decrease, with probability $1 - p_t$) as possible outcomes in dimension N_{jt}. Given the distribution of X_{jt}, the adjustment factor can be written as:

$$AF_{jt} = E\left[\left|\frac{\tilde{X}_{jt}}{N_{jt}} - p_t\right|;\ \tilde{X}_{jt} \sim B(p_t, N_{jt})\right] = \sum_{k=0}^{N_{jt}} \binom{N_{jt}}{k} {p_t}^k (1 - p_t)^{N_{jt}-k} \left|\frac{X_{jt}}{N_{jt}} - p_t\right|$$

Values of the LSV herding measures thus can be interpreted as the tendency of banks to increase loans to a given category in a given quarter above the random distribution of lending decisions. Positive values of the LSV measures that differ significantly from zero provide evidence of herding behavior. The higher the LSV measure, the stronger the herding.

I calculate the overall herding measure for each quarter, LSV_t, by averaging LSV measures of all five loan categories:

$$\begin{cases} \text{simple mean: } LSV_t = \dfrac{1}{5}\displaystyle\sum_{j=1}^{5} LSV_{jt} & (3) \\ \text{weighted mean: } LSV_t = \displaystyle\sum_{j=1}^{5} w_{jt} LSV_{jt} & (4) \end{cases}$$

where w_{jt} is the weight of loans outstanding to category j at quarter t over total loans.

I also examine whether banks collectively increase ("herd in") or decrease ("herd out") loans outstanding to each category. The relation between the overall herding measure, LSV_{jt}, and the conditional herding measures, which I call the "herding in measure", ILSV_{jt} , and the "herding out measure", OLSV_{jt}, is described as follows:

$$\begin{cases} ILSV_{jt} = LSV_{jt} | p_{jt} > p_t \\ OLSV_{jt} = LSV_{jt} | p_{jt} < p_t \end{cases} \quad (4)$$

The LSV measure has been criticized as being biased. Frey, Herbst and Walter (2007) use simulations and show that the LSV indicator is systematically biased downward. They introduced the FHW indicator as an alternative that is less statistically biased. The FHW herding measure is calculated as:

$$FHW_{jt} = \left(p_{jt} - p_t\right)^2 - E\left[\left(p_{jt} - p_t\right)^2\right] \frac{N_{jt}}{\left(N_{jt} - 1\right)} = \frac{\left(p_{jt} - p_t\right)^2 - p_t(1 - p_t)/N_{jt}}{\left(N_{jt} - 1\right)/N_{jt}} \quad (5)$$

$$\text{where } p_{jt} = \frac{X_{jt}}{N_{jt}};\ p_t \equiv \frac{\sum_{j=1}^{J} X_{jt}}{\sum_{j=1}^{J} N_{jt}}$$

The numerator in equation (4) is the empirical variance minus the expected variance of a binomial distribution with parameters N_{jt} and p_t. Frey, Herbst and Walter (2007) provides evidence that the normalization in the denominator and the use of second moment rather than the first absolute moment lead to more desirable statistical properties.

Both the LSV and FHW herding measures have limitations. First, they do not take into account lending intensity because they only use the number of banks that increase or decrease loans to certain loan categories regardless of the volume of aggregate dollar lending (Bikhchandani and Sharma, 2000). Second, the measures do not consider the initial level of banks' holding of loans. Bellando (2010) argues that there are statistical biases in both the LSV and FHW measures; however, the herding characteristics influence in opposite ways the biases of the two measures. He shows that the real herding values can be bounded by both indicators, LSV as the minimum value and FHW as the maximum value. Based on these critics, I use both measures to test the existence of herding while acknowledging that neither measure may reflect the true value of herding. The calculated LSV and FHW measures will provide boundaries of where the true herding value may lie.

4.2 Results: documenting the existence of herding

The simple mean and weighted mean LSV measure and FHW herding measure for U.S. commercial banks during the sample period are presented in Table 2 and Figure 3. All four herding measures—simple mean LSV measure, weighted mean LSV measure, square root[15] of simple mean FHW measure, and square root of weighted mean FHW measure—are significant during the entire sample period. The calculated sample means of the herding measure stand for the average fractions of U.S. commercial banks that increased or decreased loans outstanding due to herding behavior. For example, following the LSV interpretation, a simple LSV of 4.40% in the year 2010 implies that since there were 6,529 banks in that year, an increase or decrease in loans outstanding by 287 banks (4.40% of 6,529 banks) was caused by herding behavior.

Panel A of Figure 3 plots the time series pattern of the simple mean LSV measure as calculated in equation (2). Looking at the general trend, simple mean LSV measure fluctuated in the late 1970s and the 1980s, remained relatively stable with a slightly decreasing trend in the

[15] I use the square root of the FHW measure to make it comparable to the LSV measure, which is calculated based on the first moment.

1990s, and experienced a significant and continuous increase in the 2000s. Panel B of Figure 3 separates the overall herding trend and examines whether banks collectively increase ("herding in") or decrease ("herding out") loans outstanding to each category, calculated from equation (4). During the late 1970s and the most part of the 1980s, banks collectively decreased loans, and it was the herding out that contributed to the overall herding level; while the herding to increase loans was insignificant. In the 1990s, both herding in and out were significant, indicating that banks both collectively increase and decrease lending. In the 2000s, the significant increase in the simple mean LSV measure was due to the fact that banks herd to collectively decrease loans.

The vertical lines in Panel A and B indicate five NBER dated recessions[16]: January-July 1980, July 1981-November 1982, July 1990-March 1991, March-November 2001, December 2007-June 2009. Considering the late 1970s oil crisis and the NBER dated recessions during the sample period, banks in general follow a cyclical herding patter. A significant magnitude of herding was in the late 1970s, during the second oil crisis. Herding increased significantly from a simple mean LSV measure of 1.10% in the first quarter of 1976 to twice the value, 2.21%, in the third quarter of 1979. This is consistent with the expectation that banks are inclined to herd in an exogenous shock and increased uncertainties of the economy. During the oil crisis, banks faced more uncertainties as to the overall states of the economy and had difficulties evaluating borrowers. As a result, they collectively decreased lending (Panel B). This can be explained by both spurious herding, when banks in the unfavorable market conditions decreased lending together and the intentional herding out of information concerns, when banks had asymmetric information as to whether and to what extent their borrowers were affected by the crisis and therefore following others' lending decisions, assuming others had information advantage.

Examining the behavior of herding measures during the five NBER dated recessions, I find that the movements of herding measure demonstrate three different patterns: the simple mean LSV indicator (1) decreased in the 1980 recessions, (2) did not change much in the 1982, 1991, and 2001 recessions, and (3) increased dramatically during the 2007-2009 recessions. In the first case, the 1980 recession, herding was at its historically highest level before the recession, it then decreased significantly when the recession started. In the second case, the herding indicator was at a relatively low level before and during the recession. In the 1991 recession, the herding measure increased immediately after the economy started to recover. Before the most recent

[16] From the NBER website of business cycles, http://www.nber.org/cycles.html.

December 2007-June 2009 recession, the LSV indicator was stable around a high level of 2.4% from 2005 to 2007. Herding increased dramatically during the crisis—from 2.3% to 3.4% (that is, from 168 out of 7,283 banks to 233 out of 6,839 banks) between 2007:Q4 and 2009:Q2, and it increased further after the crisis, to a historic high of 4.6% (300 out of 6,529 banks) in the last quarter of 2010.

Columns (3)-(7) of Table 2 and Panel C of Figure 3 show the LSV measures for each loan category during the sample period. Studying together Panel A and C of Figure 3, it is shown that the increase in simple mean LSV measure in the late 1970s was mainly driven by the increasing herding level of C&I loans and all remaining loans, though herding in residential real estate loans decreased during the time. Simple mean LSV indicator increased in the first half of the 1980s because banks herded in residential real estate loans; and the indicator's decrease in the second half of 1980s was due to the drop of herding in all loan categories. In the 1990s, herding in the C&I loans dominated all other loans, while herding in commercial real estate loans was also significant, fluctuating around 2% during the time. In the 2000s, herding in individual loans increased dramatically, becoming a main driving force of the simple mean LSV measure, from an insignificant level in 2000 to 11.25% (833 out of 7,401 banks) in 2006, and further increased to reach 17.86% (1,166 out of 6,529) in 2010.

The analysis thus far is based on a simple mean of LSV measures over five loan categories. However, as can be seen in Figure 1 Panel A, there were discrepancies in the proportions of loans outstanding in each category over total loans. For example, the proportion of commercial real estate loans in total loans fluctuated around 5% during the sample period while the residential real estate loans moved in the range of 15% to more than 30%. Therefore, it might be more appropriate to look at a weighted mean LSV measure, where the weight assigned to herding measures of each loan category is calculated as the ratio of the loans in the category over total loans. Panel D of Figure 3 plots the weighted mean LSV measures together with the simple mean LSV measures. Comparing the two measures, the general trend does not change if we focus on the weighted mean measure and that the qualitative results from the simple mean measure still hold for the weighted mean measure. The simple mean and weighted mean LSV measure are significantly correlated at the 5% level, with a correlation of 0.8726. There are, however, two noticeable differences in the weighted mean herding measure. First, the weighted LSV measure fluctuated more in the 1970s. This can be explained by the significant changes in

the herding measures of the residential real estate loans, C&I loans, and all remaining loans whose proportions in the total loans changed significantly as well, as seen in Figure 1 Panel A. Second, the weighted means were generally lower than the simple means during most of the sample periods before 2003. This is mainly due to the fact that the LSV indicators for individual loans were high and mainly contributed to the increase in the overall herding measure, but this loan category had a low share in total loans (around 14%).

I then calculate the FHW herding measures. Since the FHW measure uses the second (central) moment, I calculate the square root of the FHW measures to make them comparable to LSV measures. Panel D of Figure 3 shows that the LSV and FHW measures follow similar trends. The square roots of the FHW measure are always higher and more volatile than the LSV measure. This is in line with Frey, Herbst and Walter (2007), who show that the LSV measure underestimates the level of herding. Following with Bellando (2010), I consider the real level of herding among the U.S. commercial banks are bounded by the LSV measure and the FHW measure, with the LSV as the minimal value and the FHW as maximum value.

Since all herding measures are significantly correlated with each other, I present only the simple LSV measure in the analysis hereafter.

5. Herding, macroeconomic conditions, and bank health

In the last section, I found evidence of herding in banks' lending decisions to different loan categories. In this section, I investigate if the time series patterns of herding measures are related to macroeconomic factors and banks' balance sheet and income statement variables. The information asymmetry explanation of herding behavior states that market participants tend to herd more when there is uncertainty about accuracy of information (Banerjee, 1992; Birhchandani, Hirshleifer and Welch, 1992, 1998; Avery and Zemsky, 1998). I consider that the information problems would become more severe when the macroeconomic conditions are worse, indicated by a low real GDP growth, high inflation, high unemployment rate, tight monetary policy, high cost of external financing, and when there are more risks in the market, measured by credit risk and liquidity risk. I also expect that banks tend to herd more when the banking industry is more vulnerable and subject to higher risks—measured by the extent to which banks are financed by short-term debt rather than insured deposits, the proportion of banks' illiquid assets as a share of total assets, banks' profitability and the extent to which banks

rely more on their non-interest income from securitization rather than interest income from lending activities, and banks' loan quality as measured by loan loss allowance and the share of non-performing loans in total loans.

5.1. Macroeconomic and market variables

I present regression results in Table 3. Columns (1) and (2) report estimates based on regressions that use simple mean LSV measure as the dependent variable and the macroeconomic variables as independent variables for each quarter with or without decade dummies. The results are robust using different herding measures (weighted mean LSV measure, simple mean FHW measure, or weighted mean FHW measure) as dependent variables. Both unemployment rate and inflation rate are significantly positively related with herding measures, suggesting that banks tend to herd more when the economic conditions are less favorable, measured by a high unemployment and inflation rate. In column (2), decade dummies are added in the regression to capture effects in different decades. Decade 80s takes 1 if year is between 1976 to 1989 and 0 other wise, and Decade 90s takes 1 if it is 1990s and 0 other wise. The R-square increases significantly, from 0.099 in regression (1) to 0.409 in regression (2) when decade dummies are included. Both decade dummies are significantly negative at the 1 percent level, indicating that controlling for macroeconomic factors, herding has a trend of increasing over time and herding level in the 2000s is significantly higher than in previous decades.

In regression (3)-(5), federal funds rates and interest rate spreads are added to the regression. Inflation rate and unemployment rate are still significantly positive. The negative and statistically significant relationship between the herding measure and the federal funds rate can be explained in two ways. The first explanation is related to the bank lending channel literature. The model of Mondschean and Pecchenino (1995) argues that a decrease in banks' external cost of funds, measured by federal funds rates in this paper, will result in an expansion in banks' lending. If each bank expects all other banks to do so then they will increase their lending and herding occurs. Second, the federal funds rate can be seen as a proxy for credit market conditions. When credit market conditions are more favorable, banks tend to ease their loan screening standards and therefore increase loans outstanding, leading to a higher level of spurious herding. This result is broadly robust across different interest rate measures, such as the 3-month, 6-month, and 1-year Treasury bill rates, and the 1-year and 10-year Treasury securities rates. The

Libor-OIS spread and the Baa-Aaa spread are significantly positively related with herding measures, as shown in column (3) and (4) separately. This suggests that banks tend to herd more when risk premiums in the banking industry are high or when there are more uncertainties in the economy. The Baa-Aaa spread is significantly correlated with unemployment rate and Libor-OIS spread (Table 3B), therefore the unemployment rate and Libor-OIS spread are excluded in regression (4) that uses the Baa-Aaa spread as an explanatory variable. In Column (5), when decade dummies are added to the regression, the significance of macroeconomic indicators and interest rate and interest spread remains. Both decade dummies are significantly negative and the absolute value of the coefficient of the decade dummy for the 1980s is higher than that of the 1990s, indicating an increasing trend of herding over time. Comparing regressions (3) and (5), the R-squared increased when decade dummies are included in the regression.

To conclude, the fact that herding is positively and significantly related to inflation, unemployment rate, and the risk premiums (indicated by the Libor-OIS spread and Baa-Aaa spread) and negatively and significantly related to banks' external cost of funding suggest that banks tend to herd more when economic conditions are less favorable and when there are more uncertainties in the banking industry and the whole economy. These results lend some evidence to the information asymmetry explanation for herding that banks tend to herd more when there are more uncertainties. The statistically significant and negative coefficients of the decade dummies indicate that herding has a significant increasing trend over time.

5.2. Bank characteristics and herding

One of the possible explanations for the time series pattern of herding measure, captured by the significant explanatory power of decade dummies in the regressions of Table 3, is the changing characteristics of the banking industry over time. For example, Section 3.2 shows that the number of banks has been decreasing since 1984. It is possible that as the number of banks declines, the surviving banks are more similar to each other and therefore make similar decisions. This possibility is consistent with Birhchandani and Sharma (2000) that banks are more likely to herd if they are sufficiently homogeneous. In this section, I examine the relation between banks' herding behavior and the changing characteristics of the banking industry.

Table 4 presents estimates based on regressions that use the simple mean LSV herding measure as the dependent variable and the bank balance sheet and income statement variables are

added to macroeconomic and interest rate variables one at a time as independent variables, since the bank variables are highly correlated with each other. Columns (1)-(3) report the estimates on banks' balance-sheet variables. I first look at the relation between herding and overall equity ratio[17] of the banking system. One of the most important regulations for banks in their lending behavior is the capital ratio requirement; therefore the equity ratio can be used as a proxy for regulation. Column (1) of Table 4 shows a positive and statistically very reliable (significant at the 1 percent level) relation between banks' aggregated equity ratio and herding measure. This is consistent with the explanation that regulation, specifically the capital adequacy requirement studied here, puts boundaries on banks' action space and therefore is likely to lead to herding behavior. However, we have to notice that equity ratio is related to many other variables, such as banks' overall health. Therefore, this result is only descriptive.

Column (2) of Table 4 shows a significant negative relation between herding measures and the banks' liquidity ratio, calculated as the ratio of the aggregated liquid assets[18] of all banks in the sample over the aggregated total assets of these banks. First, when the liquid asset ratio is low, banks are less able to cover their loan losses or losses from other investments, and banks subject to liquidity shortages may ration loans to good borrowers. Second, a low liquidity ratio is usually associated with a less favorable economic condition where uncertainties are higher and banks herd due to information concerns. By following each other's lending decisions, banks are able to identify what they thought to be the "good borrowers".

I use the fraction of assets funded with deposits as an indicator of the bank's ability to provide liquidity to borrowing firms. Previous studies use the deposit ratio and find that banks with better access to deposit funding are in a stronger position to provide liquidity during financial market turmoil (Gatev and Strahan, 2006; Ivashina and Scharfsterin, 2008). When deposit ratios are higher, banks may be more able to absorb shocks to the pricing of other liabilities and therefore change lending standards less frequently or more slowly. Column (3) of Table 4 shows a negative and statistically significant relation between herding measure and banks' core deposit over total assets[19]. Banks tend to herd more when they rely more on market

[17] I also used capital ratio (calculated as the sum of equity and retained earnings over banks' average assets for each quarter) for the entire sample period, and tier-1 capital ratio for 1991-2008, the results are similar.
[18] See Data Appendix for the calculation of liquid assets.
[19] A robustness check with the ratio of core deposits over total liabilities show the same significantly negative relation.

funding instruments and less on deposits, and are therefore more subject to funding liquidity risks.

Columns (4)-(8) demonstrate the regression results for banks' income statement variables. In Column (4), I use return on assets (ROA) as a proxy for banks' overall profitability and find a significant and negative relation between herding and the overall profitability of banks. In Column (5), I look at banks' profitability from the lending operation only and find that LSV measure is significantly negatively related to banks' net interest margin (NIM). That is, more herding occurs at the time when banks' profitability from lending operation is low. In column (6), when ROA and NIM are considered together in a regression, both variables are significantly negative—suggesting that both banks' overall profitability and banks' profitability from lending operations are related to herding behaviors.

Column (7) shows a significantly positive relation between herding and non-interest income. One of the possible explanations is that a high non-interest income ratio suggests that banks are more focused on trading, brokerage, and other related activities and that the profits from these activities are higher as a proportion of the total operating income. Meanwhile, banks are less willing to invest effort and resources in obtaining information, screening, and monitoring borrowers in their traditional loan business. As a result, they follow each other's domestic lending decisions to avoid these costs. Regression (8) shows that banks tend to herd more when they are operating less efficiently, measured by a high proportion of non-interest expense in total assets.

Columns (9) and (10) examine the relation between herding and banks' loan quality. Of the two measures, the ratio of nonperforming loans to total bank loans measures the actual bad loans and the proportion of loan loss allowances to total loans reflects banks' expected loss from bad loans. The regressions show that herding is significantly positively related to the non-performing loan ratio and negatively related to the loan loss allowance ratio. This suggests that more herding occurs at times when the actual loan loss is high, and that when banks expect to have a low level of loan loss, herding tends to increase. The relation between herding and loan quality measures can be explained by two hypotheses. The first is Berger and Udell (2003)'s institutional memory hypothesis that banks tend to forget the lessons they learned from their problem loans as time passes from their last loan bust and they ease credit standards together. Following the institutional memory hypothesis, banks allocate more of the funds to loan loss allowance when

their memory of loan bust is still fresh. This is the time when banks are more cautious and they tend to make lending decisions based on their own judgement of the market condition and borrowers' quality—that is, they tend to herd less. When banks forget the lessons from their last loan problems, they tend to increase herding, until their next loan problems occur, as measured first by a large nonperforming loan measure.

An alternative hypothesis is the reporting discretion hypothesis by Stever and Wilcox (2007). They argue that bank regulators grant banks more discretion in reporting loan loss allowances when the banking system is weaker. By being similar to each other, banks increase the odds that they are weaker and could benefit more from reporting discretion—they can report a lower level of allowances. Following this hypothesis, more herding is usually related with the weaker condition of the banking system, one of the measure of which is a high nonperforming loan ratio; and this is also the time when banks' reported loan loss allowances are low. Both hypotheses could explain the results of regressions (9) and (10). However, the causality is different: the institutional memory hypothesis states that a herding increase is partially caused by banks' memory of their past loan quality problems and the reporting discretion hypothesis argues that a high herding causes low reported loan loss allowances. The regressions can only provide evidence that banks' herding level is related to certain bank characteristics. They do not necessarily confirm causality.

6. Herding measures for banks of different sizes

To analyze differences in the herding behavior across banks of different size, I categorize banks into different size groups based on their total assets in each quarter: the largest 5% (all banks with total assets above the 95% percentile), largest 10% (all banks with total assets above the 90% percentile), largest 25% (all banks with total assets above the 75% percentile), smallest 25% (all banks with total assets below the 25% percentile), smallest 10% (all banks with total assets below the 10% percentile), and smallest 5% (all banks with total assets below the 5% percentile).

Panels C-G of Figure 1 plot the loan compositions for different bank size groups. Panel C shows the proportion of the commercial real estate loans. During the first half of the sample period, large banks held more commercial real estate loans than small banks, with a highest level of above 60% in the late 1980s while small banks only held about 20% of commercial real estate

loans in their total loan portfolio at the time. The proportions held by large banks dropped to about 20% in the middle of the 1990s, then both large and small bank groups increased their holding of the commercial real estate loans together during the period of 1995 to 2006. During the 2007-09 crisis, the proportion fell by about 20% for all bank size groups and the drop continued when the economy started to recover in 2009 and 2010. Panel D shows that the proportion of residential real estate loans experienced an increasing trend for all size groups. In Panel E, large banks held a significantly larger proportion of C&I loans than small banks during the whole sample periods. However, the difference started to narrow in the middle of the 2000s. In Panel F, small banks' holding of individual loans as a proportion of total loans decreased from about 30% in 1976 to less than 10% in the end of sample period, while the proportion of individual loans held by large banks remained stable. Small banks held about 40% of other loans, while other loans in big banks were only 20% of their holding of total loans.

Table 5 and Panel A of Figure 4 shows the weighted mean LSV herding measures for banks of different size groups. I use the weighted mean LSV measure because there were great discrepancies in the proportions of loans outstanding to each category between the different bank size groups. A number of patterns stand out. First, the overall herding measures for large bank groups—the largest 5%, 10%, and 25% banks—are generally higher than that of the small bank groups—the smallest 25%, 10%, and 5% banks. Second, the herding measures of small bank groups are relatively stable while the measures for the large bank groups are more volatile, especially in the late 1970s and early 1980s. Third, among the small bank groups, the smallest 5% banks show a stronger tendency of herding than the rest two groups; and among the large bank groups, the herding measure of the largest 5% banks is generally higher than that of the largest 10% and 25% banks.

The different time series patterns of the LSV indicators of banks of different size groups can be explained by the detailed examination of the bank groups' different herding behavior in different loan categories. Panels B-E of Figure 4 show the LSV herding measures of different size groups for each loan categories. In Panel B of the commercial real estate loans, herding was significant among the largest 25% of banks in the first half of the 1980s while the measures for small banks were insignificant during the time. In the late 1980s and early 1990s, small banks (the smallest 25% and 10%) showed significant and volatile herding patterns. It was not until the second half of the 1990s when the smallest 5% banks started to herd. From the year 2004 to

2008, the herding was insignificant for all bank size groups but it then increased sharply in 2009. Panel C shows the herding behavior in the residential real estate loans—herding was only significant during the 1970s and 1980s. There were two waves of herding for the large bank groups around the late 1970s and the second half of the 1980s. Herding among small banks demonstrated a V-shape from 1976 to 1986.

Panel D shows the herding for C&I loans. In the late 1970s and early 1980s, large bank groups had a higher level of herding among themselves than small bank groups. In the late 1980s and 1990s, there was no significant difference in herding patterns between large and small bank groups. During the 2000s, the herding for large banks, especially herding among the largest 5% banks, increased significantly from 2001 to 2004. It then decreased after 2004, reaching an insignificant level in 2009, and increased again. Consistent with the time series characteristics of the weighted mean LSV measure, I also observe that the herding measure for the smallest 5% banks was in general the highest among the herding measures for small bank groups and the herding measure for the largest 5% banks was the highest in the large groups.

Panel E shows LSV measures for the individual loans. The LSV measures for individual loans were not significant until 2003; it then increased significantly for all size groups during the 2000s. The herding among the largest 25% reached a very high level at 17.80%; that is, an increase or decrease in loans outstanding by 320 banks (17.80% of 1,795 banks) was caused by herding behaviour. Herding for all remaining loans was insignificant during the sample periods and therefore not reported.

Table 6 represents estimates based on regressions for each size group that use the weighted mean LSV herding measure as the dependent variable and macroeconomic indicators, interest rates and interest spreads as independent variables for each quarter with decade dummies. The regression results for each size group are similar to the estimates reported in Table 3 Column (5) for the whole sample of commercial banks. The inflation rate and unemployment rate are significantly positive for all size groups (except that inflation rate is insignificant for the smallest 5% banks), indicating that banks of different size groups tend to herd more when economic conditions are less favorable. The herding measure and the 3-month Treasury bill rate[20] are negative and statistically significant, indicating that for banks of all size groups more herding

[20] This result is broadly robust across different risk-free interest rate measures, such as the 6-month and 1-year Treasury bill rate, 1-year and 10-year treasury securities rate, and federal fund rates.

tends to occur at the time when the costs of external financing are higher. The Libor-OIS spread is significantly positively related with herding measures for all groups but the largest and smallest 5% banks, suggesting that banks tend to herd more when risk premiums in the banking industry are high. The Libor-OIS spread measures the credit risk in the interbank market. The insignificance for the smallest 5% size group can be explained by the fact that the smallest banks may not participate in the interbank loan market and therefore the spread does not affect their risk-taking and lending decisions.

Comparing the regression results for each size group and the overall sample, the estimates for decade dummies are different. When I look at the whole sample in Table 3 Column (5), both the decade dummies for the 1980s and 1990s are significantly negative, indicating an increasing time trend of herding behavior. However, examining each size group, this increasing trend is only found in the herding behavior among the largest 50% banks and the smallest 50% banks (Column (4) and (5)). The significantly positive coefficient for the decade dummies for the largest 5% banks indicates a decreasing trend of herding among banks of the largest 5% group. For the largest 10% banks, herding activities in the 2000s are significantly lower than in the 1990s. There is no significant time trend for the largest 25% banks. For the smallest 25%, 10%, and 5% banks, herding behaviors in the 2000s are significantly higher than the herding in the 1970s and 1980s, but lower than the herding in the 1990s. The results suggest that while overall banks tend to herd more with each other in the whole sample, there is no increasing trend in herding among banks in each specific size groups. Future studies need to look at the between-group herding in order to understand the time trend.

7. Conclusion

While much of the economics and financial literature focuses on the macroeconomic reasons for systemic risks and failures in the banking system and most of the herding literature concerns itself with capital market herding rather than banking, this paper studies herding in the banking industry and relates bank herding to macroeconomic and banking industry specific factors. In this paper, I investigate whether U.S. commercial banks have been following herding behavior in the domestic loan market from 1976 through 2010 and study the relationship among bank herding, macroeconomic conditions, and bank balance sheet and income statement variables. Applying the LSV measure and FHW measure of herding to Call Report data on loans

outstanding in different categories, I find evidence of herding in the entire sample period. Regression results show that banks tend to herd more when economic conditions and the health of the banking industry are less favorable, as measured by high inflation and unemployment rates, a wide credit risk spread and banks' funding spread. Herding is also negatively related to banks' deposits ratio, the ratio of liquid asset to total assets, profitability, and loan quality and positively related to off-balance-sheet activities. Comparing banks of different size groups, I find large banks tend to have a higher degree of herding in most quarters in the sample.

Herding is not necessarily bad for individual banks. However, considering the whole banking system, banks' herding behavior in lending could lead to higher bank failure in the aftermath of credit bubbles, as suggested by Mondschean and Pecchenino (1995) and evidenced in the most recent 2007-09 financial crisis and credit crunch. The analysis and results of this paper have several policy implications. First, the existence of herding of banks' domestic lending suggests banks' asset correlation, and therefore regulations should not consider individual banks, but the overall banking system as a whole. Second, since information is a major problem that leads to herding most of the time, it would be beneficial if regulators could consider making some of the information publicly available. For example, policy should implement mechanisms for the identification of asset prices bubbles, since past recessions and crises had highlighted the critical importance of asset prices bubbles. Third, this paper shows that regulations limit banks' action space and possibly lead to herding; the 2007-09 financial crisis has highlighted the need for macroprudential approach to regulation and supervision.

Data Appendix

I follow the series definitions in the Federal Reserve's Notes on forming consistent time series.

Total assets: Total assets are taken from item RCFD2170.

Total equity: Total equity is computed as RCFD3210.

Total deposits: Total deposits are computed as RCFD2200.

Total loans: Total loans are reported in the call report item RCFD1400. Starting in 1984:Q1, this item also includes lease-financing receivables. To ensure continuity, total loans must be computed as the sum of RCFD1400 and RCFD2165 (lease-financing receivables) for the period prior to 1984:Q1.

Total real estate loans: Total real estate loans are taken from item RCFD1410.

Commercial real estate loans: Commercial real estate loans are taken from item RCON1480 (real estate loans secured by non-farm non-residential properties).

Residential real estate loans: Residential real estate loans are calculated as the sum of RCFD1430 (real estate loans secured by 1-4 family residential properties) and RCFD1460 (loans secured by multifamily (>5) residential properties).

Commercial and Industrial (C&I) loans: C&I loans are computed as the sum of RCFD1600 (commercial and industrial loans) and RCFD1590 (agriculture loans).

Individual loans: Individual loans are taken from item RCFD1975.

Liquidity: Following Loutskina (2011), the measure of banks' liquidity is computed as the sum of RCFD0400 (book value of U.S. treasury securities), RCFD0600 (book value of U.S. government obligations), RCFD0900 (obligations of states and political subdivisions), RCFD0380 (all other bonds, stocks, and securities), and RCFD1350 (Fed funds sold and securities purchased under agreements to resell) for the prior to 1984:Q1. For the 1984:Q1-1993:Q4 period, liquidity is the sum of RCFD0390 (total investment securities), RCFD1350, and RCFD2146 (assets held in trading account). Finally, for the 1994:Q1 to 2010:Q4 period, it equals to the sum of RCFD1350, RCFD1754 (held-to-maturity securities), and RCFD1773 (total available-for-sale securities). Following Kashyap and Stein (2000), I compute the measure of banks' on-balance-sheet liquidity as a percentage of the liquid assets in the total assets in the regression analysis.

Net income: Net income is calculated as (interest income – interest expense) + (non-interest income – non-interest expense). Interest income includes all interest and dividends earned by banks on interest-bearing assets such as loans and leases. Interest expense is the result of all interest paid to depositors and other creditors of the banks. Non-interest income includes fee income, gains on securities transactions, and all other income not originated in interest payments. Non-interest expense includes personal compensations, legal expenses, office occupancy, equipment expense, and other expenses.

ROA: ROA is calculated as the ratio of inflation-adjusted net income over inflation-adjusted average assets for each quarter.

Net interest margin (NIM): NIM is calculated as the inflation-adjusted net interest income (i.e. interest income – interest expense) over the inflation-adjusted average assets for each quarter.

Nonperforming loans: Following Campello (2002), I use the measure of loan performance that avoids managerial discretion in reporting losses. It equals the sum of RCFD1403 (non-accruing loans) and RCFD1407 (loans over 90 days late). The nonperforming loan ratio is calculated as total nonperforming loans over total loans.

Loan loss reserve: Loan loss reserve (or loan loss allowance) is taken from item RCFD3123. The loan loss reserve ratio is calculated as total loan loss reserves over total loans.

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Table 1: Summaries Statistics
Panel A: Sample Mean

year	1976 -2010	1976 -1980	1981 -1985	1986 -1990	1991 -1995	1996 -2000	2001 -2005	2006 -2010
Part I: Composition of the Banking Industry								
Number of Banks	12,267	14,402	14,449	13,226	10.950	8,870	7,779	6,906
Merger	224	158	289	458	503	518	279	228
Failure	39	10	48	159	60	24	18	71
New Charters	147	175	302	182	61	185	122	79
Part II: Total Values (billions of 1983 dollars)								
Total Assets	2,196	2,092	2,301	2,568	2,572	3,234	4,093	5,355
Total Loans	1,227	1,149	1,326	1,577	1,518	1,954	2,408	3,034
Total Deposits	1,655	1,713	1,797	1,996	1,907	2,192	2,726	3,629
Total Equity	175	123	138	160	197	271	390	554
Part III: Bank Asset Side (percent of total assets):								
Loans	47.64%	54.88%	57.53%	61.41%	59.00%	60.42%	58.82%	56.13%
Securities	27.99%	18.46%	16.60%	17.15%	20.81%	17.67%	18.35%	17.19%
Cash	16.52%	17.91%	14.27%	11.24%	7.88%	6.66%	5.10%	7.07%
Other Earning Assets	6.63%	4.19%	5.47%	5.66%	7.65%	9.62%	10.15%	11.09%
Part IV: Bank Liability Side (percent of total assets):								
Equity	7.79%	5.87%	6.01%	6.23%	7.63%	8.38%	9.50%	10.48%
Borrowed Funds	6.54%	8.24%	10.70%	12.10%	12.95%	16.04%	16.18%	13.90%
Deposits	81.84%	81.88%	78.11%	77.72%	74.28%	67.86%	66.59%	68.67%
Part V:: Bank Income Statement (percent of total assets):								
ROA	0.73%	0.71%	0.67%	0.48%	0.97%	1.17%	1.25%	0.61%
NIM	2.64%	2.93%	3.17%	3.36%	3.67%	3.40%	3.14%	2.91%
Non-interest income	1.08%	0.67%	0.99%	1.44%	1.89%	2.28%	2.35%	1.86%
Non-interest income over total income	18.85%	8.40%	9.04%	14.04%	21.04%	25.36%	32.65%	29.54%
Non-interest expense	2.35%	2.39%	2.85%	3.25%	3.64%	3.50%	3.21%	2.91%
Non-interest expense over total expense	61.19%	35.88%	29.43%	37.51%	51.63%	51.49%	65.50%	67.30%
Part VI: Bank Loan Quality (percent of total loans):								
Non-Performing	2.26%	N/A	2.79%	3.17%	2.25%	1.01%	1.13%	3.30%
Allowance	1.78%	0.96%	1.19%	2.41%	2.41%	1.78%	1.65%	2.34%
Part VII: Bank Loan Composition (percent of total loans):								
Real Estate	31.44%	25.40%	25.78%	34.69%	42.17%	42.21%	51.27%	56.00%
Commercial RE	8.13%	6.41%	6.27%	9.74%	12.15%	11.67%	13.47%	14.07%
Residential RE	21.67%	14.48%	13.40%	16.70%	24.50%	25.28%	30.27%	33.58%
C&I	33.18%	33.49%	38.83%	31.33%	25.80%	27.01%	20.85%	19.02%
Individual	18.52%	19.48%	17.39%	19.30%	19.79%	17.73%	16.64%	15.86%

Panel B: 2006-2010

year	2006	2007	2008	2009	2010
Part I: Composition of the Banking Industry					
Number of Banks	7,401	7,283	7,088	6,839	6,529
Merger	309	293	260	157	183
Failure	1	15	44	134	127
New Charters	178	175	90	24	5
Part II: Total Values (billions of 1983 dollars)					
Total Assets	4,917	5,236	5,790	5,433	5,399
Total Loans	2,914	3,104	3,217	2,985	2,951
Total Deposits	3,280	3,424	3,802	3,829	3,810
Total Equity	502	535	543	592	598
Part III: Bank Asset Side (percent of total assets):					
Loans	59.27%	59.29%	55.56%	54.94%	54.66%
Securities	16.51%	14.23%	14.19%	18.60%	19.49%
Cash	4.29%	4.31%	8.46%	8.26%	7.65%
Other Earning Assets	11.39%	13.54%	13.23%	9.37%	9.74%
Part IV: Bank Liability Side (percent of total assets):					
Equity	10.21%	10.23%	9.38%	10.89%	11.09%
Borrowed Funds	15.75%	16.83%	16.89%	12.54%	12.00%
Deposits	66.70%	65.41%	65.66%	70.48%	70.57%
Part V:: Bank Income Statement (percent of total assets):					
ROA	1.27%	0.87%	0.12%	-0.10%	0.64%
NIM	2.82%	2.71%	2.60%	3.06%	3.25%
Non-interest income	2.15%	1.89%	1.58%	2.05%	1.80%
Non-interest income over total income	28.40%	25.66%	26.79%	33.47%	31.02%
Non-interest expense	2.88%	2.81%	2.69%	3.17%	2.97%
Non-interest expense over total expense	52.45%	50.49%	61.12%	75.66%	80.01%
Part VI: Bank Loan Quality (percent of total loans):					
Non-Performing	0.80%	1.33%	2.95%	5.60%	4.96%
Allowance	1.15%	1.35%	2.29%	3.29%	3.31%
Part VII: Bank Loan Composition (percent of total loans):					
Real Estate	57.37%	55.47%	56.18%	58.87%	55.36%
Commercial RE	13.55%	13.05%	13.97%	15.12%	14.54%
Residential RE	33.65%	32.04%	32.55%	35.39%	34.44%
C&I	19.05%	20.66%	20.71%	17.70%	17.01%
Individual	14.34%	14.47%	14.61%	15.05%	18.62%

Data on bank merger, failure, and new charters are from FDIC; all other data are from regulatory Call Report and aggregated for all U.S. commercial banks for each quarter. The table reports the mean for each five-year period.

Table 2: LSV Measure for the Whole Sample

year	Num of Banks	(1) Simple Mean LSV	(2) Weighted Mean LSV	(3) LSV Commercial Real Estate	(4) LSV Residential Real Estate	(5) LSV Commercial & Industrial	(6) LSV Individual	(7) LSV Remaining
1976	14,410	1.38%**	1.20%**	0	5.93%**	0.62%	0.38%	0
1977	14,411	1.74%**	1.64%**	0	6.54%**	2.02%**	0	0.16%
1978	14,391	2.36%**	2.81%**	0	5.74%**	2.85%**	0	3.20%**
1979	14,364	2.52%**	3.07%**	0	3.73%**	3.15%**	0	5.70%**
1980	14,434	1.30%**	1.67%**	0	0.75%	2.05%**	0	3.71%**
1981	14,414	0.77%**	0.75%**	0.24%	0.74%	0.03%	0	2.83%**
1982	14,451	1.13%**	0.72%**	2.16%**	2.31%**	0	0.01%	1.19%**
1983	14,469	1.07%**	0.80%**	1.03%**	3.29%**	0	0	1.03%
1984	14,496	1.38%**	0.96%**	1.56%**	4.11%**	0	0	1.25%**
1985	14,417	1.80%**	1.24%**	2.58%**	4.24%**	0	0	2.16%**
1986	14,210	1.32%**	0.84%**	2.34%**	3.36%**	0.07%	0	0.82%
1987	13,723	0.53%**	0.38%**	1.24%**	0.78%	0.42%	0	0.21%
1988	13,137	0.55%**	0.40%**	1.67%**	0.03%	0.72%	0	0.33%
1989	12,715	0.75%**	0.72%**	1.17%**	0.02%**	0.86%	0	1.68%**
1990	12,347	1.03%**	1.05%**	1.58%**	0	2.10%**	0	1.48%**
1991	11,927	1.38%**	1.37%**	2.64%**	0	4.05%**	0	0.22%
1992	11,467	1.73%**	1.85%**	2.37%**	0	5.91%**	0.36%	0
1993	10,961	1.91%**	1.99%**	2.16%**	0	6.29%**	1.08%**	0
1994	10,453	1.60%**	1.81%**	1.52%**	0	6.29%**	0.19%	0
1995	9,943	1.36%**	1.44%**	1.82%**	0	4.94%**	0.04%	0
1996	9,530	1.16%**	1.20%**	1.71%**	0	4.07%**	0.01%	0.02%
1997	9,144	1.28%**	1.19%**	2.58%**	0	3.79%**	0	0.04%
1998	8,777	1.19%**	1.00%**	2.85%**	0	3.04%**	0	0.04%
1999	8,582	0.98%**	0.81%**	2.49%**	0	2.40%**	0	0.02%
2000	8,315	1.20%**	0.82%**	3.67%**	0	2.25%**	0	0.07%**
2001	8,082	0.91%**	0.64%**	2.61%**	0	1.68%**	0	0.25%
2002	7,888	0.97%**	0.79%**	1.63%**	0	2.37%**	0.82%	0.01%
2003	7,770	1.18%**	0.99%**	0.26%	0	2.02%**	3.63%**	0
2004	7,631	1.66%**	1.33%**	0	0	1.85%**	6.44%**	0
2005	7,526	2.17%**	1.63%**	0	0	1.41%**	9.42%**	0
2006	7,401	2.48%**	1.72%**	0	0	1.17%**	11.25%**	0
2007	7,283	2.40%**	1.59%**	0	0.06%**	0.65%	11.30%**	0
2008	7,088	2.78%**	1.80%**	0	0	0.31%	13.59%**	0
2009	6,839	3.56%**	2.45%**	0.17%	0	1.98%**	15.65%**	0
2010	6,529	4.40%**	3.50%**	1.96%	0	2.17%**	17.86%**	0

**indicates that the null hypothesis of no herding is rejected at a 5% significance level.
Source: Author's calculations based on Call Report Data.

Table 3: Regression on Macroeconomic and Market variables:

VARIABLES	(1) simple LSV	(2) simple LSV	(3) simple LSV	(4) simple LSV	(5) simple LSV
GDP growth	-0.104	0.0102	-0.0640	-0.0524	0.0177
	[-1.227]	[0.141]	[-0.942]	[-0.636]	[0.265]
Inflation	1.542*	0.150**	0.271***	0.278***	0.267***
	[1.798]	[2.014]	[3.576]	[3.171]	[3.672]
Unemployment	0.00154***	0.00267***	0.00138***		0.00201***
	[3.544]	[6.443]	[3.759]		[5.180]
Fed funds			-0.00175***	-0.00172***	-0.000973***
			[-8.493]	[-6.992]	[-3.626]
Libor-OIS spread			0.00647***		0.00629***
			[4.763]		[4.799]
Baa-Aaa spread				0.00401***	
				[2.732]	
Decade 80s		-0.0132***			-0.00857***
		[-7.916]			[-4.133]
Decade 90s		-0.00819***			-0.00491***
		[-5.578]			[-3.322]
Constant	0.00749**	0.00513*	0.0125***	0.0186***	0.00857***
	[2.503]	[1.851]	[5.193]	[9.243]	[3.193]
Observations	139	139	139	139	139
R-squared	0.099	0.397	0.457	0.286	0.523

Notes:

(1) Dependent variable is simple mean LSV measure.

(2) Definition of independent variables:

- GDP growth is the quarterly real GDP growth.
- Inflation is the quarterly inflation rate.
- Unemployment rate is the quarterly unemployment rate.
- Fed funds is the federal funds rate. I also used the 3-month, 6-month, 1-year Treasury bill rate, and the 1-year and 10-year Treasury Securities rate. Regression results are the same.
- Libor-OIS spread is the spread between London interbank offer rate (Libor) and overnight index swap (OIS).
- Baa-Aaa spread is Moody's spread between corporate bonds with Baa and Aaa ratings.
- Decade 80s is a dummy variable that takes 1 if year is between 1976 to1989 and 0 other wise.
- Decade 90s is a dummy variable that takes 1 if year is between 1990 to1999 and 0 other wise.

(3) All independent variables are lagged one quarter.

(4) Values of t-statistics are in brackets.

(5) *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. *denotes significance at 10 percent level.

Table 3B: Correlation Matrix of Macroeconomic and Market variables

	GDP growth	inflation	unemployment	Fed funds	Baa-Aaa	Libor-OIS
GDP growth	1					
inflation	0.1067	1				
unemployment	-0.0365	0.031	1			
Fed funds rates	0.0368	0.5632*	0.102	1		
Baa-Aaa	-0.3649*	-0.0013	0.6002*	0.2718*	1	
Libor-OIS	-0.1879*	0.0203	0.2947*	0.1177	0.5448*	1

Table 4: Regression on Macroeconomic, Market, and Bank Condition variables

VARIABLES	(1) simple LSV	(2) simple LSV	(3) simple LSV	(4) simple LSV	(5) simple LSV	(6) simple LSV	(7) simple LSV	(8) simple LSV	(9) simple LSV	(10) simple LSV
GDP growth	-0.00248	-0.0225	-0.0293	0.0334	0.00423	0.116	-0.0964	-0.0178	0.00644	-0.163
	[-0.0427]	[-0.324]	[-0.438]	[0.284]	[0.0455]	[1.009]	[-1.075]	[-0.248]	[0.0582]	[-1.581]
Inflation	0.236***	0.328***	0.318***	0.0308	0.0117	-0.0278	0.0990	0.258***	0.0542	0.132
	[3.680]	[4.143]	[4.273]	[0.250]	[0.120]	[-0.234]	[1.065]	[3.143]	[0.463]	[1.225]
Unemployment	0.00212***	0.00188***	0.00220***		0.00293***		0.00353***	0.00196***		0.00313***
	[6.483]	[4.382]	[5.146]		[7.246]		[9.006]	[4.790]		[6.014]
Fed funds	-0.000450*	-0.00145***	-0.0012***	-0.0020***	-0.0011***	-0.0017***			-0.0019***	-0.0016***
	[-1.815]	[-5.929]	[-4.840]	[-6.583]	[-4.513]	[-5.866]			[-6.601]	[-6.056]
Libor-OIS	0.00543***	0.00693***	0.00628***	0.00511**	0.00265*	0.00345*	0.00507***	0.00796***	0.00563***	0.00558***
	[4.695]	[5.112]	[4.762]	[2.546]	[1.684]	[1.751]	[3.464]	[5.435]	[3.090]	[3.381]
Equity ratio	0.362***									
	[7.354]									
Deposit ratio		-0.0213**								
		[-2.173]								
Liquidity ratio			-0.0370*							
			[-1.874]							
ROA				-0.526***		-0.500***				
				[-2.716]		[-2.710]				
NIM					-0.982***	-0.685***				
					[-5.636]	[-3.380]				
NII							0.0577***			
							[8.656]			
NIE								0.0230***		
								[7.186]		
NonPerforming									0.193***	
									[3.787]	
Allowance										-0.305**
										[-2.491]
Constant	-0.0250***	0.0206***	0.00597	0.0285***	0.0418***	0.0544***	-0.0195***	-0.0105***	0.0185***	0.00984***
	[-4.555]	[4.655]	[1.565]	[9.584]	[6.185]	[6.649]	[-5.927]	[-2.809]	[9.600]	[2.990]
Observations	139	139	139	108	108	108	107	139	108	108
R-squared	0.615	0.476	0.502	0.450	0.651	0.506	0.662	0.397	0.483	0.568

Notes:

(1) Dependent variable is simple mean LSV measure.

(2) Definition of independent variables:

- Equity ratio is calculated as aggregated banks' total equities over aggregated banks' assets.
- Liquidity ratio is calculated as aggregated banks' liquid assets over aggregated banks' assets.
- Deposits ratio is calculated as aggregated deposits over aggregated banks' assets.
- NIM is calculated as aggregated net interest income (interest income minus interest expense) over aggregated average assets.
- NII is calculated as aggregated non-interest income over aggregated average assets.
- NonPerforming is the ratio of aggregated non-performing loans of all commercial banks over total loans. A robustness check with non-accruing loans gives the same result.
- Allowance is calculated as aggregated loan loss allowance over aggregated total loans. Loan loss allowance is highly correlated with provision, so a robustness check with provision gives the same result.

(3) All independent variables are lagged one quarter.

(4) Values of t-statistics are in brackets.

(5) *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at 10 percent level.

Table 5: LSV Measure for Different Size Groups

year	(1) Largest 5%	(2) Smallest 5%	(3)=(1)-(2)	(4) Largest 10%	(5) Smallest 10%	(6)=(4)-(5)	(7) Largest 25%	(8) Smallest 25%	(9)=(7)-(8)
1976	2.16%**	1.15%	1.00%**	2.00%	1.39%**	0.61%**	1.99%	1.18%	0.81%
1977	2.97%**	1.72%**	1.25%	2.68%	1.67%	1.02%	2.36%	1.35%	1.01%**
1978	3.01%	1.59%**	1.42%	3.11%	1.42%	1.69%	3.84%**	1.58%	2.26%**
1979	4.67%**	1.22%	3.45%**	4.12%	1.07%	3.04%**	3.56%	1.85%**	1.71%**
1980	2.95%**	1.06%**	1.90%**	2.56%	0.98%	1.58%**	2.01%	0.95%	1.05%**
1981	3.35%**	1.13%**	2.22%	2.09%	0.83%	1.26%**	0.94%	0.52%	0.42%**
1982	1.61%**	1.02%**	0.59%	0.70%	0.91%	-0.21%	0.72%	0.71%	0.00%**
1983	1.69%**	1.43%**	0.26%**	0.83%	0.69%	0.14%	0.90%	0.87%	0.03%
1984	2.53%**	1.02%**	1.51%	0.95%	0.69%	0.27%	0.93%	0.79%	0.14%
1985	2.67%**	1.23%	1.44%	1.46%	0.75%	0.71%**	1.11%	1.26%**	-0.16%**
1986	3.03%**	1.70%**	1.34%**	2.44%	0.63%	1.81%**	1.60%	0.46%	1.14%**
1987	2.37%**	1.07%**	1.31%**	2.00%	0.84%	1.15%**	1.21%	0.55%	0.66%**
1988	2.50%**	1.54%**	0.96%**	1.99%	1.03%	0.96%**	1.32%	0.57%	0.75%**
1989	2.29%**	2.34%**	-0.05%	1.64%	1.32%	0.32%	1.23%	0.61%	0.61%**
1990	3.09%**	1.80%**	1.29%	2.05%	1.12%	0.94%**	1.22%	0.56%	0.66%**
1991	4.05%**	2.36%**	1.69%	3.24%	1.56%	1.68%	2.17%	1.07%	1.10%**
1992	3.73%**	1.90%**	1.83%	3.18%	1.66%	1.52%	2.22%	1.37%	0.85%
1993	3.42%**	2.05%**	1.36%	3.00%	1.26%	1.75%	2.16%	1.14%	1.02%
1994	3.88%**	1.91%**	1.97%	3.61%	1.57%	2.05%	2.71%	1.23%	1.48%
1995	2.68%	1.54%**	1.14%	2.69%**	1.30%	1.40%	1.91%	0.95%	0.96%
1996	2.00%	1.89%**	0.11%	2.22%**	1.10%	1.13%	1.60%	0.97%	0.63%
1997	2.43%	1.75%**	0.68%	2.50%**	1.08%	1.43%	1.70%	0.82%	0.88%
1998	1.90%**	2.39%**	-0.49%	1.53%	1.53%	-0.01%**	1.12%	0.94%	0.18%
1999	2.13%**	1.64%**	0.48%	1.87%	1.17%	0.70%**	1.17%	0.62%	0.55%
2000	0.65%	1.95%**	-1.30%**	1.08%**	1.35%	-0.28%**	0.59%	0.87%	-0.28%**
2001	2.56%**	1.57%**	0.99%	1.44%	1.13%	0.32%**	0.68%	0.80%	-0.13%**
2002	2.02%**	1.45%**	0.58%**	1.32%	0.80%	0.52%	1.09%	0.63%	0.46%
2003	1.92%**	1.77%**	0.14%	1.67%	1.18%	0.49%	1.48%	0.93%	0.55%
2004	1.85%**	1.38%**	0.47%	1.62%	1.09%	0.53%**	1.73%	1.09%	0.64%**
2005	1.97%**	1.58%**	0.39%	1.80%	1.23%	0.58%	1.79%	1.03%	0.76%**
2006	1.31%	1.25%**	0.06%	1.51%	1.05%	0.46%**	1.95%**	1.01%	0.94%**
2007	1.67%**	1.46%**	0.21%	1.47%	1.18%	0.29%	1.59%	0.92%	0.67%**
2008	1.43%	1.40%**	0.03%	1.83%	1.34%	0.49%**	2.26%**	1.29%	0.97%**
2009	2.52%	1.81%**	0.71%**	2.55%	1.73%	0.82%**	2.86%**	1.52%	1.35%**
2010	2.40%	1.58%**	0.83%	2.79%	1.48%	1.32%	3.58%**	1.55%	2.03%**

** indicates that the null hypothesis of no difference in herding measure in different size group is rejected at a 5% significant level in *t* test.

*In column (1), (4), and (7), ** indicates the highest herding level in the largest bank size groups.

*In column (2), (4), and (8), ** indicates the highest herding level in the smallest bank size groups.

Source: Author's calculations based on Call Report Data.

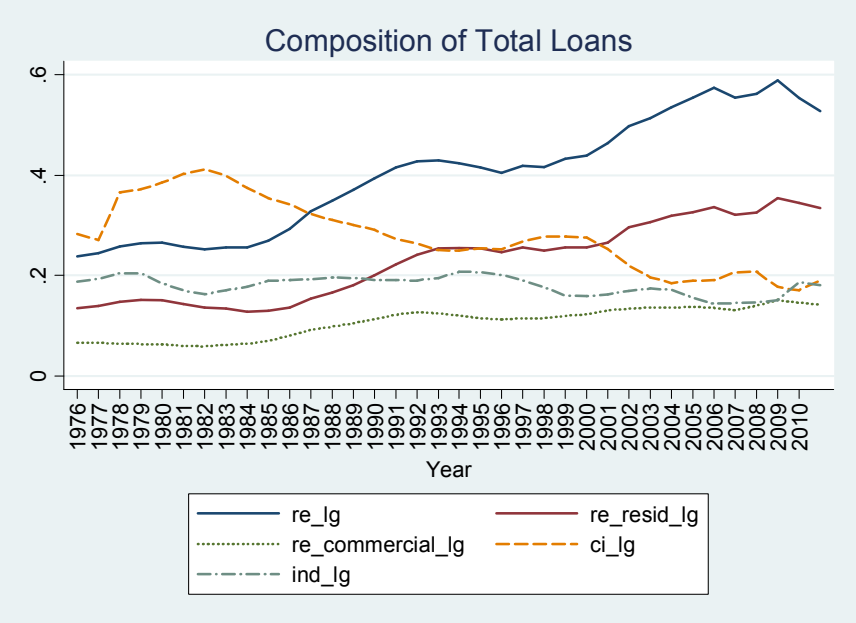
Table 6: Regression on Macroeconomic and Market variables: By Different Bank Size Group

VARIABLES	(1) largest 5%	(2) largest 10%	(3) largest 25%	(4) largest 50%	(5) smallest 50%	(6) smallest 25%	(7) smallest 10%	(8) smallest 5%
GDP growth	-0.0716	-0.0809	-0.0575	0.0182	0.0128	0.0252	0.0604	0.0891*
	[-1.093]	[-1.268]	[-0.791]	[0.244]	[0.229]	[0.557]	[1.305]	[1.899]
Inflation	0.262***	0.319***	0.342***	0.293***	0.186***	0.157***	0.108**	0.0195
	[3.677]	[4.607]	[4.335]	[3.620]	[3.065]	[3.204]	[2.154]	[0.382]
Unemployment	0.000788**	0.000925**	0.00159***	0.00236***	0.00176***	0.00136***	0.000793***	0.000887***
	[2.074]	[2.500]	[3.781]	[5.440]	[5.434]	[5.209]	[2.954]	[3.261]
Fed funds	-0.00167***	-0.00180***	-0.00156***	-0.00100***	-0.000829***	-0.000771***	-0.000496***	-0.000314*
	[-6.358]	[-7.032]	[-5.349]	[-3.354]	[-3.703]	[-4.259]	[-2.673]	[-1.668]
Libor-OIS spread	0.00198	0.00419***	0.00649***	0.00728***	0.00469***	0.00381***	0.00232**	-0.000105
	[1.540]	[3.354]	[4.559]	[4.980]	[4.292]	[4.304]	[2.553]	[-0.114]
Decade 80s	0.00641***	0.00133	-0.00321	-0.00791***	-0.00846***	-0.00867***	-0.00916***	-0.00975***
	[3.157]	[0.673]	[-1.426]	[-3.422]	[-4.893]	[-6.204]	[-6.386]	[-6.714]
Decade 90s	0.00598***	0.00300**	-0.00260	-0.00518***	-0.00357***	-0.00137	0.00172*	0.00313***
	[4.129]	[2.131]	[-1.621]	[-3.143]	[-2.899]	[-1.374]	[1.682]	[3.025]
Constant	0.0175***	0.0171***	0.0131***	0.00754**	0.00975***	0.0113***	0.0146***	0.0173***
	[6.642]	[6.670]	[4.505]	[2.518]	[4.358]	[6.224]	[7.873]	[9.181]
Observations	139	139	139	139	139	139	139	139
R-squared	0.312	0.434	0.476	0.502	0.551	0.632	0.624	0.673
Adj.R-squared	0.275	0.404	0.448	0.475	0.527	0.612	0.604	0.655

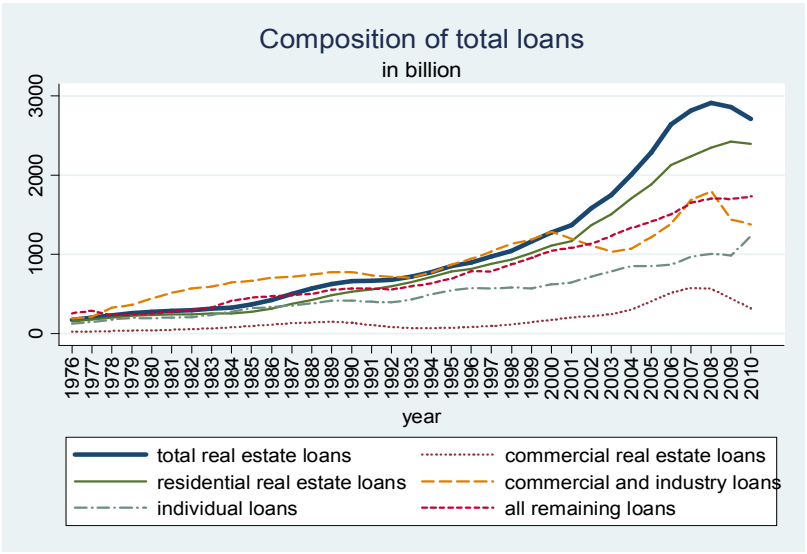
(1) Bank size is determined by banks` total assets value.
(2) All independent variables are lagged one quarter.
(3) Values of t-statistics are in brackets.
(4) *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at 10 percent level.

Figure 1: Composition of Bank Loans

Panel A: Ratio over Total Loans

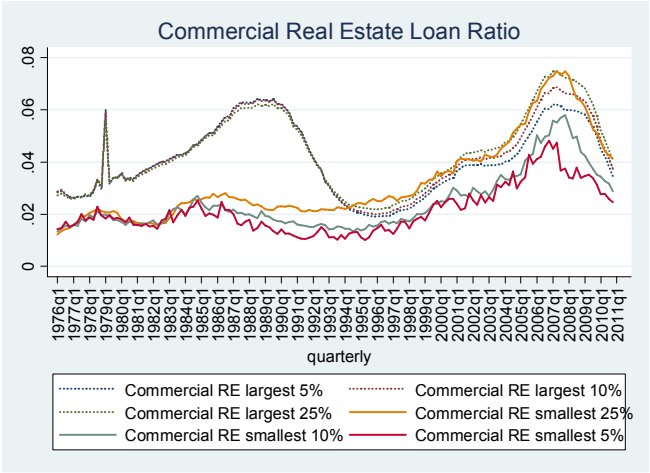


Panel B: Levels—Inflation Adjusted

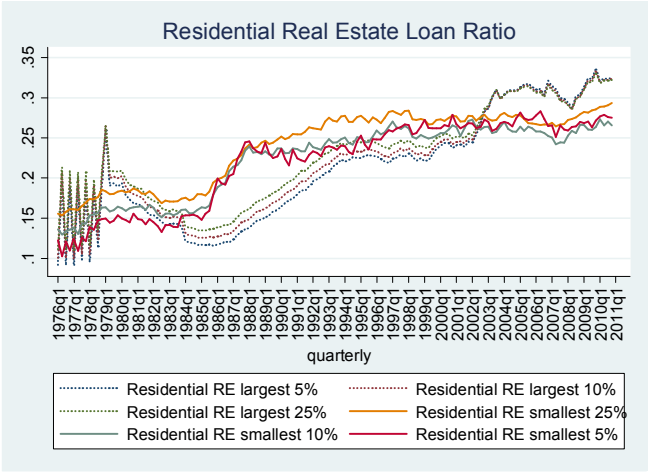


Banks' loan data are from regulatory Call Report and loans in each category are aggregated for all U.S. commercial banks for each year. All data in Panel B are inflation adjusted, base year is 1982.

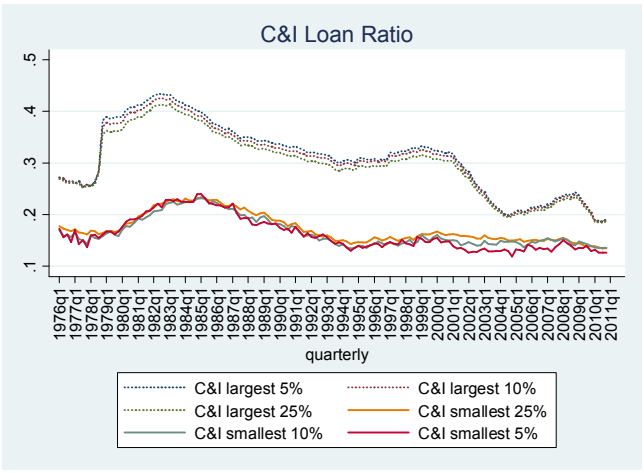
Panel C: Commercial Real Estate Loans



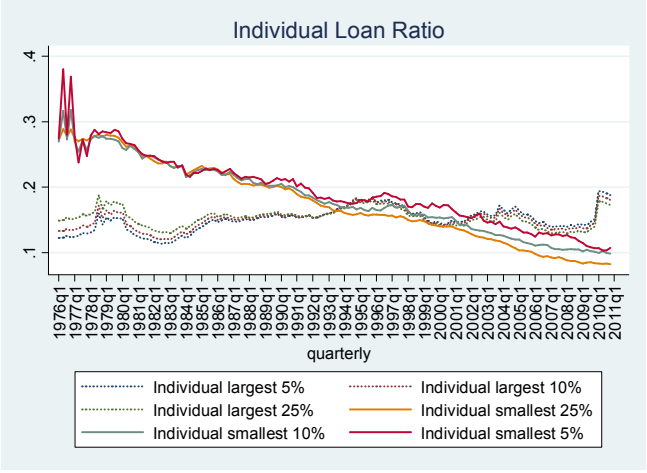
Panel D: Residential Real Estate Loans



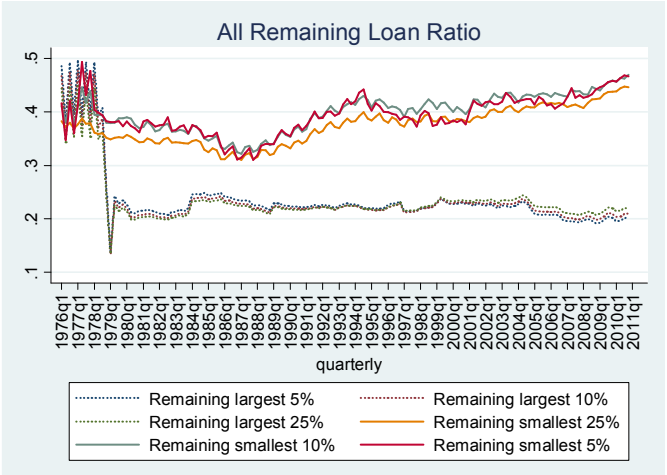
Panel E: Commercial & Industrial Loans



Panel F: Individual loans

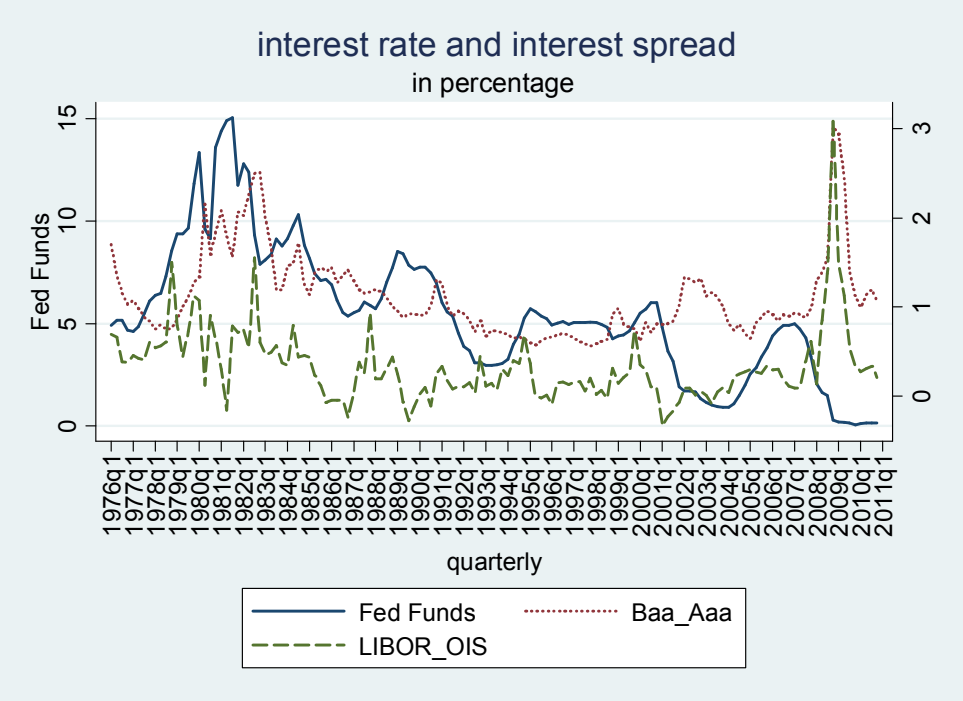


Panel G: Remaining loans for each size group



Source: Author's calculations based on Call Report Data.

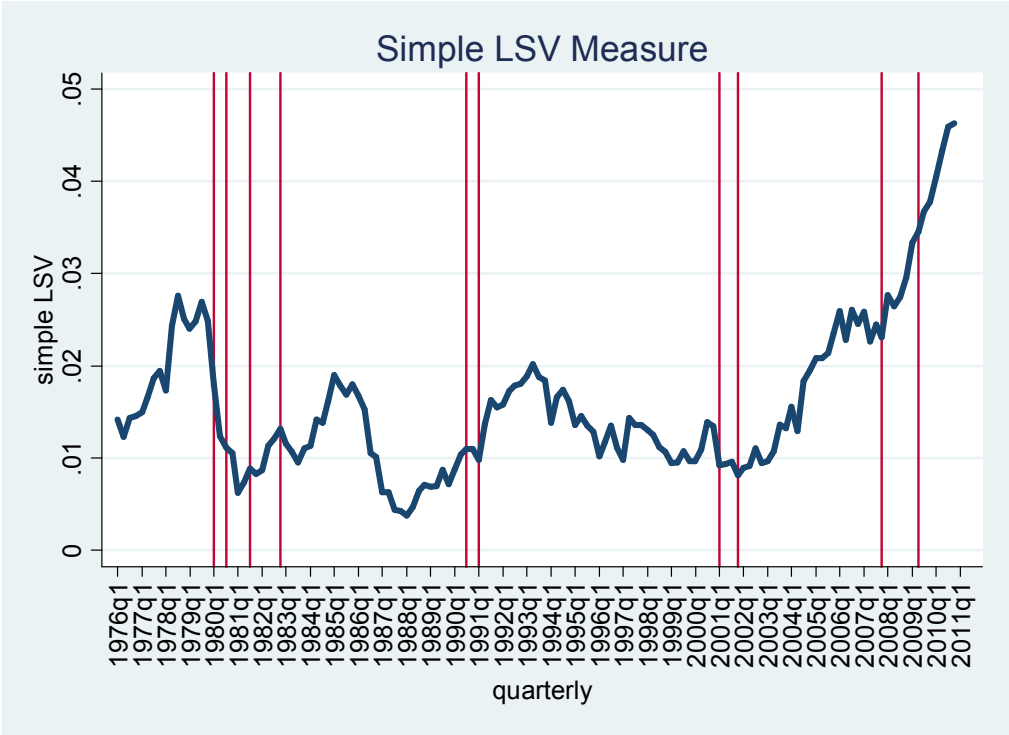
Figure 2: Interest Rate and Interest Spread in Percentage



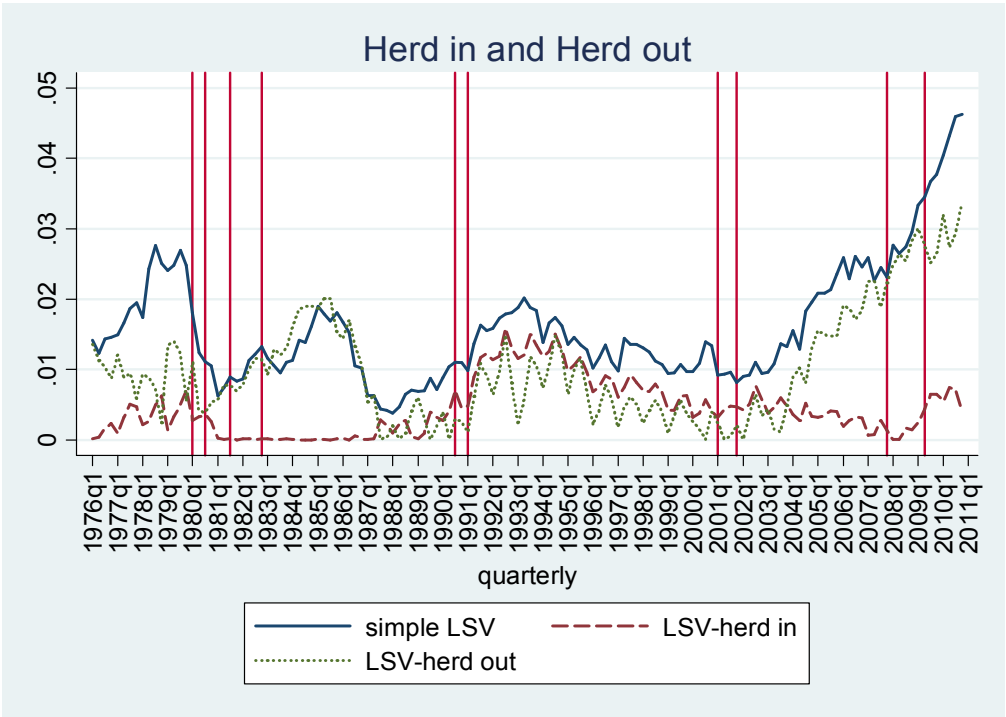
LSV measure is calculated based on loan data from Call Report. Federal funds rate and Baa-Aaa spread data are from H15 release of the Board of Governors of the Federal Reserve System. Libor-OIS spread is from Bloomberg. The left-hand-side scale corresponds to 3-month t-bill rate, and the right-hand-side scale corresponds to Baa-Aaa spread and Libor-OIS spread.

Figure 3: The LSV and FHW Herding Measures

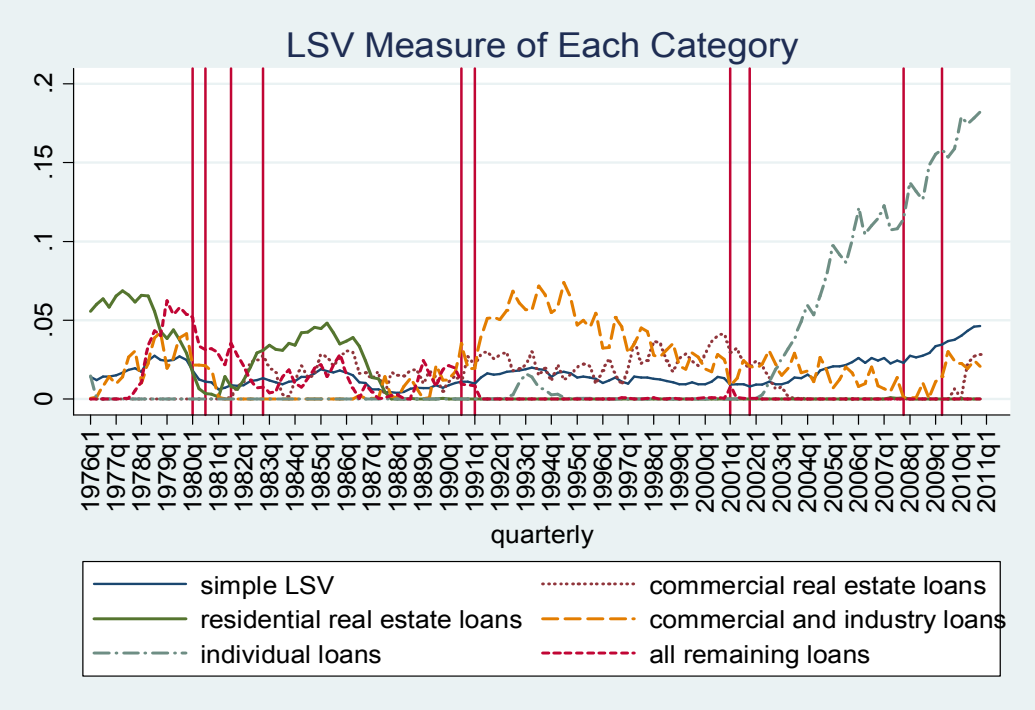
Panel A: Simple Mean LSV Measure



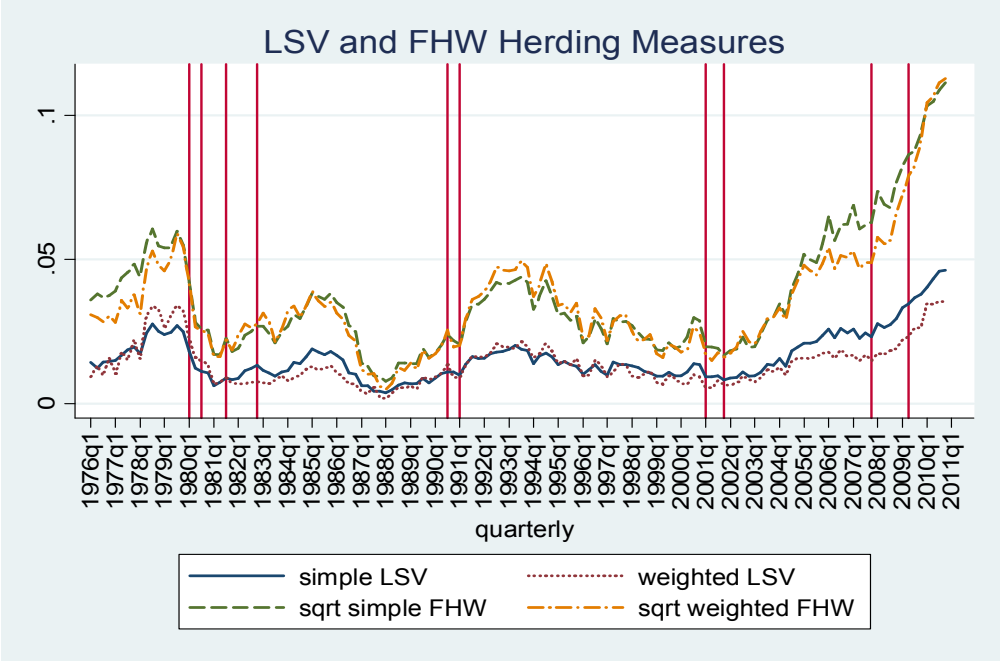
Panel B: LSV Measure: Herding In and Herding Out



Panel C: Simple Mean LSV Measure for Each Loan Category



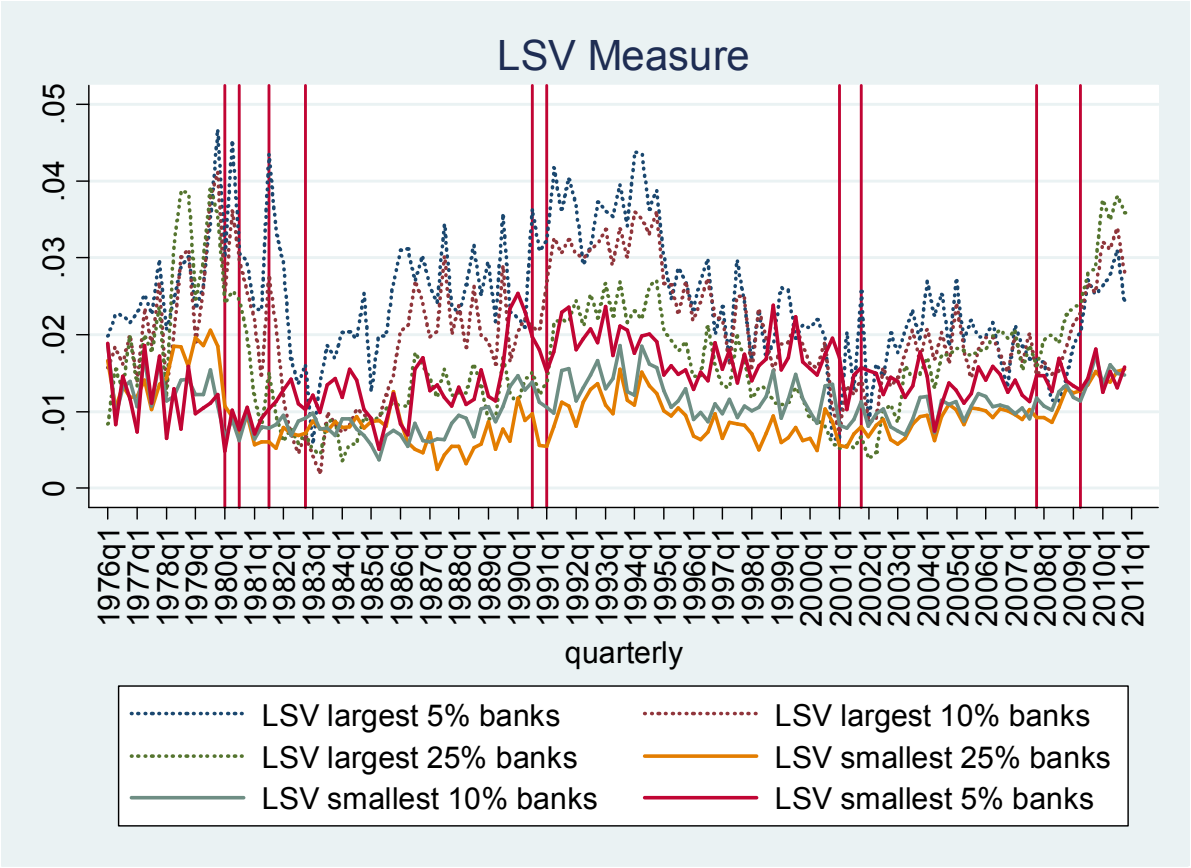
Panel D: LSV and FHW Herding Measures



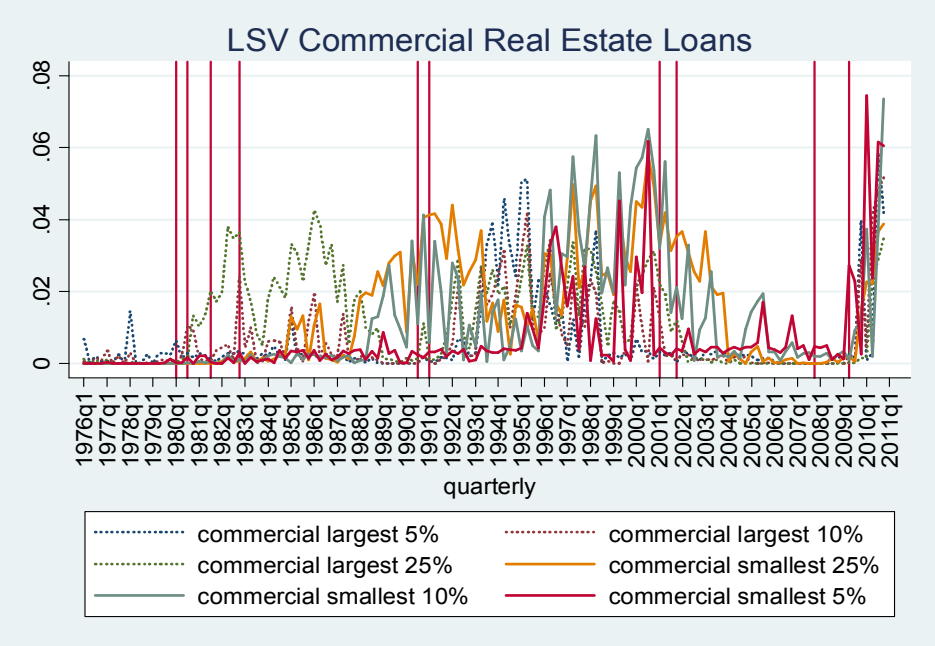
The vertical lines indicate the five NBER dated recessions: January-July 1980, July 1981-November 1982, July 1990-March 1991, March-November 2001, December 2007-June 2009. All herding measures are calculated based on loan data from Call Report.

Figure 4: LSV Herding Measure for Different Size Groups

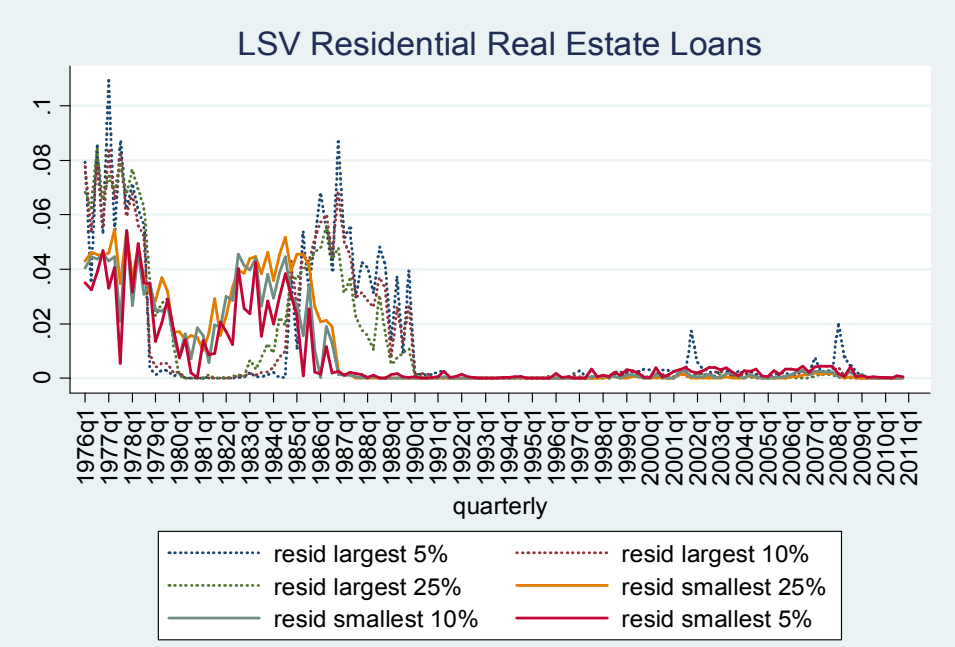
Panel A: Weighted Mean LSV Measure for Each Size Group



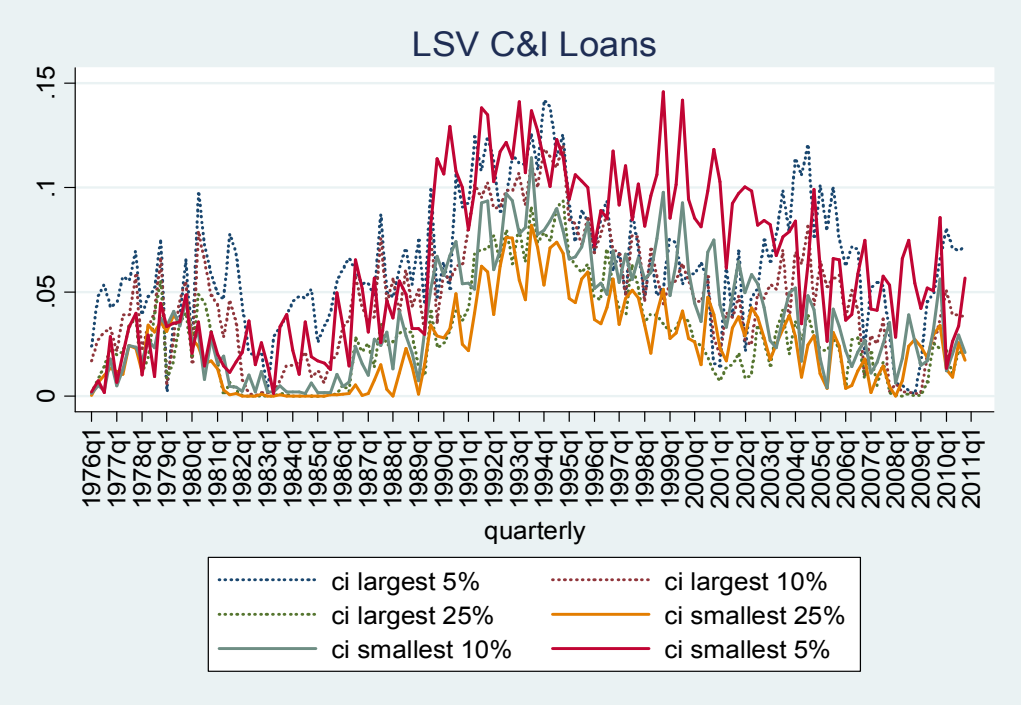
Panel B: LSV Measure for Commercial Real Estate Loans



Panel C: LSV Measure for Residential Real Estate Loans



Panel D: LSV Measure for Commercial & Industrial (C&I) Loans



Panel E: LSV Measure for Individual Loans