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Loan portfolio diversification, market structure and bank stability

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ABSTRACT

This paper examines whether the choice of bank loan diversification and market concentration are associated with a bank's financial stability. This study also investigates how the effect of loan diversification on bank stability varies depending on the level of the concentration or the competitiveness of the banking market. We find that increased loan diversification has a positive impact on the bank's financial strength. We show that market concentration is negatively associated with bank insolvency risk, consistent with the "concentration-stability" view. The results using interaction terms between loan portfolio diversification and market concentration indicate that diversifying banks operating in highly concentrated markets are more financially stable compared to those in less concentrated markets.

1. Introduction

The number of bank closures has sharply risen particularly during the most recent financial crisis in the United States. The Federal Deposit Insurance Corporation (FDIC) reports that 465 insured U.S. commercial banks failed between January 2008 and December 2012, while only 27 banks closed from October 2000 to December 2007. Politicians and regulators claim that the lack of competition in the banking industry may have played a significant role in the financial crisis period (e.g., Akins et al., 2016). Cole and White (2012) and Government Accountability Office (2013) report that the concentration on commercial real estate loans is among the contributing factors that led to an increased likelihood of recent bank closures across all states. The latest banking failure reports and collapse of large financial institutions (such as Lehman Brothers, Washington Mutual and Bear Stearns) during the financial crisis raise the following questions: Do banks reduce or increase financial fragility from diversification of their loan portfolios? Are banks in highly concentrated markets more financially stable than those in less concentrated markets or vice versa? Does the competitive nature of the market where the bank operates influence the relationship between diversification of activities and bank fragility? What are the important bank and economic characteristics that significantly influence a bank's financial stability? In this paper, we address these unanswered questions by undertaking an empirical investigation using the samples of U.S. commercial banks over the period 2002:Q1–2013:Q3.

U.S. banks have expanded their income sources from traditional lending activities toward a broader range of financial services such as brokerage, insurance underwriting, and other types of activities that generate non-interest income. The motives for diversifying income-generating activities and its implications for bank performance have received extensive attention in the literature (e.g., DeYoung and Roland, 2001; Stiroh, 2006; Stiroh and Rumble, 2006; Laeven and Levine, 2007; Guerry and Wallmeier, 2017). Banks may undertake diversification due to the benefits associated with economies of scale or scope, reduction of earnings volatility and other financial synergies. Conversely, diversification may increase potential costs associated with diseconomies of scale and aggravated agency problems. Thus, the net effect of diversification on bank performance remains an open empirical question. The empirical literature on U.S. banks has produced mixed evidence as to whether and how increased diversification affects profitability and risk (e.g., Stiroh and Rumble 2006; Shim, 2013). Given the conflicting views and inconsistent empirical results in the literature, the issue of net effects of diversification on bank's financial stability still draws attention to the need for additional investigation. We expect that loan portfolio diversification is negatively (positively) associated with bank fragility if the benefits (costs) of diversification exceed its potential costs (benefits).

The literature suggests that the nature of bank market structure has significant implications for bank's financial conditions. If market structure in banking is an important factor influencing

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individual bank's fragility, then failure to control for this variable may cause omitted variable problems and provide misleading inferences regarding the relation between diversification and bank stability. We extend and complement prior empirical studies by exploring further the role of banking system characteristics in shaping the relationship between loan portfolio diversification and bank stability. In this study, the potentially relevant banking sector characteristic is the degree of market concentration. Theoretical models derive contrasting predictions on the relationship between market concentration and bank stability.[1] One view is that a highly concentrated banking system is more stable than a less concentrated bank structure. Banks in less competitive environments have better profit opportunities and increased charter value due to high profits reduces incentives for banks to take excessive risks. The competing view predicts a positive relationship between market concentration and bank instability. Larger banks in concentrated market structure are likely to receive a greater subsidy through government safety nets when they face financial difficulty. This protective policy may create moral hazard problems and boost the bank's risk-taking incentives, leading to banking system fragility. Although theoretical literature on this topic has had some significant effect on bank regulators and policymakers, empirical evidence regarding indicators of banking market concentration and financial stability is very limited, with no clear consensus (e.g., Beck et al., 2006; Uhde and Heimeshoff, 2009). This paper attempts to provide further evidence on whether market concentration is positively (negatively) associated with a bank's financial stability.

To date, previous literature has focused either on the direct link between diversification and bank performance or on the link between market concentration and a bank's financial stability. To our knowledge, no prior empirical studies take into account the possibility that diversification of activities could confer a competitive advantage in a more (less) concentrated market. In this study, we investigate how the effect of loan diversification on bank stability varies depending on the level of the concentration or the competitiveness of the banking market. Transaction cost theory indicates that a firm would lower the level of diversification in response to increasingly competitive conditions because such competition would increase the bureaucratic costs of managing a multibusiness firm (e.g., Bergh and Lawless, 1998; Jones and Hill, 1988). This implies that a bank in a less competitive market may be better rewarded for expanding its scope than the bank operating in a more competitive market. We test this conjecture by examining the interaction effect of loan diversification and market concentration on a bank's financial stability.

By way of preview, our empirical results show that loan diversification is inversely associated with bank insolvency risk, implying that commercial banks may be able to diminish financial fragility from the diversification of their loan portfolios. We find that market concentration is negatively associated with bank insolvency risk, consistent with the "concentration-stability" view. The interaction terms between loan portfolio diversification and market concentration indicate that diversifying banks operating in highly concentrated markets are more financially stable compared to those in less concentrated markets. These main findings appear to be robust to an alternative methodology, accounting for mergers and acquisitions, and examining the pre-crisis, the crisis, and the post-crisis periods.

Our study adds to the literature in several ways. First, this is, to the best of our knowledge, the first study to examine how the interactions between loan portfolio diversification and market structure affect a bank's financial stability. This research complements the existing literature by identifying a further channel concerning the relationship between diversification and bank stability.

Second, the extant banking diversification-performance literature typically measures the diversification of banking activities by dividing total earning assets into two broad categories: lending versus non-lending activities (e.g., Laeven and Levine, 2007; Guerry and Wallmeier, 2017).[2] This simple dichotomous distinction may have potential measurement error problems and fail to account for the extent to which banks actually engage in various types of loan making activities. To overcome these problems, we identify a range of a bank's loan activities and take into account them in constructing diversification measures. Specifically, we measure the level of loan diversification by partitioning loan scope into six primary categories.[3] The use of abundant U.S. commercial bank data allows us to precisely capture the degree to which each bank provides a broad array of loan services.

Third, unlike previous studies that typically use national level market concentration, we measure market concentration based on Core Based Statistical Area (CBSA) because competition occurs locally and market concentration varies significantly by CBSA.[4] This is, to our knowledge, the first study that examines particularly the link between CBSA-level market concentration and bank fragility.

Finally, prior empirical research on the relationship between market concentration and bank stability has used the samples of a broader set of heterogeneous countries around the globe (Beck et al., 2006; Uhde and Heimeshoff, 2009). Berger et al. (2004) assert that it should be cautious in drawing inferences from the studies involving international comparisons because there is a possibility that cross-country differences in economic conditions, institutional structure, regulatory and supervisory policies may not be perfectly controlled. For this study, we use only U.S. data to attain greater homogeneity in the legal and regulatory environment. Our data obtained from one country reduce potential biases due to data constraints associated with the common employment of cross-country data.

The paper is structured as follows. Section 2 reviews the related literature and formulates main hypotheses. Section 3 describes the regression methodology and variables used in the analysis. Section 4 presents the data and analyzes empirical results. Several additional tests are also conducted in Section 4. Section 5 concludes.

2. Related literature and hypotheses development

2.1. Loan portfolio diversification and bank stability

The theoretical and empirical studies on the relationship between diversification of activities and bank performance provide conflicting predictions as well as inconsistent evidence. From the risk dimension, the standard portfolio theory predicts that the combined cash flows from low- or negative-correlated income sources should be less volatile than the component parts. Diamond (1984) in his delegated monitoring model shows that diversification serves to reduce the financial intermediary's delegation costs and financial intermediaries (such as banks) can

[1] See Boyd and De Nicoló (2005) and Beck et al. (2006) for an overview of the literature examining the relationship between concentration and competition in banking markets and banking system stability.

[2] Similarly, Stiroh and Rumble (2006), Laeven and Levine (2007) and Saghi-Zedek (2016) measure the diversification of banking activities using the breakdown of total operating income into two broad categories: net interest income versus non-interest income.

[3] The detailed components of loan portfolio used in our analysis are introduced in Section 3.2.2.

[4] The measure of market concentration based on CBSA is discussed in Section 3.2.3.

lower the probability of their default by adding more independent risks. Sinkey and Nash (1993) find that commercial banks specializing in credit-card loans have higher probabilities of insolvency than commercial banks with the mixture of traditional products. Rossi et al. (2009) show that diversification of bank's loan portfolio reduces realized risk determined by the amount of provisions of bad loans for large Austrian commercial banks. Sanya and Wolfe (2011) find that diversification across and within both interest and non-interest income generating activities increases risk-adjusted profits and decreases insolvency risk for banks in emerging economies. Shim (2013) also provides evidence that the probability of insolvency risk decreases for diversified U.S. bank holding companies that have broader sources of operating revenue. Meslier et al. (2014) show that income diversification enhances risk-adjusted profitability and foreign banks benefit more from diversification than domestic ones.

Banks acquire specific information about clients from their lending relationships that may facilitate the efficient provision of other financial services such as underwriting securities or insurance (e.g., Petersen and Rajan, 1994). Likewise, information acquired through securities and insurance underwriting, brokerage services, and other activities allows banks to better assess potential borrowers' credit risks and improve the quality of loans (e.g., Baele et al., 2007). Banks can achieve economies of scope by effectively sharing inputs such as labor, technology and information across multiple different types of loans. In addition, expanding their loan portfolio into broad sectors reduces the riskiness of commercial banks via diversification effects. Therefore, we expect that loan diversification is positively related to bank stability if diversification of activities enables banks to reduce the risk and achieve economies of scope.

Hypothesis 1a. *Loan diversification is positively associated with bank stability.*

On the other hand, diversification may lead to increase in costs as a result of the agency problem that arises from a conflict of interest between managers and shareholders.[5] It is argued that diversification activity is driven by the managers' incentive to enhance their ability to extract private benefits (Jensen, 1986). Even when diversification reduces the market value, managers may choose to diversify if the potential private gains to them from diversification exceed the costs incurred due to the decrease in market valuation. Thus, the motive for diversification may not be shareholder value maximization, but managerial self-interests that pursue their private benefits. Diversification of activities may also aggravate the agency problem by allowing cross-subsidization to poor-performing segments, creating the possibility of inefficiency (Jensen, 1986; Shin and Stulz, 1998). In these circumstances, the potential diversification benefits are likely to be offset by the increased frictional costs associated with agency problems. Berger et al. (2010) examine the effects of product and geographical focus versus diversification on performance of Chinese banks and find that diversification is associated with decreased profits and increased costs.

The diversification effect rests largely on the type of diversifying activities that bank undertakes. Diversification benefits will be limited if banks lend more of their assets to risky borrowers or hold more risky loans such as commercial real estate loans (e.g., Cole and White, 2012; DeYoung and Torna, 2013). DeYoung and Roland (2001) and Stiroh and Rumble (2006) show that the increased exposure to the non-interest and fee-based activities is associated with higher earnings volatility. Similarly, De Jonghe (2010) and Brunnermeier et al. (2016) document that non-interest generating activities increase bank system instability. Diversification may aggravate bank performance if banks diversify into new lines of business where management does not have expertise and experience (Stiroh, 2006). If diversification involves in expanding into sectors where monitoring expertise is lacking, then the worse returns in new sectors may reduce the bank's average loan returns and increase the risk of bank insolvency (e.g., Rossi et al., 2009). We expect the loan diversification to be negatively associated with bank stability if the potential costs of diversification associated with agency problems outweigh diversification gains and banks diversify more into highly risky loans.

Hypothesis 1b. *Loan diversification is negatively associated with bank stability.*

2.2. Market concentration and bank stability

The "concentration-stability" view predicts that a concentrated banking system characterized by a few large banks is more stable since banks in high concentrated markets may be more profitable, better diversified (Diamond, 1984), and easier to monitor (Allen and Gale, 2000), and hence can endure shocks without collapsing. High profits facilitate building up capital buffer to provide protection against adverse financial shocks and increase the franchise value of the bank. Higher franchise values lower incentives to take excessive risk, reducing the moral-hazard problems (Keeley, 1990; Hellmann et al., 2000). A bank with a higher franchise value is likely to preserve these values by limiting its risk exposure.

Theoretical arguments indicate that in less concentrated and more competitive banking systems, banks earn lower informational rents from their relationship with borrowers. The pressure on profits may provide fewer incentives for bank managers to properly screen borrowers, increasing the risk of bank fragility (Allen and Gale, 2000, 2004). Boyd et al. (2004) present that the likelihood of a costly banking crisis is lower under monopoly than in competitive market. Beck et al. (2006) find using data from 69 countries that systemic banking crises are less likely in more concentrated banking systems, consistent with the concentration-stability view. We expect to observe a positive relationship between market concentration and bank stability if more concentrated banking systems enhance the bank's financial strength.

Hypothesis 2a. *A more concentrated banking structure enhances the bank's financial stability.*

On the other hand, the "concentration-fragility" view suggests that a more concentrated banking structure with a few large institutions is more prone to financial fragility than a less concentrated banking sector with many banks (Boyd and De Nicoló, 2005). Banks in concentrated systems tend be larger than banks in more competitive markets. Large banks in concentrated banking systems are likely to receive a greater net subsidy through implicit "too important to fail" policies. The recent research presents that the presence of deposit insurance and other government interventions lead to moral hazard problems, which may distort banks' risk taking incentives. Thus, the potential subsidy for large banks may increase bank's risk taking incentives, heightening the fragility of concentrated banking systems (e.g., Boyd and Runkle, 1993; Mishkin, 1999). Boyd and De Nicoló (2005) argue that banks in more concentrated markets use their market power to earn more rents in their loan markets by charging higher loan rates. When confronted with higher loan rates charged by banks, borrowers may seek more risk to make up profit shortage, ultimately increasing their bankruptcy risk. The increased likelihood of borrower default leads to lower bank stability. As a consequence, theoretical

[5] Laeven and Levine (2007) argue that diversification of activities could intensify agency problems with adverse implications on the market's valuation of banks and that economies of scope are not sufficiently large to generate a diversification premium.

analyses done by Boyd and De Nicoló (2005) indicate a negative relationship between market concentration and bank stability. Using consolidated balance sheet data across the 25 Member States of the European Union (EU-25), Uhde and Heimeshoff (2009) provide evidence that national banking market concentration has a negative impact on European banks' financial soundness, supporting the concentration-fragility view. We predict that market concentration is negatively associated with bank stability if banks can endure shocks better without collapsing in less concentrated market in which the market is spread among many institutions.

Hypothesis 2b. *A more concentrated banking system enhances the bank's financial fragility.*

2.3. Interaction effect of loan diversification and market concentration on bank stability

Transaction cost theory postulates that a firm's optimal level of diversification is determined by weighing the economic gains of diversification and the bureaucratic costs of managing a portfolio of businesses (e.g., Jones and Hill, 1988). This theoretical framework suggests that a firm would reduce the level of diversification if changes in a firm's competitive environment lead to increased costs of monitoring, integrating and coordinating its diverse activities (e.g., Bergh and Lawless, 1998; Jones and Hill, 1988). Heightened competitive conditions engender both uncertainty and complexity in the marketplace, which escalates pressure on the limited amounts of managerial attention to reduce organizational inefficiencies. When a firm faces increased competition in its core business, the payoff of maintaining managerial attention on non-core businesses will be decreased. As a result, the firm will choose to reduce its level of diversification by redistributing insufficient managerial resources and attention away from its non-core businesses (e.g., Bowen and Wiersema, 2005). This theoretical perspective implies that diversification might be more advantageous in less competitive markets than in more competitive markets.

Diamond (1984), Ramakrishnan and Thakor (1984), Boyd and Prescott (1986), and others argue that concentrated banking systems tend to have larger banks and larger banks are more diversified than smaller ones.[6] Diversifying banks in concentrated banking systems have better profit opportunities possibly due to market power, economies of scope, and synergies among the businesses in a bank's portfolio. Thus, diversified banks are likely to be less fragile compared with specialized firms if they operate in a more concentrated market. Banks' risk profiles could also change if diversification affects competition in banking markets. Competition for borrowers may become intense as banks expand their loan portfolios. The increased competition decreases a bank's rents and erodes its franchise value, providing incentives for bank owners and managers to take on more risk and thus leading to a higher probability of bank failure (Keeley, 1990; Hellmann et al., 2000; Repullo, 2004). Based on the above discussion, we predict that diversifying banks in highly concentrated markets are likely to have more financial stability than those in less concentrated markets.

Hypothesis 3a. *The effect of loan diversification on the bank's financial stability is positively related to the level of market concentration.*

An alternative hypothesis can be developed based on the following reasoning. If bank loan markets become more competitive, profits may be decreased as banks charge lower rates on loans and expend more resources towards monitoring and coordinating their loan activities. However, Hughes and Mester (1998) suggests that a larger and more diversified bank may capitalize on the reduced marginal cost of managing risk provided by larger scale and diversification and take excessive risk. Demsetz and Strahan (1997) state that large bank holding companies use their diversification advantage to operate with greater leverage and to increase risky lending. As noted earlier, large diversified banks are likely to receive a greater net subsidy from the government because regulators are concerned about potential macroeconomic consequences of large bank failures (O'Hara and Shaw, 1990). This may produce an incentive for bank managers to enter excessively risky lines of business and ultimately increase financial fragility of banking systems. Furthermore, concentrated banking systems boost market power, which allows large diversifying banks to charge higher loan rates. This may induce borrowers to engage in riskier activities and thus the amount of non-performing loans might increase, resulting in a higher probability of bank default (Boyd and De Nicoló, 2005). Caminal and Matutes (2002) note that less competition can lead to reduced credit rationing and larger loans, heightening the probability of bank failure. Therefore, we expect that diversifying banks in highly concentrated markets may have more financial instability than those in less concentrated markets.

Hypothesis 3b. *The effect of loan diversification on the bank's financial stability is negatively related to the level of market concentration.*

3. Methodology and variable construction

3.1. Empirical framework

To examine links between loan portfolio diversification, market concentration and a bank' financial stability while controlling for firm-specific and economic characteristics, we conduct multivariate ordinary least squares (OLS) regressions using a series of pooled, cross-sectional, and time-series data. We use unbalanced panel data to avoid survivor bias and to maximize the number of observations. One line of research argues that the observed diversification discount is attributable to endogeneity problems (Campa and Kedia, 2002; Villalonga, 2004). A bank's decision to diversify can be endogenous if the diversification variable is correlated with other omitted variables such as management skill or industry exposure that determine, in part, bank fragility. The presence of potential endogeneity problems may lead the standard ordinary least squares (OLS) approach to produce biased and inconsistent coefficient estimates.

To mitigate some endogeneity concerns, we employ fixed-effect models that include state, time (quarter), and firm dummies. Fixed-effect models enable us to account for unobservable changes at the state-quarter level and to control for omitted bank-specific effects which may be correlated with other variables in the model. The basic regression model to test our hypotheses is written as follows:

$$Z_{i,t} = \alpha_0 + \alpha_1 Div_{i,t} + \alpha_2 MC_t + \alpha_3 (Div_{i,t} \times MC_t) + \sum \alpha_k X_{i,t} + d_{i,t} + s_{i,t} + f_{i,t} + v_{i,t} \quad (1)$$

where $Z_{i,t}$ denotes the Z-score of bank i at time t, $Div_{i,t}$ is a measure of loan portfolio diversification, MC_t is a measure of market concentration, $X_{i,t}$ is a matrix of other control variables, $d_{i,t}$ ($s_{i,t}$ and $f_{i,t}$) is a vector of time (state and firm) fixed-effect, and $v_{i,t}$ is the error term.

Similar to Laeven and Levine (2009) and Houston et al. (2010), we use the natural logarithm of Z-score considering high skewness of Z-score across our sample banks. The coefficient α_1 (α_2) measures the direct effect of loan diversification (market concentration). The coefficient α_3 of the interaction term ($Div_{i,t} \times MC_t$) measures how the effect of loan diversification on a bank's financial stability varies with the degree of competition in the banking market.

[6] Hughes and Mester (1998) note that larger size implies the potential for improved diversification in banking.

3.2. Definition of variables

3.2.1. A bank's financial stability

Following the literature, we utilize a Z-score as a proxy measure of a bank's financial stability (Hannan and Hanweck, 1988; Stiroh and Rumble, 2006; Laeven and Levine, 2009; Houston et al., 2010; Shim, 2013). The Z-score of each bank is measured by the return on assets (ROA) plus the capital to asset ratio divided by the standard deviation of ROA. The standard deviation of ROA is calculated by using rolling period data over the preceding twelve quarters. The Z-score is considered as a measure of the bank's distance-to-default since it presents the number of standard deviations that profits should fall to push a bank into insolvency. The Z-score is inversely related to the probability of insolvency. Therefore, a higher Z-score indicates a lower probability of bank default.

3.2.2. Loan portfolio diversification

We employ a Herfindahl-Hirschman index (HHI) to construct a loan-based measure of diversification for each bank. Similar to Berger and Bouwman (2013), we classify loan scope of the commercial bank into six major sectors: commercial real estate loans (REA), construction and industrial loans (IND), residential real estate loans (RES), loans to consumers (CON), agricultural loans (AGR), and all other loans (OTH).[7] Loan HHI is calculated by the sum of the squared loan portfolio shares across six types of loans:

$$Loan\ HHI = \left(\left(\frac{REA}{TOL}\right)^2 + \left(\frac{IND}{TOL}\right)^2 + \left(\frac{RES}{TOL}\right)^2 + \left(\frac{CON}{TOL}\right)^2 + \left(\frac{AGR}{TOL}\right)^2 + \left(\frac{OTH}{TOL}\right)^2\right) \quad (2)$$

where TOL denotes total loans and is equal to the sum of the values of REA, IND, RES, CON, AGR, and OTH. Loan HHI takes a value of one if all loans are made to a single sector. The loan portfolio diversification is then calculated by one minus Loan HHI. A lower value of this diversification index suggests that the bank has a specialized loan-making, while the higher value indicates that the bank engages in a combination of various loan-making activities.

3.2.3. Market concentration

While previous studies typically use the Metropolitan Statistical Areas (MSAs) to define geographical banking markets (e.g., Cetorelli and Strahan, 2006; Dick, 2006), we apply the new local market delineations based on Core Based Statistical Area (CBSA) and non-CBSA county.[8] As a direct measure of local market concentration, we use the deposit Herfindahl-Hirschman index (HHI) calculated by the sum of the squares of the percentages of total deposits across all banks ($i = 1 to n$) in each statistical area (CBSA) s and in each quarter t.

$$Concentration(HHI)_{s,t} = \sum_{i=1}^{n}\left[\frac{Deposits_{i,s,t}}{\sum_{i=1}^{n} Deposits_{i,s,t}}\right]^2 \quad (3)$$

A high HHI indicates more concentrated market, while a low HHI suggests less concentrated market.

3.2.4. Firm size

The "too important to fail" hypothesis suggests that larger banks may have more incentives to engage in riskier lending activities due to a government's safety net (e.g., Mishkin, 1999). However, the charter value acts as a restraint against moral hazard. Larger banks may deter excessive risk-taking behavior to protect their charter or franchise value (Keeley, 1990; Hellmann et al., 2000). Previous empirical studies provide mixed evidence on the relation between bank size and risk-taking. For example, Boyd and Runkle (1993) find a negative relationship between the size of bank holding companies and the volatility of asset returns, while Fu et al. (2014) show that larger banks have greater risk. Bertay et al. (2013) show that bank size is not significantly associated with bank risk measured by the Z-score. Thus, it is difficult to predict a priori the direction of impact of bank size on its stability. We measure the natural logarithm of total assets as a proxy for firm size.

3.2.5. Non-interest share

To examine the impact of increased non-interest income on bank stability, we include the non-interest share of a bank's operating revenue. DeYoung and Roland (2001) show that replacing traditional lending activities with non-interest and fee-based activities is associated with higher volatility of bank earnings. They also find that this shift in product mix is accompanied by an increase in bank profitability, suggesting a risk premium associated with these activities. Stiroh and Rumble (2006) find that increased exposure to non-interest activities is relatively volatile but not more profitable than lending activities. A higher share of non-interest income in total income is expected to be negatively related to bank stability if increased non-interest income is more exposed to high volatility. In contrast, a positive relationship between the non-interest share and bank stability is expected if cash flows from banks' expanded services are less volatile and cross-selling opportunities increase revenues. Similar to Stiroh and Rumble (2006) and Shim (2013), the non-interest share includes fiduciary income, service charges on deposit accounts, trading revenue, and other non-interest income.

3.2.6. Liquidity

The liquidity captures the ability of the bank to meet short-term financial obligations without having its investments or fixed assets sold quickly at lower prices. During the financial crisis period, some financial institutions failed because they were unable to attain liquidity. Berger and Bouwman (2013) argue that high cash holding can decrease liquidity risk and help banks lower the likelihood of failure. Cole and White (2012) and DeYoung and Torna (2013) show that banks with more liquid assets are less likely to fail. Thus, the liquidity is expected to be positively related to a bank's financial stability. The liquidity is calculated by dividing liquid assets (cash and marketable securities) by total assets.

3.2.7. Brokered deposits

Brokered deposits are deposits that banks acquire indirectly through the mediation or assistance of deposit brokers rather than from local customers. The brokers market the pooled deposits to financial institutions for a higher rate and banks often attempt to grow rapidly using riskier funding sources such as brokered deposits. The acceptance of these brokered deposits may lead a bank to take greater risk because the bank must earn more to pay high interest costs (Government Accountability Office, 2013). DeYoung and Torna (2013) and Cole and White (2012) indicate that

[7] Because a breakdown of the U.S. commercial banks' lending into specific industries is not publicly available, our loan diversification measures rely on sectoral aggregation.

[8] Areas defined on the basis of these new standards were announced in June 2003. The CBSA is a collective term for both Metropolitan and Micropolitan Statistical Areas (see http://www.census.gov/population/metro/ for more details of delineations and standards). The summary of deposit data to form HHI based on the new definition are observable at the FDIC's website. The SNL data sources are available to map commercial banks into CBSA. We exclude banks not located in either Metropolitan Statistical Areas or newly-created Micropolitan Statistical Areas from the sample.

Table 1
Definition of variables and expected sign.

Variable	Description	Expected sign
Z-score	Return on assets (ROA) plus the capital to asset ratio divided by the standard deviation (SD) of ROA	
Loan diversification	1- Herfindahl index of loan portfolio classified into six major sectors	±
Concentration (HHI)	Market concentration, as measured by CBSA-level Herfindahl index based on total deposits	±
Firm size	Natural logarithm of total assets	±
Non-interest share	Non-interest income / (net interest income + non-interest income)	±
Liquidity	Liquid assets (cash and marketable securities) / total assets	+
Brokered deposits	Brokered deposits / total assets	−
Core deposits	Sum of demand deposits, automatic transfer, money market deposits, savings deposits and small time deposits divided by total assets	+
BHC member	Indicator equal to one if the bank is a member of bank holding company and zero otherwise	+
De novo bank	Indicator equal to one for de novo banks and zero otherwise	−
FDIC	Indicator equal to one for banks supervised by the FDIC and zero otherwise	−
Federal Reserve	Indicator equal to one for banks supervised by the Federal Reserve and zero otherwise	−
Unemployment rate	Deviation of state-level unemployment rate from the national average	−
GDP growth rate	Deviation of state-level GDP growth rate from the national average	+
CBSA loan diversification	Three-year average loan diversification of other banks domiciled in the same CBSA as bank *i*	+
CBSA asset growth	Three-year average asset growth rate across all banks domiciled in the same CBSA as bank *i*	+

CBSA loan diversification and CBSA asset growth are instrumental variables used in the IV-GMM estimation method.

brokered deposits tend to be positively associated with the likelihood of bank failure. Berger and Bouwman (2013) show that small banks are less likely to survive if they have more brokered deposits. Consequently, the higher level of brokered deposits is expected to be positively associated with bank fragility. We include brokered deposits normalized by total assets.

3.2.8. Core deposits

Core deposits are typically funds of a bank's regular customers and viewed as relatively stable and less costly sources of funding with the lower interest rates. Following the Uniform Bank Performance Report (UBPR) User Guide, we define core deposits as the sum of demand deposits, automatic transfer service (ATS) accounts, money market deposit accounts (MMDAs), savings deposits and time deposits under $100,000, minus brokered deposits under $100,000, normalized by total assets.[9] Berger and Bouwman (2013) show that more core deposits help small and medium-sized banks survive. DeYoung and Torna (2013) find that core deposits are associated with a reduced probability of failure. We expect a positive coefficient on this variable if banks with larger shares of core deposits face a lower chance of bank failure.

3.2.9. Member of bank holding company

To control for different banking organization, we include an indicator variable equal to one if the bank is a member of bank holding company (BHC) and zero otherwise. BHC membership is predicted to be positively associated with bank stability if banks affiliated with BHC have ready access to greater financial resources and managerial expertise when needed (DeYoung, 2003; Berger and Bouwman, 2013).

3.2.10. De novo banks

De novo banks are newly chartered banks, which can be an important source of competition in local markets and tend to specialize in supplying the credit needs of small businesses. However, the literature suggests a relatively high failure rate of these de novo banks compared with established ones (e.g., DeYoung, 2003). To investigate the relationship between de novo banks and their financial stability, we include an indicator variable set equal to one for de novo banks and zero otherwise. The coefficient sign of this variable is expected to be negative if de novo banks are less profitable and more financially fragile than their established bank counterparts.

3.2.11. Supervisory choice

A bank has the option to choose its supervisor in general. The presence of several supervisors leads to differences in the leniency of supervisory constraints and supervisory costs (e.g., Berger and Bouwman, 2013). Excessive leniency may facilitate the bank's excessive risk taking. To examine how supervisory choice influences the bank's risk taking behavior, we include two indicator variables set equal to one for banks with the Federal Reserve (for state member banks) and the FDIC (for state nonmember banks), respectively and set equal to zero otherwise. The omitted category consists of banks supervised by the Office of the Comptroller of the Currency (for national charter banks).

3.2.12. Unemployment rate and GDP growth rate

To examine the impact of local economic conditions on the bank's financial stability, unemployment rate and GDP growth rate in the state where the bank is headquartered are included as proxies for the economic conditions in the bank's home market. The state-level unemployment rate and GDP growth rate are measured in terms of deviations from the national average. DeYoung (2003) argues that banks in states with stable economies are less likely to suffer loan quality problems. We expect the state-level unemployment rate (state-level GDP growth rate) to be negatively (positively) associated with bank stability if bank profits rise (fall) in economic upturns (downturns) and if the volatility of the bank profits increases (decreases) during the economic downturns (upturns). The definitions and expected signs of the variables used in the regression analysis are summarized in Table 1.

4. Data and empirical results

4.1. The sample

The financial data representing banks' portfolio and operating characteristics are taken from the Call Reports. Our sample consists of an unbalanced panel on a quarterly frequency over the pe-

[9] As of March 31, 2011, the definition was modified to reflect the FDIC's deposit insurance coverage increase from $100,000 to $250,000 (Federal Deposit Insurance Corporation, 2011).

Table 2
Summary statistics.

Variable	Mean	Median	Std Dev	Minimum	Maximum
Z-score	116.6014	97.6668	84.7378	2.7325	365.7588
ROA	0.0020	0.0022	0.0091	−0.7370	1.0350
Capital to asset ratio	0.1204	0.1003	0.0963	0.0048	0.9888
SD of ROA	0.0024	0.0011	0.0050	0.0001	0.3454
Loan diversification	0.3632	0.3381	0.1158	0.1752	1.0000
Market concentration	0.3643	0.2912	0.2640	0.0145	1.0000
Firm size	12.1140	11.9616	1.3729	7.2378	21.4113
Non-interest share	0.1750	0.1445	0.1456	0.0000	1.0000
Liquidity	0.2627	0.2352	0.1551	0.0000	0.9991
Brokered deposits	0.0415	0.0000	0.0879	0.0000	0.9384
Core deposits	0.2967	0.2900	0.1499	0.0000	0.9409
BHC member	0.8443	1.0000	0.3626	0.0000	1.0000
De novo bank	0.2534	0.0000	0.4350	0.0000	1.0000
FDIC	0.6600	1.0000	0.4737	0.0000	1.0000
Federal reserve	0.1371	0.0000	0.3440	0.0000	1.0000
Unemployment rate	0.0047	0.0026	0.0150	−0.0617	0.0609
GDP growth rate	0.0059	−0.0003	0.0353	−0.0649	0.3376
CBSA loan diversification	0.3637	0.3503	0.0715	0.2078	1.0000
CBSA asset growth	0.0160	0.0159	0.0231	−0.6325	0.3407

This table reports the descriptive statistics of bank-specific, industry and economic characteristics. The sample used in the primary specification consists of 136,400 bank-quarter observations over the period 2002:Q1–2013:Q3. The variables are defined in Table 1.

riod between 2002: Q1 and 2013: Q3.[10] To avoid survivorship bias, our sample contains both failed and non-failed commercial banks operating at any point over the sample period. State-level unemployment data are taken from the Bureau of Labor Statistics' Employment and Earnings.

Similar to the literature (e.g., Laeven and Levine, 2007), we eliminate banks that report missing values in accounting variables such as assets, equity capital, deposits, and total loans. There are a number of extreme values among the observations of dependent variable (Z-score) and financial ratios constructed from raw data. Similar to the literature (e.g., Stiroh and Rumble, 2006; Houston et al., 2010; Saghi-Zedek, 2016) and to ensure that statistical outcomes are not severely influenced by outliers, we winsorize our main dependent variable (Z-score) along with other control variables at the 1% and 99% levels. Finally, the banks that do not have at least twelve continuous quarterly time series observations are excluded because we need to calculate rolling-window standard deviations of ROA over the preceding twelve quarters. This procedure leads to a final sample of approximately 136,400 quarterly observations. The descriptive statistics on the variables used in the regressions are presented in Table 2.

4.2. Results for primary specification

Table 3 reports estimations of the parameters from the Eq. (1) using the natural logarithm of Z-score (columns 1 and 2) and Z-score itself (columns 3 and 4) as a measure of a bank's financial stability.[11] Columns 1 and 3 (2 and 4) present the results of fixed effects with state and quarter (state, quarter and bank) dummy variables.[12] Standard errors that control for heteroskedasticity and firm-level clustering are reported in parentheses (Petersen, 2009).

The results in Table 3 show that the estimated coefficients of loan diversification are positive and significant within the 1% significance level, providing support for Hypothesis 1a that loan diversification is positively associated with a bank's financial stability. The results suggest that banks diversifying loan portfolio can reduce the risk of their fragility more efficiently than banks focusing their loan-making on the specialized area.

The coefficients of market concentration measured by CBSA-level deposit HHI are statistically significant and positive, showing that market concentration is positively associated with a bank's financial stability. The result suggests that banks operating in the concentrated market structures with a few large firms that supply most of the market are more financially secure than those in less concentrated market structures with many institutions, each with a small share of the market. This result provides evidence supporting the concentration-stability view and is consistent with our Hypothesis 2a and previous theoretical and empirical studies (e.g., Boyd et al., 2004; Beck et al., 2006).

The interaction terms between loan diversification and market concentration show that the effect of loan diversification is different for banks in more or less concentrated markets. Specifically, the interaction terms are positive and significant, providing support for the Hypothesis 3a that the effect of loan diversification on the bank's financial stability is positively associated with the level of market concentration. The result indicates that diversifying banks in highly concentrated markets are likely to be more financially stable than those in less concentrated markets. As discussed in Section 2.3, this result is consistent with a theoretical view that diversification of activities is more advantageous in markets that are less competitive.

The results of other control variables are generally consistent with our predictions. The coefficient of bank size is statistically significant and positive, suggesting that large banks tend to have lower financial fragility than small banks. The result might be consistent with the view that charter or franchise value may reduce managers' incentives to take more risk (Keeley, 1990; Hellmann et al., 2000). The non-interest income share is negatively related to the Z-score, as expected if the growing share of non-interest income results in the increased volatility of accounting returns. The coefficient of liquidity is positive and significant in two of the four regressions, partially suggesting that a greater proportion of liquid assets have a positive effect on the bank's financial strength.

[10] Because of calculating the standard deviation of ROA based on the preceding twelve-quarter rolling periods, other variables for regression analysis span the period from 2005: Q1 through 2013: Q3.

[11] We estimate the Variance Inflation Factor (VIF) to investigate the presence of multicollinearity for the variables used in the regressions. Because values of VIF are less than 3.0 for all variables, there is no multicollinearity concerns in our model.

[12] The coefficient estimates of state, quarter and bank dummies are not reported to conserve space. Alternatively, we include CBSA, quarter and bank fixed effects. The main results are not affected.

Table 3
Regression results for primary specification.

Variable	Dependent variable = Log (Z-score)		Dependent variable = Z-score	
Loan diversification (1)	0.353***	0.325***	25.488***	24.674***
	(0.083)	(0.086)	(4.471)	(4.585)
Market concentration (2)	0.086**	0.101***	5.342***	6.409***
	(0.036)	(0.038)	(1.984)	(2.039)
Interaction (1) × (2)	0.107***	0.111***	5.988***	6.737***
	(0.027)	(0.028)	(1.780)	(1.835)
Firm size	0.060***	0.061***	3.661***	3.736***
	(0.008)	(0.008)	(0.405)	(0.431)
Non-interest share	−0.734***	−0.733***	−35.998***	−34.899***
	(0.065)	(0.066)	(3.187)	(3.205)
Liquidity	0.085	0.053	11.596***	9.566***
	(0.054)	(0.056)	(3.240)	(3.330)
Brokered deposits	−0.447***	−0.414***	−29.887***	−28.652***
	(0.103)	(0.105)	(5.297)	(5.356)
Core deposits	0.604***	0.637***	25.645***	27.392***
	(0.068)	(0.070)	(3.639)	(3.742)
BHC member	0.083***	0.091***	5.693***	6.110***
	(0.025)	(0.026)	(1.384)	(1.429)
De novo bank	−0.347***	−0.339***	−18.243***	−17.854***
	(0.024)	(0.024)	(1.198)	(1.221)
FDIC	−0.049**	−0.049**	−3.493***	0.190
	(0.022)	(0.023)	(1.250)	(0.458)
Federal reserve	−0.065**	−0.072**	−3.362**	0.258
	(0.029)	(0.031)	(1.704)	(0.627)
Unemployment rate	−1.320*	−1.342*	−142.007***	−140.322***
	(0.744)	(0.748)	(40.112)	(40.223)
GDP growth rate	1.243***	1.234***	66.273***	65.355***
	(0.060)	(0.060)	(3.766)	(3.757)
Constant	3.262***	3.244***	21.678**	19.958*
	(0.163)	(0.167)	(10.764)	(10.939)
State-quarter fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	No	Yes	No	Yes
Observations	136,400	136,400	136,400	136,400
Adjusted R-squared	0.127	0.253	0.114	0.288

This table reports estimation results for the primary specification of Eq. (1). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

The coefficient on the brokered deposits is negative and significant, indicating that greater reliance on brokered deposits may have a negative impact on the bank's financial health. In contrast, core deposits have a positive influence on the bank's financial strength, as expected if core deposits are considered to be a stable and less costly source of funding. The results suggest that the use of brokered deposits rather than core deposits is associated with an increased likelihood of bank insolvency.

The significant and positive sign of the BHC variable indicates that BHC membership may be advantageous for the bank's financial safety. The negative and significant coefficient of de novo banks shows that de novo banks, all else being equal, have a significantly higher likelihood of being insolvent compared with more mature ones. The coefficients of the FDIC and Federal Reserve are significant and negative in three of the four regressions, indicating that banks supervised by the FDIC and Federal Reserve are more likely to be associated with higher financial instability, compared with banks operating under the supervision of the Office of the Comptroller of the Currency.

The coefficient of the state-level unemployment rate (GDP growth rate) is significant and negative (positive) across all models, indicating that economic conditions in the markets where a bank operates appear to affect financial health of U.S. commercial banks. The result implies that banks operating in states with robust economies are likely to have a relatively lower probability of insolvency, while banks in depressed states are more likely to suffer financial problems.

We conduct regressions on the components of the Z-score to obtain a better understanding of the relationship between loan diversification, market concentration and a bank's financial stability. Specifically, we perform separate regressions using the return on assets (ROA), capital to asset ratio, and the volatility of ROA as a dependent variable. This analysis allows us to capture which element of the Z-score is primarily driving the relationship between our key independent variables and the bank's financial strength.

The regression results are presented in Table 4. The coefficient of loan diversification is positive and significant in the ROA equation, and statistically significant with a negative sign both in the capital to asset ratio and in the volatility of ROA equations. The results demonstrate that the relationship between loan diversification and reduction in bank insolvency risk is associated with an increase in the bank's profitability, capital savings due to diversification benefits (Shim, 2013), and the decrease in return volatility, as banks expand their loan portfolios into additional sectors.

The coefficient of market concentration variable is positive and significant in the ROA equation, indicating that banks in more concentrated markets may earn higher profits than ones in less concentrated markets. However, the significant and negative coefficients of market concentration both in the capital to asset ratio and in the volatility of ROA equations suggest that capital ratios and earnings volatility are lower for banks in more concentrated markets. Therefore, one possible explanation for the inverse relationship between market concentration and bank insolvency risk is that all else equal, higher Z-score in more concentrated markets may be more attributed to greater profits and lower earnings volatility than lower capital ratios.

The interactive term presents a positive effect on ROA and a negative effect on the volatility of ROA, both of which support our findings using either the natural logarithm of Z-score or Z-score as a dependent variable in Table 3. However, we do not find a

Table 4
Regression results for the components of the Z-score.

Variable	ROA	Capital to asset ratio	SD of ROA
Loan diversification (1)	0.010**	−0.073***	−0.055***
	(0.004)	(0.004)	(0.003)
Market concentration (2)	0.047***	−0.065***	−0.034***
	(0.009)	(0.008)	(0.006)
Interaction (1) × (2)	0.019**	−0.006	−0.019***
	(0.009)	(0.008)	(0.007)
Firm size	0.030***	−0.165***	−0.067***
	(0.002)	(0.002)	(0.001)
Non-interest share	0.428***	0.865***	0.568***
	(0.013)	(0.011)	(0.009)
Liquidity	−0.010	0.145***	0.146***
	(0.014)	(0.013)	(0.010)
Brokered deposits	−0.347***	−0.573***	−0.070***
	(0.024)	(0.020)	(0.016)
Core deposits	0.219***	−1.178***	−0.583***
	(0.015)	(0.013)	(0.011)
BHC member	0.064***	−0.164***	−0.097***
	(0.006)	(0.005)	(0.004)
De novo bank	−0.138***	−0.067***	0.067***
	(0.005)	(0.004)	(0.003)
FDIC	−0.001	−0.107***	−0.015***
	(0.005)	(0.005)	(0.004)
Federal reserve	−0.045***	−0.064***	−0.014**
	(0.007)	(0.007)	(0.006)
Unemployment rate	−3.053***	3.372***	0.852***
	(0.218)	(0.172)	(0.139)
GDP growth rate	0.603***	−0.238***	−0.378***
	(0.054)	(0.042)	(0.034)
Constant	−0.405***	3.709***	1.199***
	(0.065)	(0.059)	(0.048)
State-quarter fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Observations	136,400	136,400	136,400
Adjusted R-squared	0.095	0.264	0.182

This table reports estimation results for the components of the Z-score. Dependent variables are return on assets (ROA), capital to asset ratio, and the standard deviation (SD) of ROA, respectively. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

significant impact of the interactive term on the capital to asset ratio.

4.3. Robustness tests

We perform several additional tests to further understand the relationship between the diversification of bank activities, market concentration and bank stability.

4.3.1. Controlling for mergers and acquisitions

Graham et al. (2002) argue that diversification discount arises not because diversification destroys value but because acquiring firms purchase already discounted target firms. Similar to Laeven and Levine (2007), we control for potential influence of M & As in two ways. First, we use an indicator variable equal to one in the year of M & A completion for each bank that involves in acquiring or merging with at least one other bank and zero otherwise. Alternatively, we include indicator variables that take the value of one in the year of M & A completion and all later years for each bank that acquires or merges with at least one other bank and zero otherwise. Second, we exclude observations of acquiring banks for year t when M & A transaction occurs to account for the possibility that M & As can impact the diversification results. Additionally, we exclude bank observations in that year and all later years if the bank engages in merging with at least one other bank in year t.

Columns 1 and 3 in Panel A of Table 5 provide results using the indicator variable in the year of M & A completion and columns 2 and 4 in Panel A of Table 5 present results with indicator variables in the year of M & A completion and all later years. Similarly, columns 1 and 3 (columns 2 and 4) in Panel B of Table 5 show the results that exclude acquiring banks for the year of M & A completion (for the M & A year and all later years). As shown in Panels A and B of Table 5, the coefficients of loan diversification, market concentration and their interactive term are statistically significant and positive across all estimations, confirming that controlling for M & A activities does not affect our key findings in Table 3.[13]

4.3.2. The analysis for the pre-crisis, the crisis, and the post-crisis periods

We examine whether the loan portfolio diversification and market concentration influence bank stability differently before, during and after the financial crisis. Similar to the literature (e.g., Bhagat et al., 2015), we divide our full sample into three subperiods: the pre-crisis period (2005: Q1–2007: Q2), the crisis period (2007: Q3–2009: Q1), and the post-crisis period (2009: Q2–2013: Q3). We run regressions separately for each sub-period.

The regression results on subsamples are reported in Table 6. We find that loan diversification, market concentration and their interactions are positively associated with a bank's financial

[13] Following Laeven and Levine (2007), we exclude bank observations in year t and all later years if the bank's total assets increase more than 50% from year t-1 to year t. We exclude acquiring banks that have engaged in M & A activities during the current year, the past three years, or the past five years. We include indicator variables that take the value of one if the bank has acquired or merged with at least one other bank from year t-2 to year t or from year t-4 to year t, respectively and zero otherwise. We also control for possible impact of M & As on a quarterly basis. The signs of the coefficients on the loan diversification, market concentration and their interactive term are not influenced and remain statistically significant in all modifications. The results are available from the authors upon request.

Table 5
Regression results of controlling for mergers and acquisitions.

Panel A: Controlling for banks that acquired or merged with another bank

	Dependent variable = Log (Z-score)		Dependent variable = Z-score	
Variable	Merger [t]	Merger [t, t + 1,...,T]	Merger [t]	Merger [t, t + 1,...,T]
Loan diversification (1)	0.325***	0.326***	24.681***	24.732***
	(0.086)	(0.086)	(4.586)	(4.587)
Market concentration (2)	0.101***	0.101***	6.411***	6.429***
	(0.038)	(0.038)	(2.039)	(2.037)
Interaction (1) × (2)	0.111***	0.111***	6.739***	6.756***
	(0.028)	(0.028)	(1.835)	(1.835)
Merger [t]	0.073		−2.809	
	(0.132)		(6.392)	
Merger [t, t + 1,...,T]		−0.130		−7.483
		(0.172)		(7.470)
Control variables	Yes	Yes	Yes	Yes
State-quarter fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Observations	136,400	136,400	136,400	136,400
Adjusted R-squared	0.253	0.253	0.288	0.288

Panel B: Excluding banks that acquired or merged with another bank

	Dependent variable = Log (Z-score)		Dependent variable = Z-score	
Variable	Merger [t]	Merger [t, t + 1,...,T]	Merger [t]	Merger [t, t + 1,...,T]
Loan diversification (1)	0.325***	0.321***	24.681***	24.371***
	(0.085)	(0.085)	(4.576)	(4.575)
Market concentration (2)	0.102***	0.105***	6.460***	6.575***
	(0.037)	(0.037)	(2.037)	(2.037)
Interaction (1) × (2)	0.110***	0.111***	6.688***	6.748***
	(0.028)	(0.028)	(1.835)	(1.835)
Control variables	Yes	Yes	Yes	Yes
State-quarter fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Observations	136,219	135,779	136,219	135,779
Adjusted R-squared	0.254	0.254	0.288	0.288

This table reports estimation results that control for potential influence of M & As. In Panel A, we include M & A indicator variables. Merger [t] is an indicator variable equal to one in the year of M & A completion for each bank that involves in acquiring or merging with at least one other bank and zero otherwise (Columns 1 and 3). Merger [t, t + 1,...,T] is an indicator variable that takes the value of one in the year of M & A completion and all later years for each bank that acquires or merges with at least one other bank and zero otherwise (Columns 2 and 4. In Panel B, we exclude observations of acquiring banks for year t when M & A transaction occurs (Columns 1 and 3), or we exclude bank observations in that year and all later years if the bank engages in merging with at least one other bank in year t (Columns 2 and 4). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

stability in all three sub-periods. The result reinforces our previous findings that increased loan diversification and market concentration add to bank stability and diversifying loan-making activities is more advantageous in less competitive markets. The consistent outcome before, during and after the financial crisis may suggest banks to diversify more and motivate policymakers to focus more on market structure to preserve financial stability in the banking sector.

4.3.3. Instrumental variables-generalized method of moments (IV-GMM)

We supplement our analysis by employing IV-GMM estimation technique, which also addresses the issue concerning the endogeneity of the loan diversification measure. In the presence of heteroskedasticity, the GMM estimator is more efficient than the two-stage least squares (2SLS) estimator (Hayashi, 2000). The GMM estimator also addresses the case of overidentification in which the number of instruments exceeds the number of endogenous regressors. Following the literature (e.g., Baum et al., 2006), we use heteroskedasticity- and autocorrelation-consistent (HAC) IV-GMM estimation method to account for both serial correlation and potential heteroskedasticity. The IV-GMM method involves the selection of appropriate instrumental variables. An instrumental variable must satisfy two requirements that we refer to as the instrument relevance condition and the instrument exogeneity condition. The relevance condition requires that the partial correlation between the instrument and the endogenous variable not be zero. The exogeneity condition requires the correlation between the instrument and the structural error term to be zero (Wooldridge, 2002; Stock and Watson, 2015). The historically averaged measures of firm characteristics, industry growth, and general economic growth are suggested as commonly used instrumental variables (Campa and Keida, 2002). Laeven and Levine (2007) include firm size (the log of total assets) and average loan diversification of other banks as instruments for the diversification variable. Similar to the literature, we take account of three-year average loan diversification of other banks domiciled in the same Core Based Statistical Area (CBSA) as bank *i* (CBSA loan diversification) and three-year average asset growth rate across all banks domiciled in the same CBSA as bank *i* (CBSA asset growth) for our instruments. These instrumental variables are estimated at CBSA-level for each quarter.

The results using the HAC IV-GMM method are presented in Table 7. The Durbin-Wu-Hausman (DWH) tests show that we reject the null hypothesis of exogeneity for loan diversification variable at the 1 percent significant level. The *F*-statistic for the joint significance of the excluded instruments exceeds 10 and its *p*-value is significant at the 1% level, demonstrating that our instruments are not weak. An insignificant Sargan-Hansen *J* test statistic

Table 6
Regression results for the pre-crisis, the crisis and the post-crisis periods.

	Pre-crisis period		Crisis period		Post-crisis period	
Variable	Log (Z-score)	Z-score	Log (Z-score)	Z-score	Log (Z-score)	Z-score
Loan diversification (1)	0.221***	22.089***	0.333***	24.152***	0.083**	17.207***
	(0.038)	(2.550)	(0.118)	(6.779)	(0.039)	(5.902)
Market concentration (2)	0.082***	6.718***	0.129***	7.202**	0.226***	11.622***
	(0.021)	(1.419)	(0.045)	(2.817)	(0.020)	(2.617)
Interaction (1) × (2)	0.091***	6.676***	0.064*	3.852***	0.069***	5.252**
	(0.021)	(1.398)	(0.036)	(1.443)	(0.021)	(2.492)
Firm size	0.180***	11.928***	0.101***	6.229***	0.098***	3.497***
	(0.004)	(0.255)	(0.011)	(0.646)	(0.004)	(0.508)
Non-interest share	−0.468***	−23.360***	−0.696***	−30.325***	−0.566***	−34.089***
	(0.030)	(2.040)	(0.109)	(5.434)	(0.027)	(3.462)
Liquidity	0.248***	17.172***	0.277***	22.414***	0.326***	37.939***
	(0.031)	(2.084)	(0.080)	(5.042)	(0.031)	(3.981)
Brokered deposits	−0.782***	−45.098***	−1.125***	−59.152***	−0.150***	−11.927
	(0.046)	(3.118)	(0.133)	(7.118)	(0.050)	(7.411)
Core deposits	0.702***	41.820***	0.817***	44.718***	1.036***	32.854***
	(0.032)	(2.193)	(0.103)	(6.064)	(0.031)	(4.408)
BHC member	0.149***	9.707***	0.139***	7.460***	0.005	1.385
	(0.012)	(0.822)	(0.035)	(1.933)	(0.011)	(1.706)
De novo bank	−0.252***	−13.263***	−0.272***	−16.240***	−0.154***	−12.014***
	(0.010)	(0.657)	(0.030)	(1.707)	(0.010)	(1.538)
FDIC	0.003	1.322*	−0.046	−3.394*	−0.066***	−2.101
	(0.011)	(0.741)	(0.028)	(1.807)	(0.012)	(1.613)
Federal Reserve	−0.070***	−6.369***	−0.058	−1.956	−0.015	−4.609**
	(0.015)	(1.029)	(0.040)	(2.517)	(0.016)	(2.171)
Unemployment rate	−0.717	−39.913	−9.992***	58.265	−1.961***	76.421
	(0.797)	(53.822)	(1.179)	(71.606)	(0.681)	(58.048)
GDP growth rate	0.325***	23.833***	−0.281	−21.710	0.497	24.680**
	(0.059)	(3.983)	(0.240)	(16.024)	(0.319)	(12.417)
Constant	1.249***	−114.552***	2.622***	−22.471	2.693***	26.804
	(0.128)	(8.669)	(0.259)	(15.149)	(0.143)	(16.947)
State-quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	38,862	38,862	27,403	27,403	70,135	70,135
Adjusted R-squared	0.357	0.401	0.193	0.192	0.376	0.429

This table reports estimation results for the pre-crisis period (2005: Q1–2007: Q2), the crisis period (2007: Q3–2009: Q1), and the post-crisis period (2009: Q2–2013: Q3). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

indicates that the aforementioned instruments satisfy the exogeneity condition required for their employment. Thus, IV-GMM estimator is reliable.

Columns 1 and 2 in Table 7 shows that the coefficients of loan diversification, market concentration and their interactive term are significant and positive, confirming the existence of loan diversification benefits, supporting the concentration-stability view and reinforcing some advantages of loan diversification in more concentrated markets. The results for the components of the Z-score presented in columns 3, 4 and 5 are also consistent with those observed in Table 4 and validate our earlier findings.

5. Conclusion

We undertake an empirical investigation about how the diversification choice of bank loan activities and the level of market concentration are associated with a bank's financial stability using the data of U.S. commercial banks. This is an important issue for policymakers who involve in policy decisions such as mergers & acquisitions (M & As) guidelines and market competitiveness. In addition, bank managers can obtain a better understanding of the potential opportunities and strategies to improve the bank's financial stability through the outcomes of this research.

The empirical analysis is conducted with fixed-effect models to address the concern of potential endogeneity problems. The results present that the choice of bank loan diversification and market concentration are important factors influencing a bank's financial stability. Specifically, we find that increased loan diversification has a positive impact on the bank's financial strength. The results lend support for the statement of Government Accountability Office (2013) that a wave of bank failures during the most recent financial crisis is largely associated with high concentrations of commercial real estate loans. We show that market concentration is positively associated with the bank's financial strength. The result is consistent with the concentration-stability view that banks operating in a less concentrated market structure are more susceptible to financial fragility than those in a high concentrated market structure.

We also argue that a bank's financial stability is a function of the diversity of its product mix, but its incentive to diversify its business mix is influenced by the exogenous market conditions (i.e., concentration or competition) that the bank faces. We examine this inference by specifying the interaction terms between loan portfolio diversification and market concentration. The results indicate that diversifying banks in highly concentrated markets are likely to have more financial stability than their counterparts in less concentrated markets.

The regression analysis shows other important factors that are relevant to a bank's financial stability. We find that firm size, the use of core deposits and BHC membership are inversely associated with bank insolvency risk, whereas growing share of non-interest income, greater reliance on brokered deposits, and de novo banks are positively associated with the risk of bank insolvency. We also show that state-level economic conditions influence a bank's financial stability. Isolating such factors would provide important implications for regulators and bank managers in the monitoring of

Table 7
Regression results using the HAC IV-GMM method.

Variable	Log (Z-score)	Z-score	ROA	Capital to asset ratio	SD of ROA
Loan diversification (1)	0.454***	37.677***	0.019***	−0.070***	−0.094***
	(0.170)	(9.617)	(0.003)	(0.011)	(0.010)
Market concentration (2)	0.105***	5.522***	0.005***	−0.005***	−0.003**
	(0.036)	(1.986)	(0.001)	(0.002)	(0.002)
Interaction (1) × (2)	0.062**	4.433**	0.002**	−0.006	−0.005***
	(0.029)	(1.870)	(0.001)	(0.005)	(0.001)
Firm size	0.044***	3.443***	0.004***	−0.009***	−0.004***
	(0.007)	(0.404)	(0.000)	(0.001)	(0.000)
Non-interest share	−0.701***	−36.147***	0.014***	0.037***	0.015***
	(0.065)	(3.199)	(0.001)	(0.008)	(0.005)
Liquidity	0.084	7.311**	0.002**	0.008*	0.004
	(0.054)	(3.237)	(0.001)	(0.004)	(0.003)
Brokered deposits	−0.508***	−28.830***	−0.007***	−0.050***	0.013**
	(0.105)	(5.372)	(0.002)	(0.006)	(0.006)
Core deposits	0.475***	23.295***	0.032***	−0.070***	−0.027***
	(0.068)	(3.675)	(0.001)	(0.005)	(0.003)
BHC member	0.086***	6.075***	−0.004***	−0.015***	−0.004***
	(0.026)	(1.419)	(0.000)	(0.002)	(0.001)
De novo bank	−0.350***	−18.191***	−0.016***	0.001	0.012***
	(0.024)	(1.201)	(0.000)	(0.001)	(0.001)
FDIC	−0.045**	−3.617***	0.004	−0.002	0.001
	(0.022)	(1.256)	(0.004)	(0.001)	(0.001)
Federal reserve	−0.067**	−3.519**	−0.001	−0.003	0.001
	(0.029)	(1.715)	(0.001)	(0.002)	(0.001)
Unemployment rate	−2.043***	−148.126***	−0.500***	0.249***	0.076**
	(0.741)	(40.056)	(0.011)	(0.032)	(0.033)
GDP growth rate	1.132***	67.810***	0.008	−0.012***	−0.017***
	(0.059)	(3.685)	(0.005)	(0.003)	(0.003)
Constant	3.430***	18.491	−0.064***	0.302***	0.134***
	(0.186)	(12.066)	(0.003)	(0.015)	(0.009)
State-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
DWH test (p-value)	0.000	0.000	0.000	0.000	0.000
F-statistic	198.76	196.23	86.37	85.29	84.35
Sargan/Hansen (p-value)	0.196	0.192	0.178	0.162	0.156
Observations	136,400	136,400	136,400	136,400	136,400
Adjusted R-squared	0.124	0.113	0.097	0.137	0.072

This table reports estimation results using the HAC IV-GMM method. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

safety and financial soundness of commercial banks and developing policies to improve the bank's financial health.

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