Essays on bank diversification

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Declaration page

I declare that the thesis has been composed by myself and that the work has not be submitted for any other degree or professional qualification. I confirm that the work submitted is my own, except where work which has formed part of jointly authored publications has been included. My contribution and those of the other authors to this work have been explicitly indicated below. I confirm that appropriate credit has been given within this thesis where reference has been made to the work of others.

The work presented in Chapter 2 was previously published in *Economics Letters* (2020): 109312 with the title "Diversification and bank stability." by me and my supervisors, Dr. Fernando Moreira and Dr. Joosung Lee. This study was conceived by all of the authors. I carried out the topic and idea building, data collection and procession, statistical analysis, and paper writing.

Signed:

SHUO LIANG
30/08/2020

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Abstract

This thesis, which consists of four studies, investigates bank diversification in the context of bank stability, banks' market power, and bank competition, by constructing new diversification indicators to capture the degree of diversification at the market and country levels.

The first essay empirically tests a theory regarding the influence of diversification on bank systemic risk and investigates whether this effect is different for bank standalone risk. I construct a new country-level diversification measure to reflect the risk distribution among banks, which makes my study more suitable to evaluate the mechanical reasons behind the theory tested than traditionally used bank-level diversification indicators. My results confirm the Wagner's theory according to which diversification leads to more systemic risk but less bank standalone risk.

The second essay investigates the role of the regulatory environment, bank size, and capital in the diversification-bank stability nexus, which extends my findings in the first essay. I find that the negative relationship between diversification and bank systemic stability becomes weaker in countries with greater supervisory power of regulatory agencies, higher stringency of capital regulations, more restrictions on the scope of banks' activities, and more private monitoring. Moreover, I show that bank size and capital alleviate the negative diversification-systemic stability relationship, which implies that larger and well-capitalized banks are less subject to systemic risk when the degree of diversification in a country is high. To the best of my knowledge, my study is the first to confirm the moderating role of cross-country regulatory environments and banks' essential characteristics in the relationship between diversification and bank stability.

The third essay investigates how diversification influences banks' market power, which fills the gap in the literature regarding the lack of analyses showing whether diversification can be

a determinant or source of banks' market power. Diversification may enable banks to gain market power from obtaining new sources of revenues but could also weaken market power by inducing new costs. I find an inverse U-shaped relationship between revenue diversification and banks' market power in both lending and funding markets. This implies that diversification is an important determinant or source of banks' market power and potentially affects market power by changing banks' output prices and marginal costs of production, or a combination of both. In addition, this inverse U-shaped relationship is much more manifest in large banks than in small banks, which indicates that it is dominated by large banks.

The last essay investigates the role of market diversification in the relationship between competition and bank stability in the dimensions of individual bank stability and systemic stability, by constructing novel market-level diversification measures. My study is important to reconcile the mixed conclusions regarding the competition-stability nexus in the literature by considering the potential changing associations between competition and bank stability conditional on different degrees of diversification in the market. I find that the negative relationship between competition and systemic stability is exacerbated when the market diversification is high while this negative competition-systemic stability relationship turns to be positive when the market diversification is low. However, I do not find a significant interacting effect of market diversification on the competition-individual bank stability relationship. Lastly, I show a positive association between competition and diversification, which suggests that restrictions in banks' diversification activities in a competitive environment may help in maintaining systemic stability.

My research provides useful implications for bank managers and policymakers. First, it offers bank managers knowledge of how diversified activities are related to banks' standalone and systemic risks and suggests the feasibility of managing banks' market power by formulating an appropriate diversification strategy. Second, from the policymaking perspective, my study proposes that promoting diversification would be beneficial to bank standalone stability if banks' diversification strategy is well formulated and executed but could bring additional costs to banks and exacerbate systemic stability.

Chapter 1: Introduction

1.1 Background on bank diversification

Bank diversification is defined from different angles in the literature. Mercieca, Schaeck, and Wolfe (2007) propose that bank diversification can be viewed from three dimensions: (1) diversification across banks' products and financial services, (2) diversification through geographic expansion, and (3) diversification through a combination of business lines and geographic expansion. There are a number of existing studies viewing diversification on the dimension of geographic expansion and linking geographic diversification to issues in bank valuations and risk (Hughes et al., 1999; Akhigbe and Whyte, 2003; Deng and Elyasiani, 2008; Goetz, Laeven, and Levine, 2013; Chu, Deng, and Xia, 2019). With the recent decades of financial liberalization and technology development, financial institutions have been encouraged to seek new opportunities by expanding into non-traditional activities, such as fees, commissions, insurance underwriting, and investment banking services, from traditional interest-income-generating activities. This process is typically accompanied with banks' activities of diversifying their services or business lines. As such, in my thesis, I focus on the bank diversification as the scope of activities that banks can engage in and the extent to which banks can generate revenues from different businesses or financial services.

There are different explanations on why banks engage in diversified activities. Bank managers choose to diversify to reduce the risk of each specific activity according to the portfolio theory that the expansion of investments into activities or businesses that are not perfectly correlated can decrease the risk of an investment portfolio. This risk-reducing effect of diversification meets the interests of shareholders who value overall volatilities of firms' revenues (Smith and Stulz, 1985) and of supervisors who are more concerned with the total risk of each individual financial institution than specific diversified portfolios of banks (Berger, Molyneux, and Wilson, 2014). Moreover, expanding the scope of bank business lines can create value for banks' shareholders. Such values may come from the economy of scale since banks can reuse the extensive customer information gathered from long-term customer relationships in the area of other non-related activities by cross-selling multiple products to the same customers (Stiroh and Rumble, 2006). In addition, bank managers may have non-profit-maximizing motives to protect firm-specific human capital and private benefits through diversification (Berger, Demsetz, and Strahan, 1999; Aggarwal and Samwick, 2003). Besides these above desirable aspects of diversification, there could be negative consequences for banks when they engage in diversification. The shift into non-interest-generating activities may lead to additional costs because newly engaged business lines are typically associated with high volatility and risk (DeYoung and Roland, 2001; Stiroh, 2004a; Stiroh, 2006; Stiroh and Rumble, 2006; Lepetit et al., 2008a). Moreover, the market values of financial conglomerates that engage in diversified activities can be lower than if those that specializing in individual activities (Laeven and Levine, 2007).

In the literature, bank diversification has been linked to a number of issues in banking, which includes bank stability (Lepetit et al., 2008a; De Jonghe, 2010; Wagner, 2010; Sanya and Wolfe, 2011; DeYoung and Torna, 2013; Amidu and Wolfe, 2013a; Raffestin, 2014; Williams, 2016; Abuzayed, Al-Fayoumi, and Molyneux, 2018), bank performance (DeYoung and Rice, 2004; Stiroh, 2004b, 2006; Stiroh and Rumble, 2006; Mercieca, Schaeck, and Wolfe, 2007; Chiorazzo, Milani, and Salvini, 2008; Goddard, McKillop, and Wilson, 2008; Sanya and Wolfe, 2011), and bank valuation (Berger and Ofek, 1995; Laeven and Levine, 2007; Elsas, Hackethal, and Holzhäuser, 2010). Nevertheless, there are still some questions on bank diversification that remain to be answered: How does diversification differently affect banks' systemic risk and standalone risk? Is the relationship between diversification and bank stability conditional on a country's regulatory framework and banks' own essential characteristics? How does diversification influence banks' market power? What role does market diversification play in the relationship between competition and bank stability? To address these questions, my thesis provides four empirical studies that investigate bank diversification in the context of bank stability, banks' market power, and bank competition.

1.2 Objectives and main findings

Chapter 2 aims at empirically testing the theory of Wagner (2010) regarding the influence of diversification on bank systemic risk and investigating whether this effect is different for bank standalone risk. Wagner (2010) proposes a model showing that diversification at financial institutions makes systemic crises more likely because a higher diversification leaves institutions exposed to common risks by holding similar portfolios, although diversification is expected to reduce each institution's standalone risk according to the modern portfolio theory. Using a large dataset that consists of 1,395 international publicly listed banks from 49 countries between 1998 and 2018, I show that an increase in revenue diversification in a country leads to more systemic risk while reducing a bank's idiosyncratic risk. My results have provided empirical evidence in supporting Wagner's theory.

Chapter 3 aims to investigate the role of the regulatory environment, bank size, and capital in the diversification-bank stability nexus, which extends my findings regarding the direct relationship between diversification and bank stability in Chapter 2. I focus on four aspects of a country's regulatory framework (official supervisory power, capital regulations, bank activity restrictions, and private monitoring) and two essential banks' risk determinants (bank size and capital), and examine the associations of these factors with the relationship between diversification and bank stability. Using a sample of 1,395 international publicly listed banks from 49 countries between 1999 and 2015, I find that the negative relationship between diversification and bank systemic stability identified in Chapter 2 becomes weaker in countries with greater supervisory power of regulatory agencies, higher stringency of capital regulations, more restrictions on the scope of banks' activities, and more private monitoring. In addition, I show that bank size and capital have a positive moderating effect on the negative diversification-systemic stability relationship, which suggests that larger and well-capitalized banks are less subject to systemic risk when the degree of bank diversification in a country is high.

Chapter 4 aims at investigating how diversification influences banks' market power. No prior study addresses the question about whether diversification is a determinant or source of banks' market power. Using a large sample of around 9,991 U.S. commercial banks and bank holding companies between 1991 and 2017, I find an inverse U-shaped relationship between diversification and banks' market power, and this relationship holds for banks' market power in both lending and funding markets. Moreover, this inverse U-shaped relationship is more manifest for large banks than for small banks.

Chapter 5 aims to investigate the role of market diversification in the relationship between competition and bank stability in dimensions of both idiosyncratic and systemic stability. The literature shows mixed findings on the competition-bank stability relationship, including competition-stability views (Boyd and De Nicoló, 2005; Schaeck, Čihák and Wolfe, 2009; Anginer, Demirgüç-Kunt and Zhu, 2014a) and competition-fragility views (Keeley, 1990; Allen and Gale, 2004; Repullo, 2004; Beck, Demirgüç-Kunt and Levine, 2006). The controversy about the relationship between competition and bank stability indicates the need to provide new evidence to discuss the potential mechanism behind this relationship. Based on my findings in Chapter 2 regarding the influence of diversification on bank stability, I assume that diversification has a moderating effect on the relationship between competition and bank stability, and investigating this moderating effect can help in explaining why competition has different effects on bank stability. Through an analysis based on the sample of 467 publicly listed U.S. banks over the period between 1994 and 2017, I find that the negative relationship between competition and systemic stability is exacerbated when market diversification is high while this negative relationship turns out to be positive when market diversification is at a low level. This interacting effect of diversification is not significant on the competition-individual stability relationship. Moreover, I find a positive association between competition and market diversification, which suggests that restrictions in banks' diversification activities in a competitive environment may help in maintaining systemic stability.

1.3 Contributions

First, my thesis contributes to the literature by conducting an empirical analysis to test the theoretical study of Wagner (2010) on the relationship between diversification and bank stability in Chapter 2. Wagner's theory has received considerable attention because it provides a novel insight into bank systemic risk by identifying a mechanical reason for the adverse effect of diversification even under normal circumstances. Nevertheless, this theory has not been empirically tested yet in the context of banking due to the challenge in constructing a diversification measure that can reflect the mechanism in which diversification influences bank risk.

Furthermore, my research provides three empirical analyses to fill the gaps in the literature regarding bank diversification in the context of stability and market power. Chapter 3 contributes to the literature by examining whether a country's regulatory framework and banks' essential risk determinants (bank size and capital) are associated with the observed diversification-bank stability relationship, considering the fact that there are differences in regulatory environments across countries and in size and capital between banks. This study enriches the literature regarding the direct relationship between diversification and bank stability (Wagner, 2010; DeYoung and Torna, 2013; Raffestin, 2014; Williams, 2016; Abuzayed, Al-Fayoumi, and Molyneux, 2018). This study is the first to explicitly take into account potential moderating factors in the relationship between diversification and bank stability, which helps in understanding whether there is uniform impact of diversification on idiosyncratic and systemic risk for banks with different sizes and capitalization levels and in countries with distinct regulatory environments. Chapter 4 contributes to the literature by linking diversification to banks' market power. Since a diversified bank earns revenues not only from traditional lending activities but also from activities that generate non-interest incomes such as fee- and trading-based services, diversified activities may enable banks to gain market power by obtaining new sources of revenues or deteriorate market power by bringing additional costs that make banks less likely to lower marginal costs. Studies most relevant to my research link market power to revenues and margins (Maudos and Fernández de Guevara, 2004; Valverde and Fernández, 2007; Nguyen, Skully, and Perera, 2012a). However, previous literature does not investigate possible links between diversification and banks' market power. This gap motives me to expect a connection between them and investigate whether diversification can be regarded as a determinant or source of banks' market power. My study is the first to investigate both linear and non-linear relationships between diversification and banks' market power, which aims to show a full picture on the extent to which banks' market power can be influenced by diversification. Moreover, this chapter employs seven distinct diversification indicators to show comprehensive information regarding the degree of bank diversification in terms of revenues, loans, and deposits (Laeven and Levine, 2007; Mercieca, Schaeck, and Wolfe, 2007; Elsas, Hackethal, and Holzhäuser, 2010). Chapter 5 provides new empirical evidence and insight on the controversial debate on the competition-bank stability relationship by introducing the moderating effect of bank diversification. That is, this chapter takes into account the potential changing associations between competition and bank stability conditional on different degrees of diversification in the market.

Lastly, my thesis develops new measures to reflect bank diversification at country and market levels. In Chapter 2, I build up a new diversification measure to reflect the overall level of bank diversification at the country level. This indicator can capture the distributions of banks' revenues and is suitable to test Wagner's theory. In Chapter 5, I propose the "market diversification" definition and constructs a new diversification indicator to capture it, which provides a new perspective on showing the degree of diversification in a specific market that banks operate. My market diversification indicator reflects the degree of diversification considering both an individual bank and its competitors, which extends the scope of information inherent in previously used diversification indicators in the literature (Laeven and Levine, 2007; Mercieca, Schaeck, and Wolfe, 2007) and makes it possible to examine how banks' risk will respond to outside environment factors such as competition and diversification.

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Chapter 2: Diversification and Bank Stability

2.1 Introduction

Wagner (2010) proposes a model showing that diversification at financial institutions makes systemic crises more likely since a higher diversification makes institutions exposed to common risks through holding similar portfolios, although diversification is expected to reduce each institution's standalone risk according to the modern portfolio theory. In an event of systemic shock, banks have to liquidate their assets at fire-sale prices to meet their liquidity needs in the market or regulatory requirements. Such actions may generate severe distress for banks that hold similar portfolios because the action of selling assets of one bank encourages other banks holding common assets to jointly liquidate their assets at much lower prices, which results in systemic risk (Allen, Babus and Carletti, 2012).

Wagner’s theory has received considerable attention because it provides a novel insight into bank systemic risk by identifying a mechanical reason for the adverse effect of diversification even under "normal circumstances." Nevertheless, this theory has not been empirically tested yet in the context of banking due to the challenge in constructing a diversification measure that can reflect the mechanism in which diversification influences risk. While most existing studies focus on examining how diversification affects bank idiosyncratic risk, there is little empirical research investigating this question from the perspective of systemic risk. My study aims to empirically test Wagner’s theoretical study on the influence of diversification in systemic risk, and further investigates whether this effect is different for bank standalone risk.

The main contribution of this chapter is conducting a new empirical analysis to test Wagner’s theory regarding the different impacts of diversification on dimensions of both individual and systemic stability.[1] To the best of my knowledge, no empirical study has been conducted to validate the abovementioned theory. The second contribution is to build up a new diversification measure to reflect the overall level of revenue diversification of banks in a country. My country-level diversification indicator utilizes revenue data of individual banks in a country and reflects the risk distributions among banks by capturing the distributions of banks' revenues. This characteristic of my diversification measure makes the empirical analysis more suitable to test the mechanical reasons of Wagner (2010) than other studies that employ traditionally used bank-level diversification indicators (Mercieca, Schaeck, and Wolfe, 2007; Laeven and Levine, 2007; Elsas, Hackethal, and Holzhäuser, 2010).

Using a large dataset that consists of 1,395 international publicly listed banks from 49 countries from 1998 to 2018, I document that an increase in bank revenue diversification in a country leads to more systemic risk while reducing bank idiosyncratic risk, which confirms theoretical conclusions of Wagner (2010). My results are robust to several robustness tests, for example, using alternative diversification and bank risk indicators, considering the potential influence of the global financial crisis, and taking into account additional regulatory and institutional control variables.

The remainder of this chapter is organized as follows. Section 2.2 presents an overview of the relevant literature. Sections 2.3 and 2.4 introduce the data, measures and methodology employed in this research. In Section 2.5, I report the empirical findings, followed by robustness tests in Section 2.6. Section 2.7 concludes and discusses the main implications of my study.

[1] My thesis defines "bank risk" as the opposite of "bank stability".

2.2 Literature review

Most of the existing literature focuses on the impact of diversification on bank standalone risk, and typically links the influence of diversification with the nature of non-interest income-generating activities that banks engage in. Using a sample of bank holding companies (BHCs), Boyd, Graham, and Hewitt (1993) investigate the influence of the expansion into non-banking activities through mergers in banks' risk, and the authors conclude that the exact influence of diversification depends on the nature of the new activities that banks expand into. Mergers of BHCs with security firms or real estate firms would increase risk while mergers of BHCs with life insurance or property insurance firms may decrease risk. Based on a sample of U.S. commercial banks between 1988 and 1995, DeYoung and Roland (2001) find that fee-based activities lead to higher revenue and earnings volatilities, which implies that the trend towards engaging in non-traditional activities would result in some extent of instability to banks. Other studies such as Stiroh (2004a), Stiroh (2006), Stiroh and Rumble (2006) and Lepetit et al. (2008a) provide further evidence to support the fact that non-interest-generating activities are associated with high volatilities and risks. Stiroh (2004a) empirically evaluates the potential diversification benefits in the U.S. banking industry and finds that banks with more reliance on non-interest revenues, especially trading incomes, are more likely to endure higher risk and lower profits. Stiroh (2006) investigates the impact of increased non-interest income on banks' return and risk profiles by using market-based risk indicators. This study also concludes that banks with reliance on non-interest income-generating activities tend to be riskier and do not perform better in terms of returns yielded because they engage in more non-interest income-generating activities. Stiroh and Rumble (2006) examine whether diversification benefits from non-interest income generating activities exist in a sample of U.S. financial holding companies over the period 1997–2002. They find that diversification benefits are not sufficient to cover the costs incurred from more volatile non-interest activities. Lepetit et al. (2008a) show that the expansion into non-interest income activities leads banks to higher insolvency risk than the expansion of interest income-generating activities does. DeYoung and Torna (2013) examine whether non-traditional incomes contribute to the collapse of hundreds of U.S. commercial banks during the financial crisis, and conclude that the impact of non-traditional activities on bank stability depends on the nature of activities that banks engage in. Asset-based non-traditional activities such as investment banking and securitization result in a higher probability of bank failures, whereas pure fee-based non-traditional activities such as securities brokerage and insurance sales reduce the chance of bank failures.

Few studies examine the impact of diversification on bank systemic stability. Focusing on a sample of European listed banks, Baele, De Jonghe, and Vennet (2007) compare the performances and risk profiles of diversified and specialized banks, and find that the diversification of revenue streams from distinct financial activities leads to higher the systemic risk of banks while this has a predominately downward-sloping effect in reducing banks' idiosyncratic risk. De Jonghe (2010) employs a market-based systemic risk exposure to investigate the impact of revenue diversity on European banking systemic stability. The author finds that a diversity towards non-traditional banking activities increases banks' tail betas and decreases bank systemic stability, and banks' interest incomes are less risky than other types of revenues. Wagner (2010) provides theoretical evidence that diversification affects financial stability differently depending on the dimensions of banks' risk. More specifically, this study concludes that diversification decreases individual banks' probability of default whereas it makes systemic crises more likely because of greater similarities among banks' portfolios and activities as the degree of diversification grows. Ibragimov, Jaffee, and Walden (2011) develop a model to show that intermediaries' diversification actions are optimal for individual financial institutions but suboptimal for the society, and the negative externality generated from diversification actions depends on the distributional properties of risks. Raffestin (2014) proposes models to quantify the externality of contagion and compare it with the risk-reducing effect of individual market participants, and finds that the probability of market participants failing simultaneously is larger than the probability of individual bankruptcies at a high degree of diversification. Chu, Deng, and Xia (2019) investigate the causal effect of geographic diversification on systemic risk by using the U.S. interstate banking deregulation as exogenous shocks to bank geographical expansion. They find that bank geographical diversification leads to more systemic risk due to greater asset similarities between banks.

Other studies find a certain extent of benefits from diversification on bank stability even though these positive effects are limited. Goddard, McKillop, and Wilson (2008) examine the effect of revenue diversification in the financial performance of U.S. credit unions over the period 1993–2004. They find that a credit union heavily diversified between interest income and non-interest income-generating activities would have lower risk-adjusted returns. Sanya and Wolfe (2011) analyze the effect of revenue diversification on bank performance and risk based on a sample of listed banks in emerging economies, and they find that diversification across and within banks' interest and non-interest revenue-generating activities reduces bank insolvency risk. Based on a sample of listed and unlisted banks from the Gulf Cooperation Council (GCC) countries between 2001 and 2014, Abuzayed, Al-Fayoumi, and Molyneux (2018) find that banks' income diversification does not improve bank stability. In addition, the authors show evidence of a non-linear relationship between non-interest income and bank stability, which implies the existence of a risk-reducing effect at higher degree of diversification.

In addition to focusing on bank risk, another strand of literature links the impact of diversification on bank performance. Laeven and Levine (2007) suggest the existence of a diversification discount in market valuations of financial conglomerates in a sample of international financial institutions. The authors state that institutions with a greater diversity of activities are more likely to have lower market values than those specializing in less diverse activities, potentially because financial conglomerates are subject to greater agency problems in the process of engaging in multiple activities, which implies that economies of scale are not sufficient to produce diversification premium. Focusing on small European banks in the period of 1997–2003, Mercieca, Schaeck, and Wolfe (2007) propose that there are no direct diversification benefits within and across banks' business lines and that banks' non-interest activities are negatively associated with bank performance. Chiorazzo, Milani, and Salvini (2008) find that income diversification increases banks' risk-adjusted returns, and this effect is stronger for larger banks.

Through reviewing relevant studies, I identify two gaps in the literature that motivates me to conduct new research in this chapter. First, although Wagner (2010) provides a novel insight into bank systemic risk by identifying a mechanical reason for the adverse effect of diversification even under normal circumstances, this theory has not been empirically tested yet in the context of banking. Second, the literature traditionally uses bank-level diversification indicators (Mercieca, Schaeck, and Wolfe, 2007; Laeven and Levine, 2007; Elsas, Hackethal, and Holzhäuser, 2010), and there is a lack of diversification indicator showing the overall degree of diversification among all banks from a country's perspective. This chapter aims to empirically test Wagner's theory by constructing a new country-level diversification measure to reflect the risk distribution among banks.

2.3 Data and measures

2.3.1 Data

This chapter constructs an unbalanced panel dataset composed of 1,395 international publicly listed banks from 49 countries, which covers the period from 1998 to 2018. Table 2.1 presents the list of countries in my sample. My study uses annual bank-specific accounting information retrieved from Worldscope provided by Thomson Reuters to construct the diversification indicator. I use consolidated balance sheets and income statements to avoid counting duplications. To calculate bank systemic risk measures, I obtain banks' stock price information from CRSP, Datastream and Compustat Global. My sample consists of only listed banks since I need market stock pricing information to build up bank systemic risk measures. In addition, focusing on international banks enhances cross-country comparability among banks because international publicly listed banks tend to comply with international accounting standards, which reduces the concern that differences in accounting standards could drive the results.

Table 2.1. The List of Countries in the Sample

Country	Number of banks	Country	Number of banks
Argentina	7	Mexico	7
Australia	10	Morocco	6
Austria	6	Netherlands	3
Belgium	3	Nigeria	14
Brazil	22	Norway	3
Canada	5	Peru	4
Chile	6	Philippines	14
China	12	Poland	14
Colombia	8	Portugal	4
Denmark	30	Republic of Korea	12
Egypt	10	Russian Federation	6
Finland	3	Singapore	4
France	9	Slovakia	3
Germany	13	South Africa	10
Greece	9	Spain	17
Hong Kong	11	Sri Lanka	6
India	39	Switzerland	12
Indonesia	30	Taiwan	29
Ireland	3	Thailand	14
Israel	7	Tunisia	5
Italy	19	Turkey	14
Japan	91	United Kingdom	16
Kenya	7	United states of America	794
Luxembourg	3	Venezuela	8
Malaysia	13	All countries	1,395

Notes: The countries in my sample are restricted to the ones with at least three listed banks included in the Worldscope in order to alleviate the concern about the low representativeness of a country-level diversification indicator in countries with too few listed banks. The sample includes both listed and delisted banks to treat the survivorship bias.

2.3.2 Country-level diversification measure

I propose a country-level revenue diversification (*CRD*) indicator and use it to capture the overall degree of bank diversification of each country in the sample. The *CRD* is computed as follows:

$$CRD_{j,t} = 1 - \left[\left(\frac{\Sigma |INT_{i,t}|}{\Sigma |TOP_{i,t}|} \right)^2 + \left(\frac{\Sigma |NON_{i,t}|}{\Sigma |TOP_{i,t}|} \right)^2 \right] \quad (2.1)$$

where subscripts i, j, and t denote bank *i*, country *j* and year *t*. For bank *i* from country *j*, INT is bank *i*'s interest income and NON is non-interest income. NON is total operating income, $TOP = |INT| + |NON|$. I use the absolute values of INT and NON to ensure that my computed diversification measures are not largely distorted by banks' business unit performance since my study is more interested in the relative scales of interest-income and non-interest income generating activities rather than whether these activities are profitable or not.[2] I calculate the *CRD* by separately taking the sum of each component of revenues of all banks from a specific country and then calculate this indicator with reference to the Herfindahl-Hirschman Index based diversification indicators used in previous banking studies (Mercieca, Schaeck, and Wolfe, 2007; Laeven and Levine, 2007; Elsas, Hackethal, and Holzhäuser, 2010).[3] To generate a more straightforward diversification measure, I modify the *CRD* by using one minus the original form of *HHI* measure given by the expressions in brackets in the equation above.[4] Under this modification, a high value of *CRD* indicates a high degree of diversification between banks' interest and non-interest income generating activities from a country's perspective.

[2] Net revenues have both positive and negative streams, so the values of diversification measures could take on large negative values in the case that the sum of total operating revenues is smaller than its single component given that negative revenues compensate for positive ones. This would be contrary to the normal case, and it would be hard to interpret the meaning of the HHI-based measure with a value far below zero.

[3] The details of the calculation of bank-level diversification is shown in the Appendix.

[4] The original 'HHI' form of bank diversification measure inversely represents the diversification level, with a high value indicating a low degree of diversification.

Compared with traditionally used bank-level diversification indicators (Mercieca, Schaeck, and Wolfe, 2007; Laeven and Levine, 2007; Elsas, Hackethal, and Holzhäuser, 2010), my country-level diversification indicator shows the degree of bank diversification from a new perspective. My measure simultaneously utilizes revenue data of individual banks in a country and reflects the risk distributions between banks by capturing the distributions of banks' revenues among banks. This characteristic makes my empirical analysis more suitable to test the mechanical reasons of Wagner (2010) than those traditionally employed bank-level diversification indicators. Particularly, for the mechanical reasons on the adverse effect of diversification in bank systemic stability, Wagner (2010) argues that the higher homogeneity of banks' portfolios or activities due to more diversification leads to more systemic risks. Thus, the nature of my country-level diversification measure that reflects the information on the risk distributions between banks allows me to better empirically test this theory than using bank-level indicators that only capture the distributions of revenues within individual banks. In addition, building up a country-level measure enables me to explore how banks' idiosyncratic and systemic risks can differently respond to changes in the degree of diversification from a country's perspective.

Since my sample consists of only publicly listed banks in each country in order to build up the market-based systemic risk measure, the construction of the *CRD* is only based on the income statements information of a country's listed banks. Therefore, I am not able to construct this measure by including all listed and non-listed banks in each country. Nevertheless, my country-level diversification measure may not be subject to considerable limitations due to the absence of non-listed banks because of the following reasons. First, compared with non-listed banks, listed banks are typically the largest banks in a nation and have much more significant presence in the domestic market in terms of total assets and scales of streams of revenues. Second, studying listed banks is more appropriate to the investigation of their systemic risk contributions than non-listed relatively small banks. Third, listed banks typically have more diverse business lines than non-listed banks do, which provides more comparable panels to capture a country's overall degree of diversification based on a sample of banks with similar capabilities of engaging in different financial activities. To alleviate the concern regarding the low representativeness of a country-level diversification indicator of countries with too few listed banks included in the sample, I drop countries with less than three banks included in the sample. That would make each country's diversification measure not dominated by a single bank, especially for countries with only one or two banks included.

2.3.3 Bank stability measure

2.3.3.1 Individual stability measure

I use the *Z-Score* as the measure of idiosyncratic risk of a bank. The *Z-Score* is an accounting-based bank stability measure and is used in previous banking studies (Laeven and Levine, 2009; Beck, De Jonghe, and Schepens, 2013; Ijtsma, Spierdijk, and Shaffer, 2017). The *Z-Score* can be interpreted as the distance from bank insolvency (Roy, 1952), or the number of standard deviations by which banks' realized returns have to decrease from their mean to wipe out all banks' equity (Boyd and Runkle, 1993). A higher *Z-Score* implies a lower probability of bank insolvency and a higher degree of individual bank stability. The *Z-Score* is computed at the bank level as follows:

$$Z\text{-}Score_{i,t} = \frac{ROA_{i,t} + \frac{E_{i,t}}{A_{i,t}}}{\sigma(ROA_{i,t})} \quad (2.2)$$

where ROA is the return on assets for bank i at time t. E/A represents the equity to asset ratio. I use a three-year rolling time window, rather than the whole sample period, to compute the standard deviation of return on assets, $\sigma(ROA)$, to allow for time variations in the denominator of the *Z-Score*. This approach avoids the possibility that the variations in *Z-Score* within banks over time are exclusively driven by the variations in the levels of capital and profitability (Schaeck and Čihák, 2010). I take the natural logarithm of *Z-Score* to mitigate the influences from the high skewness of this measure.

2.3.3.2 Systemic stability measure

I use the conditional value-at-risk (Δ*CoVaR*) proposed by Adrian and Brunnermeier (2016) as the systemic risk indicator of a bank. Δ*CoVaR* is constructed by computing the value-at-risk (*CoVaR*) of the banking system conditional on a financial institution being in distress. More specifically, a bank's contribution to systemic risk is defined as the difference between the *CoVaR* of the banking market conditional on this bank being in distress and the banking market's *CoVaR* in the median state of this bank. The systemic risk contribution of bank i to the overall bank market M is defined as:

$$\Delta CoVaR_q^{M|i} = CoVaR_q^{M|i} - CoVaR_{50\%}^{M|i} \quad (2.3)$$

where $CoVaR_q^{M|i}$ represents the *VaR* of banking system M when the asset returns of bank i are at the *qth* percentile, and $CoVaR_{50\%}^{M|i}$ denotes the *VaR* of the market returns conditional on bank i being in its median state. The term $\Delta CoVaR_q^{M|i}$ captures how much a bank contributes to the overall systemic risk. The conditional market *CoVaR* is calculated as follows:

$$X_t^i = \alpha^i + \gamma^i M_{t-1} + \epsilon_t^i \quad (2.4)$$

$$X_t^M = \alpha^{M|i} + \beta^{M|i} X_t^i + \gamma^{M|i} M_{t-1} + \epsilon_t^{M|i} \quad (2.5)$$

where X_t^i is the growth rate of market-value total assets of bank i, and relevant data required are daily market-value total equity and quarterly book-value total assets and equity. The daily market-value data and quarterly book-value data have to be converted to a weekly frequency.

X_t^M is the market capitalization weighted average of each bank's asset returns. M_{t-1} denotes a vector of lagged state variables that capture time variation in the conditional moments of asset returns. The state variables include weekly change of 3-month T-bill rate, term spread, market return (computed from S&P 500 return), and VIX (Chicago Board Options Exchange Volatility Index). The parameters α, β, and γ are estimated by using quantile regression on a weekly basis. The *CoVaR* of the banking system is computed by using the estimated parameters in the abovementioned equations:

$$VaR_t^i = \alpha^i + \gamma^i M_{t-1} \quad (2.6)$$

$$CoVaR_t^{M|i} = \alpha^{M|i} + \beta^{M|i} VaR_t^i + \gamma^{M|i} M_{t-1} \quad (2.7)$$

Δ*CoVaR* for bank i is calculated as:

$$\Delta CoVaR_t^i(q) = CoVaR_t^i(q) - CoVaR_t^i(50\%) = \beta^{M|i}\left[VaR_t^i(q) - VaR_t^i(50\%)\right] \quad (2.8)$$

In this study, I compute Δ*CoVaR* at both q=1% and q=5% levels to obtain more robust results.[5] A higher Δ*CoVaR* implies a lower systemic risk contribution and a higher systemic stability.

2.3.4 Control variables

With reference to De Jonghe (2010), Demirgüç-Kunt and Huizinga (2010), Amidu and Wolfe (2013), Leroy and Lucotte (2016) and Williams (2016), my study includes several bank-specific control variables that possibly affect bank stability into the regressions. These control variables are bank-level diversification (*RD*), bank size (*Bank Size*), capitalization (*Capitalization*), non-performing loans (*NPL*), loan growth ratio (*Loangrowth*), deposit ratio (*Deposit*) and loan ratio (*Loan*). *RD* is included to control for the possibility of the presence of

[5] Adrian and Brunnermeier (2016) that propose this indicator estimate Δ*CoVaR* for both the q=1% and q=5% cases. My chapter follow this setting.

biased information on the degree of diversification in a country if the distribution of interest and non-interest revenues within each bank is not considered.[6] *Bank Size* equals the natural logarithm of total bank assets in millions of U.S. dollars, and controls for the effect that larger banks expect to be more stable than smaller ones because of economies of scale in transaction costs, monitoring, and information management. I include the equity to total asset ratio (*Capitalization*) to control for the influence that better capitalized banks face lower bankruptcy costs and are less vulnerable to market shocks. I use the *NPL* to control for bank credit risk since banks with a bad quality of loan portfolio typically face higher probability of default. *Loangrowth* is included to control for the influence of the increasing rate of a bank's main asset on bank stability. *Deposit* and *Loan* are included to control for banks' funding and lending structures. I also include a group of macroeconomic variables to control for their effects on bank stability. GDP growth rate (*GDPgrowth*) and GDP per capita (*GDPpercap*) control for the influence of variations in economic development across countries. Inflation rate (*Inflation*) is included to control for the effect of changes in prices of products or services on bank financial performance. Table 2.2 shows the definitions of all variables used in my study.

[6] Consider two extreme situations regarding the distributions of interest and non-interest revenues of two banks in a country. Assuming that these two banks have the same total operating revenues (the sum of interest and non-interest revenues), in the first situation, one bank is fully concentrated on interest incomes while the other one is concentrated on non-interest incomes. In the second situation, the distribution of revenues of these two banks is perfectly balanced between interest and non-interest revenues. The values of country-level diversification would be the same under these two extreme situations according to my specification. Therefore, it is necessary to include the bank-level diversification into the regressions to distinguish these two situations.

Table 2.2. Definitions of Variables

Variables	Definitions
Bank stability measures	
ΔCoVaR (Δ*CoVaR*)	The systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on this bank being in distress and the banking market's CoVaR in the median state of this bank (Adrian and Brunnermeier, 2016). *Source*: CRSP, Datastream, Compustat Global, and authors' calculation.
Marginal expected shortfall (*MES*)	Alternative bank systemic risk indicator and is calculated as the average of a bank's stock return during the 5% worst trading days for the overall market return in one financial year (Acharya et al., 2017). *Source*: CRSP, Datastream, Compustat Global, and authors' calculation.
Z-Score (*Z-Score*)	The idiosyncratic risk measure and is calculated as the sum of return on assets and the equity ratio divided by the standard deviation of bank return on assets. *Source*: Worldscope and authors' calculation.
Return volatility (*ReturnVol*)	Alternative bank standalone risk indicator and is calculated as the standard deviation of bank stock returns on a yearly basis using the daily stock price information. *Source*: CRSP, Datastream, Compustat Global, and authors' calculation.
Diversification measures	
Country-level revenue diversification (*CRD*)	The country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *Source*: Worldscope and authors' calculation.
Revenue diversification *(RD*)	Measure of bank-level revenue diversification between interest income and non-interest income (Mercieca, Schaeck, and Wolfe, 2007). *Source*: Worldscope and authors' calculation.
Country-level income diversity (*CID*)	The country-level diversification measure calculated by taking the difference between the sum of interest revenues of banks in a country and the sum of other operating incomes divided by the sum of total operating incomes. *Source*: Worldscope and authors' calculation.
Income diversity (*ID*)	Alternative bank-level diversification measure that captures the diversity between interest and other operating incomes (Laeven and Levine, 2007). *Source*: Worldscope and authors' calculation.
Bank-specific control variables	
Bank size (*Bank Size*)	Natural logarithm of bank total assets. *Source*: Worldscope.
Equity to total assets ratio (*Capitalization*)	The ratio of total equity to total assets. *Source*: Worldscope.
Non-performing loans ratio (*NPL*)	The ratio of bank impaired loans to total gross loans. *Source*: Worldscope.
Loan growth rate (*Loangrowth*)	The growth rate of bank loans. *Source*: Worldscope.
Deposit ratio (*Deposit*)	The ratio of bank deposits over total assets. *Source*: Worldscope.
Loan ratio (*Loan*)	The ratio of bank loans over total assets. *Source*: Worldscope.

Table 2.2 (continued). Definitions of Variables

Variables	**Definitions**
Macroeconomic control variables	
GDP growth rate (*GDPgrowth*)	Annual percentage growth rate of GDP at market prices based on constant local currency. *Source*: The World Bank.
GDP per capita (*GDPpercap*)	GDP per capita is gross domestic product divided by midyear population. *Source*: The World Bank.
Inflation ratio (*Inflation*)	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. *Source*: The World Bank.

Notes: This study retrieves accounting data from the Worldscope on an annual basis to construct bank diversification, idiosyncratic risk and bank-specific control variables, and download stock market data from Datastream, CRSP and Compustat Global on daily basis to calculate systemic risk indicator. Macroeconomic control variables are obtained from the World Bank database. Accounting- and market-based measures have been converted to the same data frequency before conducting the regression analyses.

2.4 Methodology

To investigate the effect of diversification on bank stability, I employ the fixed effects model to control for unobserved time-invariant bank and country fixed effects and year fixed effects. Fixed effect models have been widely used in the banking literature to control for unobserved time-invariant variables (Mercieca, Schaeck, and Wolfe, 2007; Anginer, Demirgüç-Kunt, and Zhu, 2014a; Leroy and Lucotte, 2016; Goetz, 2017). My model is specified as follows:

$$Bank\ risk_{i,j,t} = \alpha + \beta \times\ Diversification_{j,t-1} + \delta_1 \times Bank\ specific\ controls_{i,j,t} + \delta_2 \times Macroeconomic\ controls_{j,t} + \mu_i + \nu_j + \tau_t + \varepsilon_{i,j,t} \quad (2.9)$$

where subscripts i, j and t denote bank i in country j in year t. *Bank risk* represents bank systemic (Δ*CoVaR*) or idiosyncratic risk (*Z-Score*) measures.[7] *Diversification* denotes the country-level diversification measure (*CRD*). I use time lagged values of the diversification indicator to mitigate the issue of reverse causality from bank risk to diversification. *Bank-specific controls* and *Macroeconomic controls* are vectors of bank-specific and macroeconomic control variables that control for their potential effects on bank stability. μ_i, ν_j and τ_t capture bank, country and year fixed effects, respectively. $\varepsilon_{i,j,t}$ is the error term. α, β, and δ are the parameters to be estimated.

2.5 Results

2.5.1 Summary statistics

Table 2.3 and 2.4 present the descriptive statistics of the variables used in this chapter and their pairwise correlations, respectively. My diversification indicators, *CRD* and *RD*, have means 0.355 and 0.407, respectively. Their maximum values are equal to their theoretical maximum values, which indicates that banks in at least one country or at least one bank among all banks

[7] All dependent variables employed in my thesis, such as *Z-score*, Δ*CoVaR*, *MES* and *Lerner Index*, have no constraints in terms of range. This ensures the meaningfulness of the results of OLS-based panel data regressions.

in my sample are fully diversified between interest and non-interest income generating activities. The *Z-Score* has a mean of 24.28 with the range from -3.343 to 115.7, and the Δ*CoVaR* has a mean of -0.0352 and falls between -0.202 and 0.0392, which shows that these key risk indicators are in their expected ranges. As for the pairwise correlations, I find a negative correlation between *CRD* and Δ*CoVaR*, which indicates a negative relationship between country-level diversification and systemic stability. The correlation between *CRD* and *Z-Score* is also negative, and this indicates that country-level diversification is also negatively correlated with individual bank stability. In the next section, I will investigate the relationships between country-level diversification and both individual and systemic dimensions of bank stability by running regressions after controlling a group of variables.

Table 2.3. Descriptive Statistics

Variables	N	Mean	SD	Min	Max
CRD	29,378	0.355	0.109	0	0.500
RD	20,720	0.407	0.100	0.0176	0.500
Z-Score	20,635	24.28	16.21	-3.343	115.7
Δ*CoVaR*	20,835	-0.0352	0.0423	-0.202	0.0392
Bank Size	21,541	15.28	2.155	8.334	21.14
Capitalization	21,483	0.0874	0.510	-34.04	1.210
NPL	18,535	0.0281	0.0452	0	0.711
Loangrowth	20,129	0.126	0.259	-0.748	2.576
Loan	20,747	0.659	0.146	0	0.989
Deposit	21,327	0.716	0.167	0	0.948
GDPgrowth	29,001	0.0262	0.0251	-0.148	0.251
GDPpercap	29,001	10.24	1.068	6.206	11.63
Inflation	29,001	0.0307	0.0605	-0.0601	1.437

Notes: This table contains information on the descriptive statistics of all variables used in the chapter. *N* represents the number of observations for each variable. *SD* is the standard deviation of each variable. *Mean*, *Min*, and *Max* indicate the mean, minimum, and maximum value of each variable, respectively. Detailed information on each variable's definition and calculation are reported in Table 2.2. To account for the influence of extreme values and outliers, all variables are winsorized and the bottom 1% and top 1% of observations for each variable are set respectively to the value of the 1st and 99th percentiles. *Source*: Worldscope, CRSP, Datastream, Compustat Global, and authors' calculation.

Table 2.4. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) *CRD*	1.000												
(2) *RD*	0.188*	1.000											
(3) *Z-Score*	-0.042*	0.104*	1.000										
(4) Δ*CoVaR*	-0.101*	-0.046*	0.003	1.000									
(5) *Bank Size*	0.010	-0.368*	-0.135*	0.186*	1.000								
(6) *Capitalization*	-0.012	0.004	0.062*	0.005	0.016*	1.000							
(7) *NPL*	0.116*	-0.034*	-0.217*	0.062*	0.124*	-0.179*	1.000						
(8) *Loangrowth*	-0.015*	-0.030*	-0.050*	-0.074*	-0.093*	0.023*	-0.162*	1.000					
(9) *Loan*	0.012	0.099*	0.031*	-0.019*	-0.128*	-0.052*	-0.004	0.057*	1.000				
(10) *Deposit*	-0.003	0.286*	0.134*	0.043*	-0.262*	-0.050*	-0.015*	-0.041*	0.234*	1.000			
(11) *GDPgrowth*	-0.068*	-0.169*	-0.066*	0.026*	0.008	-0.005	-0.026*	0.228*	-0.066*	0.025*	1.000		
(12) *GDPpercap*	-0.033*	0.298*	0.266*	-0.022*	-0.145*	0.031*	-0.318*	-0.064*	0.108*	0.035*	-0.410*	1.000	
(13) *Inflation*	-0.003	-0.123*	-0.188*	-0.026*	-0.023*	0.005	0.053*	0.049*	-0.115*	-0.103*	0.060*	-0.395*	1.000

Notes: This table presents the pairwise correlations of main variables.*CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. Δ*CoVaR* is bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represents the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. * indicates statistical significance at the 5% level.

2.5.2 Empirical results

Table 2.5 shows the results on the relationship between country-level diversification and bank stability in the dimensions of idiosyncratic and systemic stability. I employ both fixed effects estimations and two-stage least square (2SLS) regressions in order to confirm that my findings are consistent and less subject to the endogeneity problem. I am concerned about the endogeneity between diversification and bank stability because there could exist omitted variables associated with banks' diversified activities affecting bank stability. Although my diversification and bank stability indicators are computed at country and bank levels, respectively, the majority of countries in my sample include a relatively lower number of banks. Excluding the U.S. and Japanese banks of which have far more banks than the other countries,[8] the remaining 45 countries have around 10 banks on average. Therefore, it is possible that banks from these countries have omitted bank-specific factors that are associated with their corresponding country-level diversification because a country-level indicator is more likely to be distorted by individual characteristics of its components as the number of banks decreases in a country.

According to the results of fixed effects estimation in columns (1) to (4), I find positive and significant coefficients of country-level diversification in columns (1) and (2), which indicates that a higher diversification decreases a bank's idiosyncratic risk.[9] This finding could be explained by the modern portfolio theory that a firm's idiosyncratic risk can be reduced by holding a well-diversified portfolio (Markowitz, 1952; Sharpe, 1964). Sanya and Wolfe (2011) also show similar results that diversification across interest and non-interest income-generating activities reduces bank-level insolvency risk. In contrast, I find negative and significant

[8] The U.S. and Japan include 794 and 91 banks, respectively, according to the information shown in Table 2.1.
[9] The values of risk indicators, *Z-score* and $\Delta CoVaR$, are both positively related to bank stability.

coefficients of *CRD* in the dimension of system stability in columns (3) and (4).[10] These findings provide empirical evidence in line with the theory of Wagner (2010) according to which diversification makes systemic crisis more likely since diversification tends to increase the similarity across banks in terms of activities or portfolios as they become more exposed to common risks. In addition, my results also confirm the theoretical study by Ibragimov, Jaffee, and Walden (2011). My findings suggest that the degree of overall diversification in a country may lead to different effects on bank stability depending on the dimensions of risk.

I present the 2SLS regression results in columns (5) to (8) in Panel A of Table 2.5. I use the Diversification Index as the instrument of diversification indicator. The Diversification Index is a variable constructed based on two survey questions from the Bank Regulation and Supervision Survey, and this index shows whether there are any regulatory rules or supervisory guidelines regarding assets diversification and whether banks are allowed to make loans abroad.[11] The information implicit in this index affects the engagement of banks in diversified activities and, via this channel, it has an influence on banks' risk. Since the Diversification Index contains the information on the regulations and guidelines applying to all banks in a particular country, I can assume that this IV has no direct relation with unobserved factors (e.g. risk appetite, managers' skills) that are specific for each bank. I calculate the pairwise correlation coefficients between the Diversification Index and the risk measures analyzed and find that their correlations are very low (-0.0284 with *Z-Score* and 0.0186 with $\Delta CoVaR$). In addition, the OLS regressions between the Diversification Index and the risk indicators show no direct signification association between the Diversification Index and the risk measures as

[10] Columns (3) and (4) of Table 2.6 present the results that use $\Delta CoVaR$ calculated at q=1%. The results do not change when $\Delta CoVaR$ is computed at q=5%, and relevant results are available upon request.
[11] This database can be accessed through the website: https://www.worldbank.org/en/research/brief/BRSS. The value of the Diversification Index ranges between 0 and 2, and a higher value indicates more diversification. The two survey questions used to construct this index are: (1) Are there any regulatory rules or supervisory guidelines regarding asset diversification? (Yes=1; No=0); (2) Are banks prohibited from making loans abroad? (Yes=0; No=1).

shown in Panel B of Table 2.5. Therefore, I employ the Diversification Index as the instrumental variable for the diversification indicator. Although the values of the Diversification Index are constant between two consecutive surveys, I do not expect that the instrumental variable is time-invariant because my study uses a relatively long period of data collected from the past five surveys conducted in 1999, 2002, 2006, 2011, and 2016, respectively. Therefore, the variations of this instrument in a country cannot be absorbed by the time-invariant fixed effects and will not be controlled for in that estimation procedure. To check the relevance of instruments with the endogenous variable, I report the F-statistic in the first-stage of the 2SLS regressions to test the hypothesis that the coefficients of instrumental variables are zero. According to the results of the first-stage regressions shown in Table 2.5, the values of the F-statistics are higher than their relevant critical values at 1% significance level, which rejects the null hypothesis and indicates the relevance of the instruments. Based on the second-stage results, I find consistent negative and significant relationship between diversification and idiosyncratic risk in columns (5) and (6) while a positive and significant relationship in the dimension of systemic risk exists in columns (7) and (8).

For the control variables, as introduced in Section 2.3.4, I include the bank-level diversification indicator (*RD*) into every regression to control for the distributions of revenues within each bank, which distinguishes different scenarios with the same values of country-level diversification (*CRD*). Since my study is only interested in the degree of diversification at the country level, the interpretations of the sign and significance of *RD* are not the focus of my study. I do not find consistent results on the coefficients of *RD* under different specifications of regressions, which implies that diversification within individual banks is differently associated with banks' idiosyncratic and systemic risks. I only find consistent significant coefficients of *RD* for bank standalone risk under different model specifications (in columns 1, 2, 5 and 6) but not for systemic risk (in columns 3, 4, 7 and 8). The significantly negative coefficients of *RD* in columns (1), (2), (5) and (6) indicate a negative effect of revenue diversification in individual bank stability, which is consistent with previous studies that non-interest-generating activities are associated with high volatilities and risks of individual banks (Stiroh, 2004a; Stiroh, 2006; Stiroh and Rumble, 2006; Lepetit et al., 2008a). For other bank-specific control variables, I find that bank size, non-performing loans ratio, deposit ratio are consistently negatively associated with individual bank stability (in columns 1, 2, 5 and 6), which indicates that larger banks and banks holding more deposits and non-performing loans tend to have more standalone risk. The negative relationship between bank size and the Z-Score is consistent with Schaeck and Cihak (2014) that larger banks tend to have lower individual stability. Stiroh (2006) also shows that banks with higher non-performing loan ratios tend to be more risker. However, these effects are not consistently significant on the dimension of systemic risk, which implies that the bank-specific control variables could determine bank risks in a different way.

Table 2.5. Baseline results: The relationship between diversification and bank stability

Panel A	**Dependent Variables**							
	Z-Score	*Z-Score*	*ΔCoVaR*	*ΔCoVaR*	*Z-Score*	*Z-Score*	*ΔCoVaR*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fixed effects estimation				*IV-2SLS*			
CRD	3.673***	3.360***	-0.00980***	-0.000610**	47.62***	15.10*	-1.104***	-0.0161**
	(0.808)	(0.687)	(0.00279)	(0.000265)	(6.946)	(8.714)	(0.0817)	(0.00770)
RD	-3.808***	-5.483***	0.0220***	-0.000314	-12.26***	-6.914***	0.244***	0.00244
	(0.827)	(0.819)	(0.00549)	(0.000546)	(1.647)	(1.736)	(0.0223)	(0.00153)
Bank Size	-0.611**	-1.908***	0.0249***	-6.96e-05	-0.536***	-1.859***	0.0250***	-8.71e-05
	(0.259)	(0.301)	(0.00125)	(0.000133)	(0.153)	(0.171)	(0.00200)	(0.000164)
Capitalization	0.576	0.766	-0.00456	-1.25e-05	0.399	0.645*	0.00821	0.000126
	(0.680)	(0.640)	(0.00566)	(0.000129)	(0.339)	(0.345)	(0.0111)	(0.000151)
NPL	-3.759*	-7.435***	0.0351**	0.000647	-10.61***	-10.97***	0.220***	0.00273*
	(2.111)	(1.998)	(0.0155)	(0.000902)	(1.917)	(1.960)	(0.0245)	(0.00163)
Loangrowth	-0.302	-0.0314	-0.00321**	9.84e-05	-0.423*	-0.147	0.00234	8.66e-06
	(0.217)	(0.216)	(0.00134)	(0.000196)	(0.237)	(0.221)	(0.00321)	(0.000194)
Loan	0.944	2.209**	-0.0326***	-0.000541	0.277	1.848***	-0.00628	2.92e-05
	(1.016)	(1.064)	(0.00595)	(0.000426)	(0.718)	(0.692)	(0.00914)	(0.000523)
Deposit	-8.016***	-11.99***	0.0438***	0.000540	-9.430***	-12.17***	0.0911***	0.000752
	(1.410)	(1.405)	(0.00851)	(0.000474)	(0.881)	(0.806)	(0.0120)	(0.000578)
GDPgrowth	13.71***	14.31***	0.164***	0.00529**	38.59***	14.83***	-0.302***	0.0110***
	(2.528)	(4.015)	(0.0126)	(0.00215)	(4.542)	(4.265)	(0.0597)	(0.00415)
GDPpercap	7.673***	1.029	0.104***	5.29e-05	10.03***	-0.766	-0.0117	-0.00171
	(1.011)	(1.249)	(0.0102)	(0.000498)	(0.914)	(1.067)	(0.0125)	(0.00107)
Inflation	-0.949	-1.296	0.0804***	0.00378***	4.130*	-1.825	-0.166***	0.00563***
	(1.790)	(1.619)	(0.0157)	(0.00138)	(2.408)	(1.464)	(0.0455)	(0.00184)
Constant	-39.19***	49.86***	-1.501***	-0.117***				
	(8.267)	(11.65)	(0.0929)	(0.00460)				
Number of Observations	16,901	16,901	16,018	16,018	15,219	15,219	14,473	14,473
Number of Banks	1,346	1,346	1,342	1,342	1,317	1,317	1,317	1,317
R-squared	0.040	0.079	0.342	0.993	-0.376	0.047	-6.102	0.990
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Kleibergen-Paap Wald rk F-statistic					245.95***	39.42***	210.48***	38.50***

Table 2.5 (continued). Baseline results: The relationship between diversification and bank stability

Panel B	**Dependent Variables**	
	Z-Score	Δ*CoVaR*
	OLS regression	
IV-Diversification Index	-0.209	0.0000586
	(0.182)	(0.000107)

Notes: This table presents the regression results on the relationship between country-level diversification and bank stability. Sample consists of 1,395 international publicly listed banks from 49 countries over the period between 1998 and 2018. Regression variables are calculated using annual bank level data. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. Δ*CoVaR* is bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represents the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Panel A reports the regression results of the fixed effects estimation in columns (1)-(4) and the IV-2SLS by employing the Diversification Index as the instrument for *CRD* in columns (5)-(8). The result of testing weak instruments (Kleibergen-Paap rk Wald F-statistic) is reported. Panel B reports the OLS results that regress risk measures, *Z-Score* and Δ*CoVaR*, on the IV-Diversification Index. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2.6 Robustness check

2.6.1 Alternative diversification measures

To test whether my results hold for different specifications of the diversification measure, I construct an alternative county-level diversification indicator, country-level income diversity (*CID*). Following Laeven and Levine (2007), I first construct the bank-level income diversity (*ID*) for each bank in my sample, and then further build up this indicator at the country level to reflect the overall degree of diversification in a country in accordance with my objective. *ID* and *CID* are calculated as:

$$ID_{i,t} = 1 - \left| \frac{Interest\ Income_{i,t} - Noninterest\ Income_{i,t}}{Total\ Operating\ Income_{i,t}} \right| \quad (2.10)$$

$$CID_{j,t} = 1 - \left| \frac{\sum Interest\ Income_{i,t} - \sum Noninterest\ Income_{i,t}}{\sum Total\ Operating\ Income_{i,t}} \right| \quad (2.11)$$

By using *CID* as an alternative diversification indicator, I find consistent results with my baseline findings showing that diversification has significant negative impacts on bank systemic stability (in columns 3, 4, 7 and 8 in Table 2.6) while there are positive impacts on individual bank stability (in columns 1, 2, 5 and 6).

Table 2.6. Robustness check: Results based on alternative diversification measure

Dependent Variables	*Z-Score*	*Z-Score*	*ΔCoVaR*	*ΔCoVaR*	*Z-Score*	*Z-Score*	*ΔCoVaR*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fixed effects estimation				*IV-2SLS*			
CID	0.989***	0.981***	-0.00389***	-0.000130*	28.04***	6.858*	-0.633***	-0.00688**
	(0.255)	(0.202)	(0.000792)	(6.68e-05)	(4.054)	(3.759)	(0.0533)	(0.00334)
ID	-2.648***	-3.778***	0.0124***	-0.000158	-8.277***	-4.637***	0.147***	0.00111
	(0.406)	(0.411)	(0.00280)	(0.000288)	(1.057)	(0.814)	(0.0170)	(0.000738)
Bank Size	-0.629**	-2.012***	0.0250***	-7.06e-05	-0.601***	-2.005***	0.0270***	-3.51e-05
	(0.259)	(0.302)	(0.00125)	(0.000133)	(0.184)	(0.169)	(0.00286)	(0.000162)
Capitalization	0.593	0.802	-0.00471	-1.34e-05	0.380	0.683**	0.0113	9.87e-05
	(0.680)	(0.639)	(0.00567)	(0.000129)	(0.332)	(0.345)	(0.0136)	(0.000140)
NPL	-3.104	-6.753***	0.0334**	0.000616	-14.19***	-10.95***	0.309***	0.00313*
	(2.095)	(1.974)	(0.0156)	(0.000905)	(2.447)	(2.101)	(0.0354)	(0.00178)
Loangrowth	-0.330	-0.0500	-0.00315**	9.80e-05	-0.622**	-0.187	0.00552	2.23e-05
	(0.216)	(0.216)	(0.00134)	(0.000196)	(0.288)	(0.225)	(0.00481)	(0.000198)
Loan	0.884	2.140**	-0.0320***	-0.000555	-0.856	1.588**	0.0174	0.000159
	(1.014)	(1.059)	(0.00594)	(0.000430)	(0.823)	(0.719)	(0.0124)	(0.000558)
Deposit	-7.646***	-11.76***	0.0429***	0.000528	-8.341***	-11.82***	0.0711***	0.000515
	(1.406)	(1.401)	(0.00849)	(0.000477)	(1.053)	(0.831)	(0.0176)	(0.000585)
GDPgrowth	12.60***	14.87***	0.166***	0.00516**	43.04***	15.10***	-0.390***	0.0106***
	(2.477)	(3.979)	(0.0125)	(0.00214)	(5.497)	(4.112)	(0.0842)	(0.00399)
GDPpercap	7.495***	0.691	0.103***	0.000101	10.99***	-1.139	-0.0326*	-0.00139
	(1.004)	(1.245)	(0.0102)	(0.000500)	(1.096)	(0.959)	(0.0171)	(0.000953)
Inflation	-1.461	-1.546	0.0820***	0.00377***	-1.130	-3.294*	-0.0446	0.00705***
	(1.771)	(1.592)	(0.0156)	(0.00139)	(2.318)	(1.844)	(0.0433)	(0.00226)
Constant	-36.36***	55.51***	-1.502***	-0.118***				
	(8.131)	(11.63)	(0.0927)	(0.00463)				
Number of Observations	16,901	16,901	16,018	16,018	15,219	15,219	14,473	14,473
Number of Banks	1,346	1,346	1,342	1,342	1,317	1,317	1,317	1,317
R-squared	0.042	0.084	0.342	0.993	-1.496	0.007	-20.272	0.989
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Kleibergen-Paap Wald rk F-statistic					181.64***	35.02***	156.79***	34.92***

Notes: This table presents the robustness check results on the relationship between country-level diversification and bank stability. Sample consists of 1,395 international publicly listed banks from 49 countries over the period between 1998 and 2018. Regression variables are calculated using annual bank level data. *CID* and *ID* are the country- and bank-level income diversity measures, respectively. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. Δ*CoVaR* is bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. This table presents the results of using Δ*CoVaR* calculated at q=1%. The regression results do not change when Δ*CoVaR* is computed at q=5%, and relevant results are available upon request. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represents the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. This table reports regression results of the fixed effects estimation in columns (1)-(4) and the IV-2SLS by employing the Diversification Index as the instrument for *CID* in columns (5)-(8). The result of test for checking weak instruments (Kleibergen-Paap rk Wald F-statistic) is reported. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2.6.2 Alternative bank risk measures

In addition, I build up alternative bank idiosyncratic and systemic risk indicators. Following Laeven and Levine (2009), Demirgüç-Kunt and Huizinga (2010), and Anginer, Demirgüç-Kunt, and Zhu (2014b), I use the stock return volatility (*ReturnVol*) as an alternative indicator of bank standalone risk, which is calculated as the standard deviation of bank stock returns on a yearly basis using the daily stock price information. Higher values of the *ReturnVol* indicator are associated with greater return volatilities and risks. For bank systemic risk, I employ the marginal expected shortfall (*MES*) to capture a bank's contribution to systemic risk (Acharya et al., 2010, 2017). *MES* is computed as the average of a bank's stock returns during the 5% worst trading days of the overall market return in a financial year. A high value of *MES* indicates low bank's systemic risk contributions.[12] The marginal expected shortfall for a given bank-year observation is calculated as follows:

$$MES_{i,t} = \frac{\sum R_i}{N_{worst\ days}} \quad (2.12)$$

where R_i denotes the daily stock return of bank *i* during the 5% market's worst trading days in year *t*. N is the number of 5% worst days of the market return. According to the results shown in Table 2.7, by using *ReturnVol* and *MES* as alternative bank risk indicators, I find consistent results with the baseline results according to which the overall degree of income diversity in a country has significant negative impacts on bank systemic stability (in columns 2 and 4) while positive impacts occur on individual bank stability by reducing stock return volatility (in columns 1 and 3).

[12] In this study, I keep the original form of the marginal expected shortfall (*MES*). Typically, it has a negative value, and a low value captures a high systemic risk contribution.

Table 2.7. Robustness check: Results based on alternative bank risk measure

Dependent Variables	*ReturnVol*	*MES*	*ReturnVol*	*MES*
	(1)	(2)	(3)	(4)
	Fixed effects estimation		*IV-2SLS*	
CRD	-0.0151***	-0.00400*	-0.373***	-0.291***
	(0.00459)	(0.00222)	(0.0345)	(0.0271)
RD	0.00563*	-0.00222	-0.0689***	0.0604***
	(0.00323)	(0.00268)	(0.00950)	(0.00753)
Bank Size	-0.000483	-0.00823***	-0.000948	-0.00717***
	(0.000608)	(0.000446)	(0.000800)	(0.000616)
Capitalization	-0.0742***	-0.0216***	-0.136***	0.0237***
	(0.0129)	(0.00558)	(0.0160)	(0.00889)
NPL	0.106***	-0.0236***	0.0536***	0.0230***
	(0.0126)	(0.00582)	(0.0123)	(0.00831)
Loangrowth	0.000977	-0.00178**	-0.000883	-0.00184*
	(0.000995)	(0.000719)	(0.00124)	(0.000973)
Loan	0.00342	-0.00925***	-5.15e-05	-0.00320
	(0.00354)	(0.00251)	(0.00393)	(0.00303)
Deposit	-0.0107**	0.0117***	-0.0232***	0.0234***
	(0.00435)	(0.00307)	(0.00466)	(0.00372)
GDPgrowth	-0.217***	0.223***	-0.0387	0.0733***
	(0.0155)	(0.0144)	(0.0252)	(0.0198)
GDPpercap	-0.0166***	0.0341***	0.0113**	0.0110***
	(0.00362)	(0.00240)	(0.00546)	(0.00419)
Inflation	-0.0107	-0.0378***	0.0456**	-0.0831***
	(0.00892)	(0.00681)	(0.0213)	(0.0145)
Constant	0.212***	-0.245***		
	(0.0318)	(0.0201)		
Number of Observations	16,355	16,337	14,855	14,836
Number of Banks	1,342	1,342	1,316	1,315
R-squared	0.114	0.145	-1.624	-1.308
Bank fixed effect	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Kleibergen-Paap Wald rk F-statistic			212.67***	210.23***

Notes: This table presents the robustness check results on the relationship between country-level diversification and bank stability. Sample consists of 1,395 international publicly listed banks from 49 countries over the period between 1998 and 2018. Regression variables are calculated using annual bank level data. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *ReturnVol* is an alternative bank standalone risk indicator and is calculated as the standard deviation of bank stock returns on a yearly basis using the daily stock price information. *MES* is an alternative bank systemic risk indicator and is calculated as the average of a bank's stock return during the 5% worst trading days for the overall market return in one financial year. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represents the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. This table reports regression results of the fixed effects estimation in columns (1)-(2) and the IV-2SLS by employing the Diversification Index as the instrument for *CRD* in columns (3)-(4). The result of test for checking weak instruments (Kleibergen-Paap rk Wald F-statistic) is reported. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2.6.3 Checking whether the results are driven by the financial crisis

To check the consistency of my results, I also consider whether my results could be driven by the global financial crisis. The financial crisis may have brought about structural changes to the banking market by influencing risk-taking decisions of banks or the scope of activities that banks are allowed to engage as required by the regulatory agencies in different countries. I run subsample regressions by setting the pre-crisis sample from 1998 to 2007 and post-crisis sample between 2010 and 2018. The usage of 2SLS estimation does not technically apply to the post-crisis sample because the data for building up my instrumental variable is from only two surveys, and the instrument takes relatively constant values during the post-crisis period (2010–2018), so the instrumental variable hardly explains the variations in the values of the endogenous variable during that period. Therefore, I only report the fixed effects results for this robustness test in Table 2.8. According to the results as shown in Table 2.8, my observed baseline results do not change in both pre- and post-crisis subsamples.

Table 2.8. Robustness check: Considering the financial crisis

Dependent Variables	*ReturnVol*	*MES*	*ReturnVol*	*MES*
	(1)	(2)	(3)	(4)
	Pre-crisis sample		*Post-crisis sample*	
CRD	-0.0166***	-0.00171*	-0.00977**	-0000403*
	(0.00568)	(0.000912)	(0.00385)	(0.000200)
RD	-0.00251	-0.000139	-0.00337	0.000649**
	(0.00350)	(0.000816)	(0.00535)	(0.000299)
Bank Size	-0.00267**	-0.000545**	-0.00398**	-0.000129
	(0.00112)	(0.000274)	(0.00174)	(0.000199)
Capitalization	-0.0185	0.00434*	-0.000843	3.27e-05
	(0.0119)	(0.00257)	(0.00181)	(9.72e-05)
NPL	0.0438***	0.00249	0.0647***	0.000336
	(0.0142)	(0.00202)	(0.0181)	(0.000658)
Loangrowth	0.000292	0.000592**	-0.00656***	0.000500*
	(0.000926)	(0.000281)	(0.00199)	(0.000283)
Loan	-0.00774*	-0.00211***	-0.00458	-0.000240
	(0.00467)	(0.000657)	(0.00633)	(0.000572)
Deposit	0.00676	0.00231**	-0.0145*	-0.000831
	(0.00698)	(0.000947)	(0.00787)	(0.000674)
GDPgrowth	-0.00744	0.00466	0.0197	0.00154
	(0.0253)	(0.00309)	(0.0472)	(0.00180)
GDPpercap	0.00520	-0.000121	-0.0159**	-0.00182*
	(0.0101)	(0.00191)	(0.00648)	(0.00105)
Inflation	-0.00952	-0.00106	-0.00510	0.00386
	(0.00986)	(0.00121)	(0.0191)	(0.00238)
Constant	0.0232	-0.108***	0.266***	-0.0223**
	(0.100)	(0.0189)	(0.0743)	(0.0108)
Number of Observations	7,803	7,813	6,424	6,426
Number of Banks	1,213	1,213	954	954
R-squared	0.115	0.994	0.046	0.995
Bank fixed effect	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES

Notes: This table presents the robustness check results on the relationship between country-level diversification and bank stability. The whole sample is divided into two subsamples by excluding the observations during the crisis period. The pre-crisis sample covers the period from 1998 to 2007 and the post-crisis sample starts from 2010 to 2018. Regression variables are calculated using annual bank level data. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *ReturnVol* is an alternative bank standalone risk indicator and is calculated as the standard deviation of bank stock returns on a yearly basis using the daily stock price information. *MES* is an alternative bank systemic risk indicator and is calculated as the average of a bank's stock return during the 5% worst trading days for the overall market return in one financial year. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represents the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. This table reports regression results of the fixed effects estimation. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2.6.4 Additional regulatory and institutional control variables

It is important to consider the regulatory framework and institutional variables in different countries to draw solid conclusions on the relationship between diversification and bank stability. This is because the diversification level in a country as well as bank stability could be directly or indirectly affected by its specific regulatory and institutional environments with respect to the scope of activities and financial services that banks are allowed to engage in. If my results regarding the influence of diversification on bank stability are driven by such regulatory and institutional variables, controlling for these additional variables will make the key explanatory variables become less significant or insignificant. Hence, not considering the potential effects of these regulatory and institutional factors could possibly lead to spurious correlations between diversification and bank risks. With reference to Mercieca, Schaeck, and Wolfe (2007) and Amidu and Wolfe (2013), I consider three regulatory and institutional variables: *Banking Freedom*, *Activity Restriction*, and *Supervisory Power*. *Banking Freedom* is an index that assesses an economy's overall level of financial freedom that provides ease and effective access to financing opportunities for people and businesses in the economy. Increasing values of this index indicate more freedom in the banking market in a country. *Activity Restriction* is an index that indicates whether activities/services of banks in securities, insurance and real estate activities in a country are unrestricted, permitted, restricted or prohibited. Higher values of this index indicate more restrictions. *Supervisory Power* is an index that captures the extent to which regulatory agencies have the authority to take actions to prevent banking problems in a country. This index is increasing in the power of regulatory authority. I retrieve the data on *Banking Freedom* from the Heritage Foundation[13] and on *Activity Restriction* and *Supervisory Power* from the Barth, Caprio, and Levine (2013) based on four surveys conducted by the World Bank's Bank Regulation and Supervision Survey. I

[13] This database can be accessed through the website: https://www.heritage.org/index/financial-freedom.

report the robustness test results that consider these three regulatory and institutional control variables in Table 2.9. *Banking freedom* is negatively associated with *Z-Score* in column (1), and *Activity Restriction* and *Supervisory Power* are positively associated with Δ*CoVaR* in columns (5) and (6). In spite of such variations in the associations of these regulatory and institutional variables with bank risk, the signs and significances of the key explanatory variables hold on the dimensions of bank idiosyncratic and systemic risks by using both the fixed effects and IV-2SLS estimations after factoring in additional control variables, which confirms that my results are not driven by potentially omitted regulatory and institutional control factors.

Table 2.9. Robustness check: Considering the regulatory and institutional control variables

Dependent Variables	*Z-Score*	*Z-Score*	*Z-Score*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)
CRD	2.987***	3.460***	3.115***	-0.000607**	-0.000607**	-0.000853***
	(0.674)	(0.751)	(0.733)	(0.000266)	(0.000279)	(0.000314)
RD	-5.449***	-4.879***	-5.068***	-0.000322	-0.000516	-0.000591
	(0.820)	(0.988)	(0.833)	(0.000548)	(0.000476)	(0.000544)
Banking Freedom	-0.0379***			6.55e-07		
	(0.00941)			(3.18e-06)		
Supervisory Power		-0.0364			6.60e-05*	
		(0.0765)			(3.70e-05)	
Activity Restriction			0.109			0.000113**
			(0.0709)			(5.40e-05)
Bank Size	-1.878***	-1.851***	-2.130***	-7.19e-05	-9.39e-05	-0.000117
	(0.302)	(0.345)	(0.323)	(0.000134)	(0.000171)	(0.000155)
Capitalization	0.720	1.019	1.163	-6.42e-06	3.51e-05	-2.86e-06
	(0.639)	(1.006)	(1.029)	(0.000131)	(0.000128)	(0.000133)
NPL	-8.651***	-12.95***	-9.727***	0.000693	0.000381	0.000743
	(2.074)	(2.176)	(2.235)	(0.000915)	(0.00148)	(0.00112)
Loangrowth	-0.0848	-0.187	-0.217	1.00e-04	9.24e-05	7.42e-05
	(0.217)	(0.240)	(0.230)	(0.000196)	(0.000226)	(0.000224)
Loan	2.344**	2.240*	2.132*	-0.000542	-0.000528	-0.000552
	(1.081)	(1.206)	(1.118)	(0.000429)	(0.000502)	(0.000485)
Deposit	-12.37***	-13.65***	-12.58***	0.000536	0.000872	0.000638
	(1.437)	(1.665)	(1.536)	(0.000482)	(0.000659)	(0.000613)
GDPgrowth	13.11***	17.17***	13.49***	0.00543**	0.00787***	0.00452**
	(4.023)	(4.434)	(3.889)	(0.00219)	(0.00302)	(0.00200)
GDPpercap	2.005*	-2.260	-0.795	4.20e-05	-4.71e-05	-0.000116
	(1.195)	(1.381)	(1.282)	(0.000499)	(0.000687)	(0.000593)
Inflation	-0.920	1.159	-1.254	0.00379***	0.00522***	0.00418***
	(1.714)	(1.930)	(2.038)	(0.00139)	(0.00180)	(0.00150)
Constant	42.29***	83.70***	71.18***	-0.117***	-0.117***	-0.115***
	(11.21)	(13.11)	(12.11)	(0.00464)	(0.00658)	(0.00555)
Number of Observations	16,868	14,040	15,382	15,985	13,220	14,534
Number of Banks	1,342	1,314	1,335	1,338	1,305	1,331
R-squared	0.081	0.074	0.074	0.993	0.993	0.993
Bank fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES

Notes: This table presents the robustness check results on the relationship between country-level diversification and bank stability. Sample consists of 1,395 international publicly listed banks from 49 countries over the period between 1998 and 2018. Regression variables are calculated using annual bank level data. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. *ΔCoVaR* is bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. This table presents the results of using *ΔCoVaR* calculated at q=1%. The regression results do not change when *ΔCoVaR* is computed at q=5%, and relevant results are available upon request. *Banking Freedom* is an index that assesses an economy's overall level of financial freedom that provides ease and effective access to financing opportunities for people and businesses in the economy. *Supervisory Power* is an index that indicates the strength of official supervisory power of regulatory agencies in a country. *Activity Restriction* is an index that indicates whether activities/services of banks in securities, insurance and real estate activities in a country are unrestricted, permitted, restricted or prohibited. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represents the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2.7 Conclusions

Using a dataset with 1,395 international listed banks from 49 countries over the period from 1998 to 2018, this chapter contributes to the literature by empirically testing the theoretical model developed by Wagner (2010) regarding the differential effects of diversification on bank idiosyncratic and systemic risk. Second, this chapter contributes by building up a new diversification indicator to reflect the degree of diversification from a country's perspective and show the risk distributions among banks by capturing the distributions of banks' revenues. The nature of this indicator makes my empirical analysis more appropriate to test the theory proposed in Wagner (2010) in the literature than other studies that employ traditionally used bank-level diversification indicators.

I find that an increase in diversification in a country leads to more systemic risk measured by $\Delta CoVaR$, which is possibly due to higher similarities in activities and portfolios among banks if banks become more diversified. My results confirm the findings of the aforementioned theoretical study. My findings also indicate that diversification has a contrasting effect on banks' idiosyncratic risk measured by *Z-Score*, which is consistent with the modern portfolio theory (Markowitz, 1952; Sharpe, 1964). My conclusions remain the same under several robustness checks, for example, using alternative diversification and bank risk indicators, considering the potential influence of the global financial crisis, and taking into account additional regulatory and institutional control variables. The findings of my study suggest that policies promoting banks' diversification activities, if well executed, may have benefits to individual bank's stability. However, they could also bring additional costs to banks and exacerbate systemic stability. Therefore, my study implies a desired degree of diversification among banks from the perspective of society.

Chapter 3: Diversification and Bank Stability: The Role of Regulatory Framework, Bank Size, and Capital

3.1 Introduction

In Chapter 2, I empirically test the theory on the direct relationship between diversification and bank idiosyncratic and systemic risk by constructing a new diversification indicator. In line with Wagner (2010), my findings confirm the theory that diversification has a negative effect on bank systemic stability while it has a positive influence on individual bank stability. Based on the conclusions in the previous chapter, in this chapter, I extend my research by investigating whether the diversification-bank stability relationship may vary according to a country's regulatory framework and banks' core risk determinants. To the best of my knowledge, my research is the first work that explicitly accounts for the role of regulatory framework, bank size and capital in assessing the effect of diversification on bank stability.

The variations in the regulatory environment across countries and mixed conclusions on the effect of regulation on bank stability[14] arouse my interests in investigating whether the regulatory framework is associated with the diversification-bank stability relationship in countries with different regulatory environments. Banks' diversification activities could have an interacting effect with a country's regulatory framework, which leads to a joint influence on bank stability. For example, regulatory authorities have cross-country differences in supervisory power, so they may have different expertise to discipline banks to establish sound corporate governance and monitor banks' risk-taking activities, which may moderate the effect of diversification on bank risk in a country. In addition, banks in countries with distinct private

[14] Details in previous studies that discuss the mixed findings on the relationship between bank regulation and supervision and risk are shown in Section 3.2.

monitoring environments may have varying levels of excessive risk-taking incentives, which possibly shows different reactions of banks in terms of taking diversified activities.

In addition to the regulatory framework, I also examine the moderating effects of banks' characteristics on the relationship between diversification and bank stability. Following Laeven, Ratnovski, and Tong (2016), my study focuses on two bank-specific risk factors – bank size and capital – as the recent global financial crisis has brought about the debate on these two characteristics as key determinants of bank systemic risk. Moreover, the literature shows mixed findings on the relationship between bank size, capital, and risk,[15] which is different for other risk indicators that have a uniform effect on bank risk such as non-performing loan and leverage ratio. Therefore, the mixed conclusions of these risk factors above raise my interests in exploring whether bank size and capitalization can moderate the relationship between diversification and bank risk.

This chapter contributes to the literature in two aspects. Firstly, this chapter is the first to investigate the role of the regulatory environment in the relationship between diversification and bank stability. This investigation is especially important to understand whether the diversification-bank stability relationship is conditional on the country-specific regulatory environment. Based on the cross-country database on bank regulation and supervision presented by Barth, Caprio, and Levine (2013), my study focuses on four aspects of the regulatory framework of a country: official supervisory power, capital regulations, bank activity restrictions, and private monitoring. These variables are the core in the agenda of policymakers and have also been employed to investigate their direct or indirect impacts on bank stability (Agoraki, Delis, and Pasiouras, 2011; Anginer, Demirgüç-Kunt, and Zhu, 2014a; Noman, Gee, and Isa, 2018). Second, my study is the first to investigate a potential association

[15] Detailed theories in explaining the relationship between bank size, capital, and risk are presented in Section 3.2 of this chapter.

between banks' two essential risk determinants (bank size and capital) and the diversification-bank stability relationship. This investigation is important to understand whether the relationship between diversification and banks stability uniformly applies to all banks or is conditional on banks with different characteristics, which provides insights to banks managers to formulate suitable diversification strategies based on banks' characteristics.

Using a large sample of 1,395 international listed banks from 49 countries from 1999 to 2015, I find a negative association between diversification and bank systemic stability that is mitigated in countries with powerful supervisory agencies, higher stringency of capital regulations, more restrictions on the scope of banks' activities, and more private monitoring. Moreover, my study shows that bank size and capital have a positive moderating effect on the negative association between diversification and systemic risk, which implies that larger and well-capitalized banks are less subject to systemic risk when the degree of diversification in a country is high. My findings have important policy implications as the effect of diversification on bank stability is possibly conditional on the country-specific regulatory framework and banks' own characteristics, which provide regulators and bank managers with new guidance in regulating diversified activities of banks in the market and formulating diversification strategies.

The remainder of this chapter is organized as follows. Section 3.2 presents previous research relevant to my study. Section 3.3 introduces the data and regulatory variables used in this chapter. Section 3.4 shows the methodology employed in this research. Section 3.5 reports my empirical findings, followed by robustness tests in Section 3.6. Section 3.7 concludes and discusses the main implications of my findings.

3.2 Literature review

There are significant cross-country variations in terms of bank regulation and supervision such as capital requirements, power of official supervisory agencies, permissible banking activities, and deposit insurance (Beck, De Jonghe, and Schepens, 2013; Barth, Caprio, and Levine, 2013). Such cross-country differences in regulatory framework may explain why existing studies show mixed findings on the effect of bank regulation on bank risk. Previous studies show no convincing or limited evidence supporting the idea that regulation results in better performance and stability (Barth, Caprio, and Levine, 2004; Demirgüç-Kunt and Detragiache, 2011; Klomp and De Haan, 2012; Beltratti and Stulz, 2012). Barth, Caprio, and Levine (2004) state that policies inducing accurate information disclosure and incentives for private-sector corporate control of banks work best to promote banking sector stability. Demirgüç-Kunt and Detragiache (2011) find no evidence supporting the hypothesis that better regulation and supervision result in sounder banks. Klomp and De Haan (2012) find that bank regulation and supervision does not have a uniform impact on banking risk. Beltratti and Stulz (2012) find no evidence that tighter regulation in general is associated with better bank performance during the global financial crisis or with less risky banks before the crisis. González (2005) states that regulation may even increase banks' incentives to engage in risk-taking activities since their charter values are eroded in a stricter regulatory environment.

The literature shows mixed conclusions regarding the relationship between bank size and risk. There are three theories supporting the conclusions that larger banks are subject to more risks. First, according to the moral hazard theory, large banks are more likely to induce significant externalities to the market than smaller ones, which consequently increases the chances of receiving more subsidy from the deposit insurance scheme and government's guarantees and leads to greater risk-taking incentives for large banks (Kareken and Wallace, 1978; Sharpe, 1978; Flannery, 1989; Chan, Greenbaum, and Thakor, 1992). Second, the too-big-to-fail theory suggests that large and complex banks have incentives to take on excessive risks with the expectation of government bailouts (O'Hara and Shaw, 1990; Acharya and Yorulmazer, 2007; Farhi and Tirole, 2012; Brunnermeier, Dong, and Palia, 2020). Third, large and complex banks will suffer from severe agency problems through engaging in multiple activities, which can transfer into risks (Bolton, Freixas, and Shapiro, 2007; Laeven and Levine, 2007). In contrast with generating more risks, large banks are more resilient and less vulnerable to macroeconomic shocks because larger ones have advantages in the acquisition of information and the economy of scale (Diamond, 1984; Ramakrishnan and Thakor, 1984; Williamson, 1986; Allen, 1990) and can benefit more from engaging in diversified activities (Matutes and Vives, 2000; Boyd, De Nicolo, and Smith, 2004).

As for the role of capital on bank risk, the literature suggests that greater capitalization provides banks with buffers to sustain huge losses in financial distress (Repullo, 2004; Von Thadden, 2004), improves borrower screening and risk monitoring (Coval and Thakor, 2005; Allen, Carletti, and Marquez, 2011), and mitigates the moral hazard issue in banks' investment (Calomiris and Kahn, 1991; Laeven, Ratnovski, and Tong, 2016). On the contrary, other studies show that higher capital may lead to greater risks by increasing portfolio risks (Koehn and Santomero, 1980; Calem and Rob, 1999). After summarizing different strands of literature regarding how bank regulation and supervision, bank size and capital are related to bank risk, I will investigate whether or not countries' regulatory framework or bank size and capital are related to distinct influences of diversification on bank risks.

3.3 Data and measures

3.3.1 Data

This study retrieves cross-country regulation and supervision data from a comprehensive database provided by Barth, Caprio, and Levine (2013),[16] which is compiled based on four consecutive versions of the World Bank's Bank Regulation and Supervision Survey. These four surveys were conducted in 1999, 2002, 2006 and 2011, respectively, and contain detailed and comprehensive information on a wide scope of regulation and supervision practices, such as official supervisory power, private monitoring, deposit insurance, capital regulation, and activity restriction. Therefore, these surveys provide excellent grounds to investigate whether bank regulatory framework plays a role in the relationship between diversification and bank stability. Since the values of country-level regulatory variables remain constant between consecutive surveys, following Anginer, Demirgüç-Kunt, and Zhu (2014a), I use the data from the previous survey until a new survey is available as the values of regulatory variables between two consecutive surveys. More specifically, I use the survey data of 1999 for years from 1999 to 2001, the survey data of 2002 for years from 2002 to 2005, the survey data of 2006 for years from 2006 to 2010, and the survey data of 2011 for years 2011 to 2015.

The dataset in this chapter is an extension of the original dataset used in Chapter 2. One difference though is that the ending year in this chapter is 2015, which is one year before the most recent Bank Regulation and Supervision Survey that was initially undertaken in 2016. I drop observations for year 2016-2018 from the original database because the database of Barth, Caprio, and Levine that includes the information on the regulatory variables constructed based on the latest version of Bank Regulation and Supervision Survey has not been released so far. The accounting data used to construct bank diversification, idiosyncratic risk and bank-specific control variables is obtained from the Worldscope, and the stock market data for calculating

[16] This database can be accessed through the website: http://webhome.auburn.edu/~barthjr/Web%20Dataset.htm.

systemic risk indicator is retrieved from Datastream, CRSP and Compustat Global. Macroeconomic control variables are obtained from the World Bank database.

3.3.2 Regulatory variables

I consider four aspects of a country's regulatory framework: official supervisory power, capital regulations, bank activity restrictions, and private monitoring. To avoid repetition, I do not introduce the same variables that are employed in Section 2.3 from Chapter 2 of the thesis, such as bank risk, diversification, bank-specific, and macroeconomic control variables.

3.3.2.1 Official supervisory power

I employ the supervisory power index to capture the information on whether bank supervisors can take actions against banks' directors, management, auditors, and owners on issues regarding whether the supervisory agency can meet with external auditors without the approval of the banks, take legal action against auditors for negligence, force a bank to change its internal organization structure, constitute provisions to cover actual or potential losses, suspend dividends, bonuses and management fees, supersede the rights of shareholders, and remove and replace management and directors (Schaeck, Čihák and Wolfe, 2009; Agoraki, Delis, and Pasiouras, 2011; Beltratti and Stulz, 2012; Klomp and De Haan, 2012; Barth, Caprio, and Levine, 2013; Anginer, Demirgüç-Kunt and Zhu, 2014a; Hoque et al., 2015; Noman, Gee, and Isa, 2018). This index has values between zero and fourteen, with higher values indicating more supervisory powers of regulatory authorities in a country.

3.3.2.2 Capital regulations

I use the capital regulation index to reflect the stringency of bank capital regulations regarding the amount of capital that banks must hold and the nature and source of bank capital (Beck, Demirgüç-Kunt, and Levine, 2006; Laeven and Levine, 2009; Schaeck, Čihák and Wolfe, 2009;

Agoraki, Delis, and Pasiouras, 2011; Beltratti and Stulz, 2012; Klomp and De Haan, 2012; Barth, Caprio, and Levine, 2013; Beck, De Jonghe, and Schepens, 2013; Fernández, González, and Suárez, 2013; Anginer, Demirgüç-Kunt and Zhu, 2014a; Hoque et al., 2015; Noman, Gee, and Isa, 2018). It depicts the regulatory approach in assessing the degree of capital at risk in a bank rather than showing the statutory capital requirements. This index is constructed based on eight questions: (1) Whether the minimum required capital-asset ratio is risk-weighted in line with Basel guidelines? (2) Does this ratio vary with a bank's market risk? (3) Is the market value of loan losses not realized in accounting books deducted from the book value of capital? (4) Are unrealized securities losses deducted from the book value of capital? (5) Are unrealized foreign exchange losses deducted from the book value of capital? (6) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (7) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds? This index takes the value from zero to eight, and a higher value shows greater stringency of capital requirements.

3.3.2.3 Bank activity restrictions

I employ the activity restriction index to indicate whether banks' engagement in securities market activities (e.g. brokering, underwriting, and dealing), insurance activities (e.g. insurance underwriting and selling) and real estate activities (e.g. real estate investment and management) in a country are unrestricted, permitted, restricted or prohibited (Claessens and Laeven, 2003; Beck, Demirgüç-Kunt, and Levine, 2006; Laeven and Levine, 2009; Schaeck, Čihák and Wolfe, 2009; Agoraki, Delis, and Pasiouras, 2011; Beltratti and Stulz, 2012; Klomp and De Haan, 2012; Barth, Caprio, and Levine, 2013; Beck, De Jonghe, and Schepens, 2013; Fernández, 2013; Fernández, González, and Suárez, 2013; Anginer, Demirgüç-Kunt and Zhu, 2014a; Hoque et al., 2015; Noman, Gee, and Isa, 2018). This index has values between three and twelve, with higher values indicating greater restrictions on associated activities.

3.3.2.4 Private monitoring

I use the private monitoring index to show the degree to which regulatory and supervisory policies encourage the monitoring of banks by private investors (Schaeck, Čihák and Wolfe, 2009; Beltratti and Stulz, 2012; Klomp and De Haan, 2012; Barth, Caprio, and Levine, 2013; Anginer, Demirgüç-Kunt and Zhu, 2014a; Hoque et al., 2015). The building of this index is based on nine survey questions in aspects of information disclosure from bank directors and supervisors, involvement with international auditors and rating agencies, off-balance sheet items and risk management procedures information disclosure, and the existence of an explicit deposit insurance system. This index has values from zero and twelve, with higher values indicating greater regulatory empowerment of private monitoring of banks. The detailed information on the questions used for constructing my four regulatory variables above is shown in Table 3.1.

Table 3.1. Definition of the Regulatory Variables

Variables	Definitions
Supervisory power index	This index has values between zero and fourteen, with higher values indicating greater official supervisory power. This index is calculated based on the following questions, and a value of 1 is added to the index if the answer is yes and 0 otherwise: (1) Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? (2) Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? (3) Can supervisors take legal action against external auditors for negligence? (4) Can the supervisory authority force a bank to change its internal organizational structure? (5) Are off-balance sheet items disclosed to supervisors? (6) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? (7) Can the supervisory agency suspend the directors' decision to distribute dividends? (8) Can the supervisory agency suspend the directors' decision to distribute bonuses? (9) Can the supervisory agency suspend the directors' decision to distribute management fees? (10) Can the supervisory agency legally declare-such that this declaration supersedes the rights of bank shareholders-that a bank is insolvent? (11) Does the Banking Law give authority to the supervisory agency to intervene-that is, suspend some or all ownership rights-a problem bank? (12) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency supersede shareholder rights? (13) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency supersede shareholder rights? (14) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency remove and replace management? (15) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency remove and replace directors? *Source*: Barth, Caprio, and Levine (2013).
Capital regulation index	This index has values between zero and eight, with higher values indicating higher capital stringency. This index is calculated based on the questions of the following questions, and a value of 1 is added to the index if the answer is yes and 0 otherwise: (1) Is the minimum required capital asset ratio risk weighted in line with Basle guidelines? (2) Does the ratio vary with a bank's market risk? (3) Is the market value of loan losses not realized in accounting books deducted from the book value of capital? (4) Are unrealized securities losses deducted from the book value of capital? (5) Are unrealized foreign exchange losses deducted from the book value of capital? (6) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (7) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds? *Source*: Barth, Caprio, and Levine (2013).
Activity restriction index	This index has values between three and twelve, with higher values indicating greater restrictions. This index is calculated based on the questions about whether banks in a country are (1) unrestricted, (2) permitted, (3) restricted or (4) prohibited in engaging in securities, insurance and real estate activities. A value of 1 is added to the index if an activity is unrestricted, 2 if is permitted, 3 if is restricted, and 4 if is prohibited. *Source*: Barth, Caprio, and Levine (2013).

Table 3.2 (continued). Definition of the Regulatory Variables

Variables	**Definitions**
Private monitoring index	This index has values between zero and twelve, with higher values indicating greater regulatory empowerment of private monitoring of banks. This index is computed based on the following questions: (1) Whether bank directors and officials are legally liable for the accuracy of information disclosed to the public? (2) Whether banks must publish consolidated accounts? (3) Whether banks must be audited by certified international auditors? (4) Whether 100 percent of the largest ten banks are rated by international rating agencies? (5) Whether off-balance sheet items are disclosed to the public? (6) Whether banks must disclose their risk management procedures to the public? (7) Whether accrued, though unpaid interest/principal, enter the income statement while the loan is still non-performing? (8) Whether subordinated debt is allowable as part of capital? (9) Whether there is no explicit deposit insurance system and no insurance was paid the last time a bank failed? *Source*: Barth, Caprio, and Levine (2013).

Notes: This table presents the definitions of the regulatory variables used in this chapter. To avoid repetitions, I do not show the definitions of the same variables introduced in Chapter 2 such as bank risk, diversification, bank-specific, and macroeconomic control variables.

3.4 Methodology

To investigate whether regulatory framework is associated with the relationship between diversification and bank stability, I employ the fixed effect models to control for the bank, country, and time fixed effects. Fixed effect models have been widely used in the banking literature to control for unobserved time-invariant variables (Mercieca, Schaeck, and Wolfe, 2007; Anginer, Demirgüç-Kunt, and Zhu, 2014a; Leroy and Lucotte, 2016; Goetz, 2017). My regression model is specified as follows:

$$Bank\ risk_{i,j,t} = \alpha_1 + \beta_1 \times\ Diversification_{j,t-1} + \beta_2 \times\ Regulation_{j,t-1} +$$
$$\beta_3 \times\ Diversification_{j,t-1} \times\ Regulation_{j,t-1} + \delta_1 \times Bank\ specific\ controls_{i,j,t-1} +$$
$$\delta_2 \times Macroeconomic\ controls_{j,t} + \mu_i + \nu_j + \tau_t + \varepsilon_{i,j,t} \quad (3.1)$$

where subscripts i, j and t denote bank i in country j in year t. *Diversification* denotes the country-level diversification measure (*CRD*). I use time lagged values of diversification indicator along with its interaction terms with regulatory and core risk determinant variables to mitigate the issue of reverse causality from bank risk to diversification. *Regulation* represents one of my four country-level regulatory variables, Supervisory power index, Capital regulation index, Activity restriction index, or Private monitoring index. I include the interaction term between the regulatory variable and diversification indicator, *Diversification*×*Regulation*, into the regression to capture the moderating effects of the regulatory framework. I run separate regressions for each type of regulatory variable. I use the same bank risk, bank-specific and macroeconomic control variables as described in Section 2.3 from the Chapter 2 of the thesis. *Bank risk* stands for bank systemic (Δ*CoVaR*) or idiosyncratic risk (*Z-Score*) measures. *Bank specific controls* and *Macroeconomic controls* are vectors of bank-specific and macroeconomic control variables that control for their potential effects on bank stability. I include bank-level diversification indicator (*RD*), bank size (*BankSize*), capitalization (*Capitalization*), non-performing loans (*NPL*), loan growth ratio (*Loangrowth*), deposit ratio (*Deposit*) and loan ratio (*Loan*) as bank control variables, and use GDP growth rate (*GDPgrowth*), GDP per capita (*GDPpercap*), and Inflation rate (*Inflation*) as macroeconomic control variables. μ, ν and τ capture bank, country and year fixed effects, respectively. $\varepsilon_{i,j,t}$ is the error term. α, β, and δ are the parameters to be estimated.

To examine the role of size and capital on the relationship between diversification and bank stability, I employ the following model:

$$Bank\ risk_{i,j,t} = \alpha_2 + \beta_4 \times\ Diversification_{j,t-1} + \beta_5 \times Risk\ determinant_{i,j,t-1} + \beta_6 \times Diversification_{j,t-1} \times Risk\ determinant_{i,j,t-1} + \delta_3 \times Bank\ specific\ controls_{i,j,t-1} + \delta_4 \times Macroeconomic\ controls_{j,t} + \mu_i + \nu_j + \tau_t + \varepsilon_{i,j,t} \quad (3.2)$$

where *Risk determinant* denotes one of my banks' core risk determinants, bank size or capital. *Diversification* $\times$ *Risk determinant* is the interaction term of the risk determinant with diversification variable, which is included to capture the moderating effects of bank size and capital on the diversification-bank stability relationship. I run separate regressions for each type of risk determinant.

3.5 Results

3.5.1 Descriptive statistics

Table 3.2 shows the summary statistics for all variables used in this study. I find that there are great variations in the values of the regulatory variables. The *Supervisory power index* has a mean of 12.55 and a standard deviation of 1.896, and its theoretical minimum and maximum values are 4 and 16, respectively. A mean value of this index closer to its maximum indicates that the countries in my sample have a relatively high supervisory power on average. The *Activity restriction index* has values between 3 and 12, with a mean and a standard deviation of 8.032 and 1.473, respectively. The *Capital regulation index* has a mean of 5.497 and its mean is closer to its maximum value of 7, which indicates that, on average, the stringency of capital is high in my sample. The *Private monitoring index* has a mean of 9.338 with a standard deviation of 1.310. Especially, this index has a minimum value of 5 and is larger than the theoretical minimum value, which shows a certain degree of private monitoring on average for the countries analyzed.

Table 3.3 shows the cross-country averages of selected essential variables, which provides information on the variations in these variables across countries. The *Supervisory power index* has the highest average value in Indonesia (13.923) in contrast with the lowest average value in South Africa (7.412). The average value of the *Activity restriction index* is highest in China (10.615), which is over three times higher than that in Hong Kong (3.286), the lowest value. As for the *Capital regulation index*, Turkey and Kenya share the highest average (7.000) among all countries, and Malaysia has the lowest value of 1.882. Lastly, the *Private monitoring index* is highest in Republic of Korea (10.417), which is much above that in Venezuela (5.706), the lowest index in my sample.

Table 3.2. Descriptive Statistics

Variables	N	Mean	SD	Min	Max
CRD	26,525	0.359	0.090	0	0.498
RD	19,582	0.409	0.099	0.022	0.500
Z-Score	19,487	24.17	16.16	-3.343	115.7
Δ*CoVaR*	18,495	-0.040	0.042	-0.202	0.031
Bank Size	20,188	15.12	2.141	8.334	21.14
Capitalization	20,123	0.089	0.408	-33.19	1.210
NPL	17,362	0.027	0.042	0	0.524
Loangrowth	18,895	0.132	0.266	-0.748	2.576
Loan	19,579	0.659	0.146	0	0.989
Deposit	19,999	0.715	0.169	0	0.948
GDPgrowth	26,265	0.027	0.026	-0.148	0.251
GDPpercap	26,265	10.21	1.084	6.176	11.63
Inflation	26,265	0.032	0.066	-0.060	1.437
Supervisory power index	21,105	12.55	1.896	4	16
Activity restriction index	22,858	8.032	1.473	3	12
Capital regulation index	12,374	5.497	1.470	1	7
Private monitoring index	22,632	9.338	1.310	5	11

Notes: This table contains information on the descriptive statistics of all variables used in this chapter. *N* represents the number of observations for each variable. *SD* is the standard deviation of each variable. *Mean*, *Min*, and *Max* indicate the mean, minimum, and maximum value of each variable, respectively. Detailed information on each regulatory variable's definition and calculation are reported in Table 3.1 of this chapter, and on other variables such as bank risk, diversification, bank-specific, and macroeconomic control variables are introduced in Table 2.2 of Chapter 2. I retrieve accounting data from the Worldscope on an annual basis to construct bank diversification, idiosyncratic risk, and bank-specific control variables, and download stock market data from Datastream, CRSP, and Compustat Global on daily basis to calculate systemic risk indicator. Macroeconomic control variables are obtained from the World Bank database. The Regulatory variables are obtained from the datasets provided by Barth, Caprio, and Levine (2013). Accounting- and market-based measures have been converted to the same data frequency before conducting the regression analyses. To account for the influence of extreme values and outliers, all variables are winsorized and the bottom 1% and top 1% of observations for each variable are set respectively to the value of the 1st and 99th percentiles. *Source*: Worldscope, CRSP, Datastream, Compustat Global, and authors' calculation.

Table 3.3. Averages of key variables for each country's banks

Variables	***CRD***	***RD***	***Z-Score***	***ΔCoVaR***	***Supervisory power index***	***Activity restriction index***	***Capital regulation index***	***Private monitoring index***
Argentina	0.367	0.346	6.003	-0.040	9.412	7.353	4.176	8.706
Australia	0.309	0.349	29.267	-0.045	11.588	7.294	6.417	9.588
Austria	0.423	0.412	29.309	-0.037	11.824	4.529	2.000	6.588
Belgium	0.393	0.365	11.922	-0.046	10.941	5.824	3.923	7.294
Brazil	0.417	0.401	11.956	-0.032	13.471	6.118	3.000	8.706
Canada	0.344	0.325	29.357	-0.038	8.647	5.412	2.882	8.588
Switzerland	0.188	0.377	18.900	-0.039	12.941	4.353	5.000	7.706
Chile	0.373	0.356	19.542	-0.036	11.706	9.412	3.000	7.824
China	0.384	0.370	18.554	-0.024	10.000	10.615	n.a	9.538
Colombia	0.412	0.359	9.130	-0.037	12.107	9.286	4.000	8.214
Germany	0.429	0.405	16.506	-0.047	9.235	4.500	5.294	7.647
Denmark	0.373	0.392	17.598	-0.036	9.706	6.647	n.a	9.000
Egypt	0.280	0.267	16.572	-0.039	11.375	7.824	3.647	8.706
Spain	0.392	0.325	15.302	-0.046	10.029	5.176	6.000	8.588
Finland	0.320	0.394	16.485	-0.037	7.750	5.824	5.000	8.294
France	0.393	0.355	20.536	-0.045	8.441	6.059	6.000	7.765
United Kingdom	0.340	0.342	14.779	-0.048	9.750	3.706	5.000	10.000
Greece	0.425	0.415	9.636	-0.039	10.667	6.647	4.118	7.706
Hong Kong	0.230	0.269	23.996	-0.042	9.000	3.286	4.571	8.571
Indonesia	0.404	0.417	12.375	-0.030	13.923	9.615	5.077	9.154

Table 3.3 (continued). Averages of key variables for each country's banks

Variables	***CRD***	***RD***	***Z-Score***	***ΔCoVaR***	***Supervisory power index***	***Activity restriction index***	***Capital regulation index***	***Private monitoring index***
India	0.369	0.351	16.166	-0.026	9.647	8.706	6.000	8.000
Ireland	0.379	0.326	21.429	-0.045	9.000	4.882	4.846	10.118
Israel	0.388	0.379	22.563	-0.039	9.000	9.706	4.824	9.529
Italy	0.412	0.395	18.674	-0.040	8.588	7.824	4.111	7.647
Japan	0.408	0.451	24.685	-0.041	12.000	8.500	n.a	9.000
Kenya	0.329	0.304	24.536	-0.037	13.588	8.294	7.000	7.588
Republic of Korea	0.392	0.374	8.796	-0.048	9.706	7.882	4.833	10.417
Sri Lanka	0.278	0.387	23.261	-0.039	9.667	7.235	3.000	8.471
Luxembourg	0.348	0.364	16.573	-0.021	12.118	5.529	5.000	7.583
Morocco	0.334	0.338	35.335	-0.039	12.625	8.412	5.000	8.000
Mexico	0.364	0.374	11.110	-0.034	11.188	6.941	2.000	8.923
Malaysia	0.240	0.237	20.930	-0.044	13.321	7.750	1.882	8.647
Nigeria	0.416	0.384	16.716	-0.024	12.708	7.417	3.000	8.143
Netherlands	0.404	0.398	15.014	-0.041	9.875	4.824	4.588	8.706
Norway	0.302	0.339	17.682	-0.060	8.643	6.071	6.000	7.556
Peru	0.360	0.342	8.884	-0.037	12.588	6.941	5.000	7.706
Philippines	0.400	0.371	19.322	-0.042	11.000	5.000	6.000	8.083
Poland	0.357	0.359	12.306	-0.041	10.231	8.118	5.625	8.059
Portugal	0.371	0.344	8.394	-0.042	13.286	6.824	4.643	6.647
Russian Federation	0.332	0.341	17.875	-0.012	8.765	5.706	5.000	7.000

Table 3.3 (continued). Averages of key variables for each country's banks

Variables	***CRD***	***RD***	***Z-Score***	***ΔCoVaR***	***Supervisory power index***	***Activity restriction index***	***Capital regulation index***	***Private monitoring index***
Singapore	0.221	0.237	36.014	-0.041	13.750	6.588	6.083	9.235
Slovakia	0.398	0.413	16.781	-0.028	12.000	7.824	3.765	7.167
Thailand	0.375	0.359	9.292	-0.045	11.538	8.471	6.000	8.647
Tunisia	0.238	0.234	33.182	-0.040	9.000	8.000	5.000	5.889
Turkey	0.340	0.357	6.903	-0.035	11.625	8.000	7.000	7.750
Taiwan	0.391	0.353	17.644	-0.037	12.235	9.824	5.000	8.000
United States of America	0.353	0.439	29.156	-0.042	13.441	8.471	6.000	9.941
Venezuela	0.195	0.430	10.833	-0.034	12.824	8.333	3.667	5.706
South Africa	0.298	0.294	20.455	-0.041	7.412	6.765	3.000	9.824

Notes: This table contains information on the averages of selected key variables used in this chapter. The sample consists of 1,395 international publicly listed banks from 49 countries over the period from 1999 to 2015. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. Δ*CoVaR* is bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. Bank Size is the natural logarithm of bank total assets. *Supervisory power index* is an index of the power of regulatory agencies in a country. *Activity restriction index* is an index capturing the degree of a country's restrictions on banks' activities allowed to engage in. *Capital regulation index* is an index that captures a country's stringency of capital regulations. *Private monitoring index* is an index of regulatory empowerment of private monitoring of banks. To account for the influence of extreme values and outliers, all variables are winsorized and the bottom 1% and top 1% of observations for each variable are set respectively to the value of the 1st and 99th percentiles. *Source*: Worldscope, CRSP, Datastream, Compustat Global, and authors' calculation.

3.5.2 The role of regulatory framework on the relationship between diversification and bank stability

Table 3.4 reports the results on the role of the regulatory environment on the relationship between diversification and bank stability, with corresponding results reported in columns (1)-(4) and (5)-(8) for idiosyncratic and systemic risk, respectively. According to the results in columns (1)-(4), I do not find significant results on the association of the regulatory variables on the relationship between diversification and bank idiosyncratic risk as can be inferred by the non-significant coefficients of the interaction terms of diversification with my four regulatory variables. However, I find significant associations with my four regulatory variables in the dimension of systemic risk as shown in columns (5)-(8).[17] According to the results in column (5), the coefficient of the interaction term of supervisory power index and diversification is positive and significant while the coefficient of diversification remains significant and negative, which suggests that diversification has a different effect on systemic risk depending on the degree of supervisory power of a country's supervisory agency. To compute the threshold level of supervisory power index at which the diversification-bank systemic stability relationship changes, I take the first derivative of Equation (3.1) with respect to the diversification indicator and make it equal to zero, which is $\frac{\Delta CoVaR}{\Delta diversification} = \beta_1 + \beta_3 \times supervisory\ power\ index = 0$. Then I have the equation $-0.190 + 0.0183 \times supervisory\ power = 0$ and the corresponding threshold value of supervisory power is 10.38. This result indicates that, when the value of supervisory power index is beyond its threshold value (10.38), the original negative coefficient of diversification on bank systemic stability turns to be positive, which suggests that the systemic risk contribution of banks' diversification activities becomes weak in a country with greater supervisor power of regulatory agency.[18]

[17] The investigation on the causality from regulation and its moderating effects with diversification to bank risk is beyond the scope of my study.

[18] I am concerned with the marginal effect of diversification on bank risk considering a country's regulation environment. Whether this marginal effect is statistically significant or not can be detected through taking the

Such positive effect of official supervisory power on bank stability is also found by Klomp and De Haan (2012) and Hoque et al. (2015). This may be explained by the public interest view discussed by Barth, Caprio, and Levine (2006) and Beck, Demirgüç-Kunt, and Levine (2006) that official regulatory agencies act in the interests of the public and have incentives to prevent market failures. A powerful supervisory agency has the expertise to discipline banks to promote the corporate governance and monitor banks' risk-taking activities.

As for the association of activity restriction with the relationship between diversification and bank systemic risk, I also find a positive and significant coefficient of the interaction term while there is a negative coefficient of diversification as shown in column (6). I obtain the threshold value of activity restriction index of 3.99 after taking the zero of the first derivative of Equation (3.1) with diversification ($\frac{\Delta CoVaR}{\Delta diversification} = \beta_1 + \beta_3 \times activity\ restriction\ index = 0$), which indicates that the negative effect of diversification on systemic stability is mitigated as the degree of activity restrictions increases, and this effect turns to be positive when activity restrictions remain at a relatively high level. This result implies that banks contribute less to systemic risk with the increase in the degree of overall diversification in countries with more restrictions on financial services or activities that banks are allowed to engage in, which could be due to a decreasing homogeneity of activities among banks when there are restrictions on financial services imposed by regulatory agency. My result is supported by Čihák et al. (2013), who show that banks in countries with fewer restrictions on non-traditional activities such as investment banking, insurance, and real estate are more likely to suffer crisis. My finding is

partial derivative of the regression equation with respect to the country-level diversification measure (*CRD*). The corresponding results of $\beta_1 + \beta_3 \times supervisory\ power\ index$ are related to the coefficients of *CRD* (β_1) and the interaction term $CRD \times Supervisory\ power\ index$ (β_3). If we are interested in the direct association between diversification and bank stability, we only need to look at the individual coefficient of *CRD* (β_1) since $Supervisory\ power\ index = 0$ under this situation. Although the individual coefficient of *Supervisory power index* is significant, its coefficient (β_2) does not help in explaining the marginal effect of diversification. Hence, I do not interpret the meaning of the coefficient of a single regulatory variable.

also consistent with Boyd, Graham, and Hewitt (1993) according to whom more moral hazard issues can be induced if banks are allowed to take a broad range of activities.

Column (7) of Table 3.4 shows the results regarding the effect of the stringency of capital regulation on the relationship between diversification and systemic stability. The positive and significant coefficient of the interaction term of capital regulation index and diversification indicates that the negative direct impact of diversification on systemic risk is conditional on the level of capital stringency of a specific country. In countries with higher stringency of capital regulations, the negative effect of diversification on systemic stability is mitigated. This result is in line with existing studies suggesting that more strict capital requirements result in a reduction in bank risk (Furlong and Keeley, 1989; Keeley, 1990; Hellmann, Murdock, and Stiglitz, 2000; Repullo, 2004). My finding is especially supported by Holod, Kitsul, and Torna (2017) given that they conclude that capital requirements are effective in decreasing bank risk associated with non-interest income-generating activities such as trading activity that banks typically diversify into. Moreover, my results are consistent with Fernández and González (2005), who find that more stringent capital regulations can prevent banks from taking excessive risks and increase banks' ability of absorbing losses, making banks less sensitive to systemic risk. I also calculate the corresponding threshold value of the capital regulation index equal to 3.62 ($\frac{\Delta CoVaR}{\Delta diversification} = \beta_1 + \beta_3 \times capital\ regulation\ index = 0$).

With respect to the association of private monitoring with the diversification-systemic stability nexus, I find a positive and significant coefficient of the interaction term of diversification with private monitoring index in column (8). This result indicates that, in countries with greater private monitoring, the negative effect of diversification on systemic stability becomes weaker, and the original negative influence turns to be positive when the value of the private monitoring index goes beyond its threshold value at 8.88 (the threshold value is calculated by taking the zero value of the equation $\frac{\Delta CoVaR}{\Delta diversification} = \beta_1 + \beta_3 \times private\ monitoring\ index$). These results are supported by Holod, Kitsul, and Torna's (2017) analyses, which reveals that higher private monitoring decreases the individual banks' contribution to systemic risk. In addition, my findings are consistent with Fernández and González (2005) whose results indicate that more private monitoring prevents banks from engaging in excessive risk-taking activities and improves financial soundness since it mitigates the moral hazard issue arising from asymmetric information. My research extends their findings and treats the private monitoring as an environment factor associated with the relationship between diversification and systemic risk.

Table 3.4. Baseline results: The role of regulatory framework on the relationship between diversification and bank stability

Dependent Variables	*Z-Score*	*Z-Score*	*Z-Score*	*Z-Score*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CRD	21.01***	5.489***	4.908	-5.272	-0.190***	-0.0607***	-0.167***	-0.238***
	(4.738)	(2.055)	(4.015)	(5.372)	(0.0384)	(0.0109)	(0.0367)	(0.0329)
Supervisory power index	0.357**				-0.0121***			
	(0.143)				(0.00102)			
CRD×Supervisory power index	-1.353				0.0183***			
	(0.381)				(0.00318)			
Activity restriction index		0.375***				-0.00946***		
		(0.130)				(0.000979)		
CRD×Activity restriction index		-0.352				0.0152***		
		(0.321)				(0.00216)		
Capital regulation index			0.805***				-0.00268	
			(0.294)				(0.00237)	
CRD×Capital regulation index			-0.730				0.0461***	
			(0.770)				(0.00631)	
Private monitoring index				-0.173				0.00528***
				(0.229)				(0.00127)
CRD×Private monitoring index				0.954				0.0268***
				(0.628)				(0.00364)
RD	-3.588***	-2.879***	0.0262	-3.115***	0.00341	-0.00186	0.00949	-0.00688
	(1.026)	(0.867)	(1.109)	(0.874)	(0.00570)	(0.00503)	(0.00785)	(0.00478)
Bank Size	-0.233	-0.500*	-1.568***	-0.602**	0.0197***	0.0169***	0.0134***	0.00790***
	(0.289)	(0.268)	(0.436)	(0.271)	(0.00113)	(0.00107)	(0.00264)	(0.00113)
Capitalization	3.032	3.268	1.355	3.267	0.0610***	0.0712***	0.0537***	0.0365***
	(3.039)	(3.138)	(1.077)	(3.121)	(0.0138)	(0.0138)	(0.0147)	(0.0116)
NPL	-1.660	0.628	-0.949	0.0314	0.116***	0.110***	0.0379**	0.0701***

Table 3.4 (continued). Baseline results: The role of regulatory framework on the relationship between diversification and bank stability

	(2.388)	(2.164)	(3.096)	(2.149)	(0.0155)	(0.0128)	(0.0166)	(0.0128)
Loangrowth	-0.343	-0.565**	-0.426	-0.452**	-0.00425***	-0.00357***	-0.00421**	-0.000704
	(0.221)	(0.222)	(0.458)	(0.219)	(0.00125)	(0.00115)	(0.00185)	(0.00112)
Loan	-1.289	-0.858	-1.646	-1.113	-0.0330***	-0.0429***	-0.0399***	-0.0438***
	(1.191)	(1.098)	(1.922)	(1.108)	(0.00548)	(0.00534)	(0.00696)	(0.00422)
Deposit	-2.252	-2.654**	-3.257	-2.734**	0.0348***	0.0428***	0.0119	0.0256***
	(1.395)	(1.293)	(2.003)	(1.301)	(0.00690)	(0.00648)	(0.0105)	(0.00514)
GDPgrowth	8.156***	12.19***	16.47***	12.53***	0.277***	0.318***	0.216***	0.249***
	(3.090)	(2.580)	(4.699)	(2.817)	(0.0242)	(0.0202)	(0.0288)	(0.0154)
GDPpercap	5.609***	6.737***	5.502***	6.063***	0.171***	0.157***	0.0816***	0.111***
	(1.514)	(1.319)	(2.009)	(1.297)	(0.0123)	(0.0104)	(0.0104)	(0.00923)
Inflation	0.579	-1.794	-0.440	0.281	0.0765***	0.0403***	0.0226	-0.0176
	(1.761)	(1.908)	(3.333)	(1.602)	(0.0145)	(0.0150)	(0.0239)	(0.0112)
Constant	-31.64**	-37.72***	-8.691	-24.75**	-1.982***	-1.873***	-1.082***	-1.351***
	(12.70)	(10.87)	(17.12)	(10.88)	(0.116)	(0.0971)	(0.111)	(0.0887)
No. of observations	11,909	13,142	5,984	13,076	11,966	13,192	6,241	13,131
R-squared	0.019	0.022	0.030	0.021	0.421	0.378	0.647	0.501
No. of banks	1,296	1,320	960	1,310	1,302	1,327	1,000	1,318
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the regression results on the role of regulatory environment on the relationship between diversification and bank stability. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *Supervisory power index* is an index of the power of regulatory agencies in a country. *Activity restriction index* is an index capturing the degree of a country's restrictions on banks' activities allowed to engage in. *Capital regulation index* is an index that captures a country's stringency of capital regulations. *Private monitoring index* is an index of regulatory empowerment of private monitoring of banks. *CRD×Supervisory power index* is the interaction term of diversification and supervisory power index. *CRD×Activity restriction index* is the interaction term of diversification and activity restriction index. *CRD×Capital regulation index* is the interaction term of diversification and capital regulation index. *CRD×Private monitoring index* is the interaction term of diversification and private monitoring index. *Z-Score* is the individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. *ΔCoVaR* is the bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represent the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Results regarding the role of regulatory environment on the relationship between diversification and bank idiosyncratic risk are reported in columns (1)-(4) and systemic risk in columns (5)-(8). Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

3.5.3 The role of bank size and capital on the relationship between diversification and bank stability

I am also interested in investigating whether the relationship between diversification and bank stability varies with essential characteristics of banks. Considering the fact that there are great variations across individual banks in terms of their characteristics, such as size, capitalisation and liquidity. It is important to investigate whether the diversification-bank stability relationship uniformly applies to all banks or is conditional on banks with different characteristics. Understanding this is also important to bank managers to formulate suitable diversification strategies depending on banks' characteristics, especially characteristics essential to banks' risk profile. With reference to Laeven, Ratnovski, and Tong (2016), my study focuses on two essential risk factors – bank size and capital, and the recent global financial crisis has brought about the debate on these two characteristics as key determinants of bank systemic risk. The results on the role of bank size and capital on this relationship are reported in Table 3.5. I find no significant association of size in the dimension of idiosyncratic risk in column (1) and a negative coefficient of *CRD-Capitalization* interaction variable on bank standalone risk in column (3). This finding indicates that the beneficial effect of diversification in reducing bank idiosyncratic risk is weakened as capital level increases, and this beneficial effect turns to be negative when capital reaches a level with a threshold value of 0.09, which is found by setting the zero value of the first derivative of Equation (3.2) equal to zero ($\frac{\Delta Zscore}{\Delta diversification} = \beta_4 + \beta_5 \times capitalization$=0). This result may be due to a moral hazard problem in increasing banks' risk-taking as highly capitalized banks want to take the upside benefits from risk-taking activities (Calem and Rob, 1999).

From the perspective of systemic risk, I find significant associations of bank size and capital on the diversification-systemic stability relationship as shown in columns (2) and (4). The significant and positive coefficients of *CRD-Bank Size* and *CRD-Capitalization* terms indicate that bank size and capital can mitigate the negative direct effect of diversification on systemic stability,[19] which implies that larger and well-capitalized banks are less subject to systemic risk when the degree of diversification in a country is high. By including both the *CRD-Bank Size* and *CRD-Capitalization* terms into the same regression, I find the same results that are shown in column (6). As suggested by the modern intermediation theory (Diamond, 1984), large banks tend to have better capabilities in management and operations and can enjoy the benefits from engaging in diversified activities, which provides buffers making those banks less vulnerable to macroeconomic shocks (Matutes and Vives, 2000; Boyd, De Nicolo, and Smith, 2004). When banks engage in diversified activities, well-capitalized banks typically hold sufficient buffers to counteract potential shocks in the market (Repullo, 2004; Von Thadden, 2004). In addition, higher capital induces a greater level of borrower screening by banks, which is beneficial for bank stability (Coval and Thakor, 2005; Allen, Carletti, and Marquez, 2011). My result is in line with the conclusions of Berger and Bouwman (2013) according to which higher capital holdings are associated with a higher survival probability for banks. Column (6) shows the results that include both size and capital variables, and the results remain the same as what are discussed above.

Table 3.5. The role of bank size and capital on the relationship between diversification and bank stability

Dependent Variables	*Z-Score*	*ΔCoVaR*	*Z-Score*	*ΔCoVaR*	*Z-Score*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)
	Bank Size		*Capitalization*		*Bank Size and Capitalization*	
CRD	0.509	-0.285***	39.05***	-0.0872***	99.70***	-0.515***
	(7.938)	(0.0475)	(4.638)	(0.0133)	(12.24)	(0.0552)
CRD×Bank Size	0.208	0.0162***			-3.647	0.0252***
	(0.484)	(0.00295)			(0.585)	(0.00306)
CRD×Capitalization			-428.8***	0.718***	-461.0***	1.038***

[19] The negative direct relationship between diversification and systemic stability can be inferred from the negative and significant coefficients of *CRD* in columns (2) and (4) of Table 3.5. My systemic risk indicator, *ΔCoVaR*, is positively (negatively) related to bank systemic stability (risk).

Table 3.5 (continued). The role of bank size and capital on the relationship between diversification and bank stability

			(55.12)	(0.131)	(58.96)	(0.158)
RD	-4.118***	0.00987	-4.021***	0.0158**	-2.882***	0.00841
	(0.849)	(0.00634)	(0.822)	(0.00628)	(0.829)	(0.00640)
Bank Size	-0.636*	0.0182***	-0.0194	0.0240***	1.367***	0.0147***
	(0.328)	(0.00167)	(0.238)	(0.00160)	(0.333)	(0.00175)
Capitalization	4.219	0.0516***	192.1***	-0.221***	206.3***	-0.339***
	(3.919)	(0.0142)	(23.95)	(0.0512)	(25.67)	(0.0597)
NPL	1.183	0.173***	-0.281	0.173***	-0.569	0.176***
	(2.173)	(0.0164)	(2.235)	(0.0161)	(2.219)	(0.0163)
Loangrowth	-0.385**	-0.00419***	-0.371**	-0.00426***	-0.369**	-0.00429***
	(0.187)	(0.00132)	(0.184)	(0.00135)	(0.184)	(0.00134)
Loan	-0.946	-0.0433***	-1.185	-0.0419***	-0.958	-0.0432***
	(0.993)	(0.00710)	(0.955)	(0.00707)	(0.948)	(0.00706)
Deposit	-2.639**	0.0267***	1.585	0.0236***	1.696	0.0242***
	(1.233)	(0.00855)	(1.134)	(0.00837)	(1.114)	(0.00844)
GDPgrowth	13.06***	0.107***	7.059***	0.132***	10.42***	0.109***
	(2.747)	(0.0155)	(2.551)	(0.0157)	(2.629)	(0.0156)
GDPpercap	6.260***	0.186***	4.077***	0.184***	3.345***	0.188***
	(1.243)	(0.0168)	(1.188)	(0.0173)	(1.173)	(0.0170)
Inflation	1.783*	0.0688***	2.316**	0.0706***	2.869***	0.0672***
	(0.986)	(0.0225)	(1.016)	(0.0228)	(0.989)	(0.0226)
Constant	-27.82***	-2.233***	-33.39***	-2.278***	-49.80***	-2.154***
	(10.44)	(0.158)	(10.01)	(0.157)	(10.33)	(0.158)
No. of observations	15,232	15,121	15,232	15,121	15,232	15,121
No. of banks	1,338	1,340	1,338	1,340	1,338	1,340
R-squared	0.024	0.425	0.107	0.426	0.113	0.430
Bank fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES

Notes: This table presents the regression results on the role of bank size and capital on the relationship between diversification and bank stability. *CRD* is the country-level diversification measure calculated based on the form of the Herfindahl-Hirschman Index by taking sum of each type of revenue streams of banks in each country included in the sample. *RD* is the bank-level revenue diversification indicator. *CRD×Bank Size* is the interaction term of diversification and bank size. *CRD×Capitalization* is the interaction term of diversification and bank capital. *Z-Score* is the individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. Δ*CoVaR* is the bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represent the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Results regarding the role of bank size on the relationship between diversification and bank idiosyncratic and systemic risks are reported in columns (1) and (2) and the role of capital in columns (3) and (4). Columns (5) and (6) show the results of regressions that include both the size and capital variables. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

3.6 Robustness check

To check whether my results regarding the role of regulatory framework, bank size and capital on the relationship between diversification and bank stability hold under different diversification and risk measures, I build up alternative diversification and bank risk indicators. Similar to the robustness check in Chapter 2, I use country-level income diversity (*CID*) and bank-level income diversity (*ID*) as alternative diversification indicators at country and bank levels, and employ the stock return volatility (*ReturnVol*) and the marginal expected shortfall (*MES*) as alternative bank idiosyncratic and systemic risk indicators, respectively.

As for the association of regulatory environment with the diversification-bank stability relationship, in Table 3.6, I find consistent results with my baseline results showing that the negative relationship between diversification and bank systemic stability is weakened in countries with stronger power of supervisory agency, higher stringency of capital regulations, greater banks' activities restrictions, and more private monitoring according to the results in columns (1)-(4) using $\Delta CoVaR$ as system risk indicator[20] and in columns (5)-(8) using *MES* as the alternative systemic risk measure.[21] In line with my main results, I do not find consistent significant effects of the four regulatory variables considered on the relationship between diversification and bank standalone risk based on the results in Table 3.7.

I also test my findings on the role of bank size and capital on the diversification-bank stability nexus by using the country-level income diversity, and I find consistent results in Table 3.8 confirming that bank size and capital have positive association on the negative relationship

[20] I repeat my analyses using the $\Delta CoVaR$ as the dependent variable in regressions (1)-(4) in Table 3.6 in order to check whether my regressions that use alternative diversification indicators (*CID* and *ID*) generate consistent results with the baseline results when using the same dependent variables.
[21] Although seven out of eight results in Table 3.6 are consistent with my original analyses regarding the association of the regulatory environment on the diversification-systemic risk relationship, the result in columns (7) is not significant.

between diversification and systemic risk, which indicates that larger and well-capitalized banks are less subject to systemic risk when the overall diversification in a country is high.

Table 3.6. Robustness check: The role of regulatory framework on the relationship between diversification and systemic risk

Dependent Variables	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*	*MES*	*MES*	*MES*	*MES*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CID	-0.119***	-0.0222***	-0.0821***	-0.0849***	-0.232***	-0.0287*	0.0932	-0.167**
	(0.0140)	(0.00256)	(0.0190)	(0.0135)	(0.0736)	(0.0150)	(0.0983)	(0.0683)
Supervisory power index	-0.0110***				-0.00887***			
	(0.000736)				(0.00261)			
CID×Supervisory power index	0.0110***				0.0203***			
	(0.00125)				(0.00647)			
Activity restriction index		-0.00739***				0.00323		
		(0.000620)				(0.00321)		
CID×Activity restriction index		0.00677***				0.00587*		
		(0.000785)				(0.00351)		
Capital regulation index			0.00586***				0.0208**	
			(0.00195)				(0.0106)	
CID×Capital regulation index			0.0182***				-0.0173	
			(0.00369)				(0.0198)	
Private monitoring index				0.00992***				-0.0123***
				(0.000865)				(0.00416)
CID×Private monitoring index				0.0102***				0.0199**
				(0.00164)				(0.00807)
ID	0.00216	-0.00333	0.00776*	-0.00684***	-0.0439***	-0.0419***	-0.0398*	-0.0375***
	(0.00267)	(0.00250)	(0.00402)	(0.00229)	(0.0148)	(0.0141)	(0.0220)	(0.0137)
Bank Size	0.0197***	0.0166***	0.0129***	0.00800***	-0.0279***	-0.0263***	-0.0189**	-0.0233***
	(0.00112)	(0.00106)	(0.00274)	(0.00112)	(0.00494)	(0.00494)	(0.00914)	(0.00509)
Capitalization	0.0624***	0.0727***	0.0648***	0.0359***	-0.103*	-0.0695	0.0440	-0.0620
	(0.0137)	(0.0137)	(0.0164)	(0.0115)	(0.0615)	(0.0694)	(0.104)	(0.0708)

Table 3.6 (continued). Robustness check: The role of regulatory framework on the relationship between diversification and systemic risk

NPL	0.116***	0.109***	0.0395**	0.0715***	-0.0113	0.0762	0.0949	0.0700
	(0.0156)	(0.0130)	(0.0170)	(0.0129)	(0.0655)	(0.0743)	(0.115)	(0.0740)
Loangrowth	-0.00418***	-0.00358***	-0.00365**	-0.000793	-0.0264***	-0.0280***	-0.0122	-0.0249***
	(0.00126)	(0.00115)	(0.00185)	(0.00112)	(0.00731)	(0.00778)	(0.0141)	(0.00755)
Loan	-0.0328***	-0.0438***	-0.0424***	-0.0452***	0.0463**	0.0447**	0.0566*	0.0363*
	(0.00547)	(0.00535)	(0.00724)	(0.00424)	(0.0219)	(0.0209)	(0.0322)	(0.0209)
Deposit	0.0346***	0.0437***	0.0138	0.0268***	0.0365	0.00642	-0.0393	0.0158
	(0.00690)	(0.00647)	(0.0107)	(0.00515)	(0.0271)	(0.0268)	(0.0492)	(0.0271)
GDPgrowth	0.285***	0.321***	0.171***	0.247***	0.979***	0.841***	0.871***	0.843***
	(0.0227)	(0.0198)	(0.0222)	(0.0157)	(0.142)	(0.0983)	(0.141)	(0.101)
GDPpercap	0.170***	0.158***	0.0772***	0.113***	0.180***	0.160***	0.140**	0.165***
	(0.0122)	(0.0104)	(0.0101)	(0.00925)	(0.0337)	(0.0329)	(0.0581)	(0.0330)
Inflation	0.0735***	0.0350**	0.00859	-0.0112	-0.233**	-0.293***	0.00390	-0.246***
	(0.0144)	(0.0145)	(0.0224)	(0.0115)	(0.107)	(0.0932)	(0.166)	(0.0917)
Constant	-1.981***	-1.886***	-1.055***	-1.419***	-1.434***	-1.374***	-1.347**	-1.335***
	(0.114)	(0.0968)	(0.106)	(0.0871)	(0.302)	(0.290)	(0.573)	(0.300)
No. of observations	11,966	13,192	6,241	13,131	11,890	13,102	6,217	13,043
R-squared	0.423	0.378	0.630	0.500	0.035	0.028	0.052	0.026
No. of banks	1,302	1,327	1,000	1,318	1,302	1,326	999	1,317
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the robustness test results on the role of regulatory environment on the relationship between diversification and bank systemic risk. *CID* and *ID* are the country- and bank-level income diversity measures, respectively. *Supervisory power index* is an index of the power of regulatory agencies in a country. *Activity restriction index* is an index capturing the degree of a country's restrictions on banks' activities allowed to engage in. *Capital regulation index* is an index that captures a country's stringency of capital regulations. *Private monitoring index* is an index of regulatory empowerment of private monitoring of banks. *CID×Supervisory power index* is the interaction term of diversification and supervisory power index. *CID×Activity restriction index* is the interaction term of diversification and activity restriction index. *CID×Capital regulation index* is the interaction term of diversification and capital regulation index. *CID×Private monitoring index* is the interaction term of diversification and private monitoring index. Δ*CoVaR* is the bank's systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. *MES* is an alternative bank systemic risk indicator and is calculated as the average of a bank's stock return during the 5% worst trading days for the overall market return in one financial year. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represent the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Results regarding the role of regulatory environment on the relationship between diversification and bank systemic risk are reported in columns (1)-(4) using Δ*CoVaR* and in columns (5)-(8) using *MES* as dependent variables. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 3.7. Robustness check: The role of regulatory framework on the relationship between diversification and idiosyncratic risk

Dependent Variables	*Z-Score*	*Z-Score*	*Z-Score*	*Z-Score*	*ReturnVol*	*ReturnVol*	*ReturnVol*	*ReturnVol*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CID	4.406**	0.499	4.093**	-4.349*	-0.0990***	-0.00951***	-0.0120	-0.0768***
	(1.989)	(0.489)	(1.889)	(2.591)	(0.0110)	(0.00148)	(0.0112)	(0.00923)
Supervisory power index	0.00746				-0.000825**			
	(0.103)				(0.000390)			
CID×Supervisory power index	-0.299*				0.00911			
	(0.174)				(0.000979)			
Activity restriction index		0.223***				-0.00214***		
		(0.0860)				(0.000341)		
CID×Activity restriction index		0.0669				0.00328		
		(0.119)				(0.000409)		
Capital regulation index			0.942***				-0.00492***	
			(0.213)				(0.00114)	
CID×Capital regulation index			-0.760**				0.00313	
			(0.378)				(0.00220)	
Private monitoring index				-0.106				-0.00567***
				(0.165)				(0.000553)
CID×Private monitoring index				0.624**				0.00976
				(0.317)				(0.00113)
ID	-2.387***	-2.382***	-0.539	-2.539***	0.0141***	0.00789***	0.00755***	0.00989***
	(0.506)	(0.448)	(0.644)	(0.436)	(0.00211)	(0.00197)	(0.00278)	(0.00193)
Bank Size	-0.242	-0.528**	-1.583***	-0.632**	-0.00103	-0.000106	0.000853	0.000334
	(0.291)	(0.268)	(0.433)	(0.271)	(0.000877)	(0.000753)	(0.00141)	(0.000764)
Capitalization	3.088	3.314	1.381	3.310	-0.0845***	-0.0999***	-0.157***	-0.103***
	(3.052)	(3.139)	(1.079)	(3.120)	(0.0177)	(0.0145)	(0.0252)	(0.0148)

Table 3.7 (continued). Robustness check: The role of regulatory framework on the relationship between diversification and idiosyncratic risk

NPL	-0.610	1.564	-0.588	0.872	0.125***	0.129***	0.153***	0.134***
	(2.387)	(2.164)	(3.103)	(2.146)	(0.0180)	(0.0159)	(0.0225)	(0.0160)
Loangrowth	-0.357	-0.579***	-0.420	-0.463**	-0.000448	-0.00198*	-0.00689***	-0.00176
	(0.221)	(0.221)	(0.457)	(0.219)	(0.00118)	(0.00108)	(0.00193)	(0.00115)
Loan	-1.395	-0.935	-1.740	-1.218	0.00781*	0.0130***	0.0152***	0.0144***
	(1.196)	(1.098)	(1.925)	(1.104)	(0.00427)	(0.00401)	(0.00539)	(0.00399)
Deposit	-1.812	-2.372*	-3.110	-2.417*	-0.0143***	-0.0140***	-0.0381***	-0.0156***
	(1.395)	(1.289)	(2.005)	(1.297)	(0.00501)	(0.00446)	(0.00646)	(0.00455)
GDPgrowth	5.808*	11.02***	15.75***	11.47***	-0.197***	-0.250***	-0.250***	-0.227***
	(2.964)	(2.549)	(4.406)	(2.790)	(0.0214)	(0.0151)	(0.0285)	(0.0176)
GDPpercap	5.540***	6.792***	5.568***	5.979***	-0.0186***	-0.0140***	-0.0313***	-0.0132**
	(1.517)	(1.323)	(2.028)	(1.288)	(0.00649)	(0.00523)	(0.0101)	(0.00514)
Inflation	-0.0755	-2.265	-0.436	0.0923	-0.0252*	-0.00655	-0.0283	-0.0106
	(1.771)	(1.922)	(3.346)	(1.594)	(0.0130)	(0.0106)	(0.0236)	(0.0113)
Constant	-25.45**	-36.02***	-9.189	-23.30**	0.245***	0.191***	0.395***	0.212***
	(12.61)	(10.91)	(17.26)	(10.60)	(0.0561)	(0.0459)	(0.0966)	(0.0467)
No. of observations	11,909	13,142	5,984	13,076	11,949	13,175	6,232	13,114
R-squared	0.019	0.024	0.031	0.023	0.235	0.197	0.270	0.191
No. of banks	1,296	1,320	960	1,310	1,302	1,327	999	1,318
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the robustness test results on the role of regulatory environment on the relationship between diversification and bank idiosyncratic risk. *CID* and *ID* are the country- and bank-level income diversity measures, respectively. *Supervisory power index* is an index of the power of regulatory agencies in a country. *Activity restriction index* is an index capturing the degree of a country's restrictions on banks' activities allowed to engage in. *Capital regulation index* is an index that captures a country's stringency of capital regulations. *Private monitoring index* is an index of regulatory empowerment of private monitoring of banks. *CID×Supervisory power index* is the interaction term of diversification and supervisory power index. *CID×Activity restriction index* is the interaction term of diversification and activity restriction index. *CID×Capital regulation index* is the interaction term of diversification and capital regulation index. *CID×Private monitoring index* is the interaction term of diversification and private monitoring index. *Z-Score* is the individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. *ReturnVol* is an alternative bank standalone risk indicator and is calculated as the standard deviation of bank stock returns on a yearly basis using the daily stock price information. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represent the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Results regarding the role of regulatory environment on the relationship between diversification and bank idiosyncratic risk are reported in columns (1)-(4) using *Z-Score* and in columns (5)-(8) using *ReturnVol* as dependent variables. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 3.8. Robustness check: The role of bank size and capital on the relationship between diversification and bank stability

Dependent Variables	*Zscore*	*ΔCoVaR*	*Zscore*	*ΔCoVaR*	*Z-Score*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)
	Bank Size		*Capitalization*		*Bank Size and Capitalization*	
CID	1.440	-0.0693***	13.00***	-0.0107***	40.20***	-0.139***
	(3.252)	(0.00993)	(2.074)	(0.00306)	(6.899)	(0.0249)
CID×Bank Size	-0.0329	0.00386***			-2.056***	0.00751***
	(0.190)	(0.000586)			(0.366)	(0.00136)
CID×Capitalization			-176.7***	0.0907***	-283.2***	0.422***
			(24.19)	(0.0300)	(35.29)	(0.104)
ID	-2.854***	0.00103	-2.376***	0.00111	-1.311***	0.00393
	(0.419)	(0.00153)	(0.402)	(0.00153)	(0.404)	(0.00322)
Bank Size	-0.550*	0.00701***	-0.0668	0.00879***	0.856***	0.0202***
	(0.285)	(0.000710)	(0.242)	(0.000712)	(0.322)	(0.00164)
Capitalization	4.273	0.0188***	119.4***	-0.0304*	128.5***	-0.111***
	(3.920)	(0.00660)	(15.56)	(0.0172)	(15.07)	(0.0420)
NPL	2.255	0.0698***	1.298	0.0686***	1.360	0.171***
	(2.162)	(0.00781)	(2.224)	(0.00771)	(2.204)	(0.0165)
Loangrowth	-0.397**	-0.00147**	-0.434**	-0.00146**	-0.396**	-0.00423***
	(0.186)	(0.000641)	(0.185)	(0.000649)	(0.180)	(0.00133)
Loan	-1.001	-0.0187***	-1.080	-0.0185***	-0.814	-0.0426***
	(0.991)	(0.00319)	(0.956)	(0.00319)	(0.952)	(0.00712)
Deposit	-2.209*	0.0103***	1.652	0.00874**	1.059	0.0230***
	(1.224)	(0.00381)	(1.139)	(0.00376)	(1.123)	(0.00848)
GDPgrowth	11.70***	0.208***	3.375	0.223***	8.134***	0.122***
	(2.666)	(0.00943)	(2.589)	(0.00972)	(2.691)	(0.0158)
GDPpercap	6.036***	0.0870***	3.483***	0.0874***	2.584**	0.189***
	(1.227)	(0.00753)	(1.187)	(0.00769)	(1.183)	(0.0172)
Inflation	1.421	0.0502***	1.931*	0.0518***	0.135	0.0746***
	(1.017)	(0.0122)	(1.077)	(0.0124)	(1.199)	(0.0234)
Constant	-26.09***	-1.072***	-18.63*	-1.102***	-21.18**	-2.290***
	(10.11)	(0.0704)	(9.905)	(0.0706)	(9.898)	(0.158)
No. of observations	15,232	15,121	15,232	15,121	15,232	15,121
No. of banks	1,338	1,340	1,338	1,340	1,338	1,340
R-squared	0.024	0.425	0.107	0.426	0.076	0.425
Bank fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES

Notes: This table presents the robustness test results on the role of bank size and capital on the relationship between diversification and bank stability. *CID* and *ID* are the country- and bank-level income diversity measures, respectively. *CID×Bank Size* is the interaction term of diversification and bank size. *CID×Capitalization* is the interaction term of diversification and bank capital. *Z-Score* is the individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. Δ*CoVaR* is the systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on the bank being in distress and the banking market's CoVaR in the median state of the bank. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *Loangrowth* is the growth rate of bank total loans. *Loan* represents the ratio of bank total loans on total assets. *Deposit* is the ratio of bank total deposits on total assets. *GDPgrowth* represent the annual percentage growth rate of GDP at market prices based on constant local currency. *GDPpercap* is the gross domestic product divided by midyear population. *Inflation* is the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Results regarding the role of bank size on the relationship between diversification and bank idiosyncratic and systemic risks are reported in columns (1) and (2) and the role of capital in columns (3) and (4). Columns (5) and (6) show the results of regressions that include both the size and capital variables. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

3.7 Conclusions

Using a sample of 1,395 international publicly listed banks from 49 countries between 1999 and 2015, this chapter contributes to the literature by empirically investigating the role of the regulatory environment in the relationship between diversification and bank stability. Based on the cross-country database on bank regulation and supervision presented by Barth, Caprio, and Levine (2013), I focus on four regulatory variables in the agenda of policymakers (Agoraki, Delis, and Pasiouras, 2011; Anginer, Demirgüç-Kunt, and Zhu, 2014a): supervisory power index, capital regulation index, activity restriction index, and private monitoring index. In addition, I investigate whether standalone and systemic risks of banks with different size and capital holdings will respond differently to changes in diversification.

I find that the impact of diversification on bank stability is conditional on the specific regulatory environment in a country. In particular, the negative impact of diversification on bank systemic stability is mitigated in countries with powerful supervisory agencies, higher stringency of capital regulations, more restrictions on the scope of banks' activities, and more private monitoring. Moreover, my study shows that bank size and capital alleviate the negative impact of diversification on systemic risk, which implies that larger and well-capitalized banks are less subject to systemic risk when the degree of diversification in a country is high. However, I did not find a similar role of regulatory framework and banks' essential risk factors on the dimension of bank idiosyncratic risk.

My findings have important implications for policymaking and bank management. Given that a country's regulatory environment has a significant association with the relationship between diversification and bank stability, regulators should consider cross-country variations in regulatory environments when setting policies to regulate the diversification of banks. From the perspective of bank management, banks' diversification decisions should be based on the evaluations of both the potential idiosyncratic and systemic risk inherent from the activities that banks may engage in. Excessive diversification may benefit individual bank stability but increase exposures to correlated risks among banks with similar portfolios through diversification. Bank managers formulating their diversification strategy should evaluate the size and capital holdings of their institutions since these characteristics may determine the extent of the benefits from diversified activities.

This chapter only deals with the associations of regulatory framework and banks' risk determinants with the relationship between diversification and bank stability. In future research, the potential causality among them could be investigated. In addition, this study can be further improved by considering other dimensions of a country's regulatory framework (i.e. deposit insurance scheme and bank governance) and institutional settings (i.e. property rights, information sharing, and stock market development).

Chapter 4: How diversification influences banks' market power

4.1 Introduction

The scope of activities that U.S. banks are allowed to engage in has changed following some key regulations in the financial market. In the aftermath of the Stock Market Crash of 1929, the Banking Act of 1933 (the Glass-Steagall Act) was passed to prevent financial institutions that provide investment banking services from engaging in commercial banking activities such as taking deposits. Then, from the 1980s, the U.S. banking market underwent a deregulation wave, and this deregulation trend culminated in the passage of the Financial Services Modernization Act of 1999 (the Gramm-Leach-Bliley Act), which repealed the Glass-Steagall restrictions and allowed U.S. banks to engage in non-traditional banking activities such as investment banking, venture capital, securities brokerage, insurance underwriting and asset securitization. The cumulative impact of decades of deregulation has paved the way for the presence of widely diversified banks that now dominate the U.S. banking market (Berger, Molyneux, and Wilson, 2014).[22]

There are different explanations on why banks choose to diversify activities or services. First, from the risk management perspective, a firm's idiosyncratic risk can be reduced by holding a well-diversified portfolio (Sharpe, 1964). Second, expanding the scope of bank business lines can create value for banks' shareholders. Such values may come from the economy of scale since banks can reuse the extensive customer information gathered from long-term customer relationships in the area of other non-related activities by cross-selling multiple products to the

[22] Diversified financial institutions, especially systemically important banks, are also subject to regulatory pressures to maintain financial stability. For example, the Dodd-Frank Act and the Volcker Rule impose constraints on bank size and activities.

same customers (Stiroh and Rumble, 2006). Moreover, banks with high operating leverage can enjoy cost advantage in the process of diversifying related activities (Elsas, Hackethal, and Holzhäuser, 2010). Third, banks may have non-profit-maximizing motives to protect firm-specific human capital and private benefits through diversification (Berger, Demsetz, and Strahan, 1999; Aggarwal and Samwick, 2003).

Among the extensive studies related to bank diversification, little is known so far regarding whether bank diversification activities can be a source or a determinant of market power. Diversification may affect banks' market power through leading changes to banks' revenues and/or marginal costs. A diversified bank earns revenues not only from traditional lending activities but also from activities that generate non-interest incomes such as fee-based services. Therefore, diversification may allow banks to increase their revenues and gain market power while diversification could also induce costs to banks, which weakens banks' pricing power by making them less likely to lower marginal costs in order to reap monopoly rents.

This chapter contributes to the literature in three aspects. First, to my knowledge, this study is the first to investigate how diversification influences banks' market power. No prior study addresses the question about whether diversification is a determinant or source of banks' market power. I investigate both linear and potential non-linear relationships between diversification and banks' market power in order to present a full picture on the extent to which banks' market power is influenced by diversification. I employ a group of bank diversification measures to reflect the extent to which banks diversify between traditional interest income and non-traditional income-generating activities, which helps to obtain relatively general conclusions on the relationship between bank diversification and market power and to exclude the possibility that my findings are driven by the specifications of diversification measures. I define market power from the perspective of monopoly power of banks in pricing, and I employ the Lerner Index (Lerner, 1934), which is based on the divergence between product price and marginal cost of production. To engage in diversified activities, banks need to allocate resources between existing activities (e.g. lending service) and new income-generating activities. This process leads to changes in revenue and cost profiles of banks and further affects bank output prices and marginal costs of production, or a combination of both.

Second, I contribute to the literature by investigating the effect of diversification on banks' market power in both lending and funding markets by constructing indicators of loan and deposit market power separately, which provides supplementary evidence to my main contribution based on the findings using banks' overall market power. A bank with market power in the lending market has information advantage and is less subject to information asymmetry, which is beneficial for access to financing (Petersen and Rajan, 1995; Boot and Thakor, 2000). On the other hand, collecting deposits is the main source of funding for banks and the market power in the deposit market determines whether banks can have access to funding at a relatively low cost. The Lerner Index only shows information on banks' market power for overall banking activities because this index uses a single output specification so that it typically incorporates both interest and non-interest incomes into bank output pricing, and, correspondingly, uses associated interest and non-interest costs to calculate marginal cost of production. Changes in the degree of diversification could result in different effects to banks' market power in different markets. This raises the necessity of constructing separate measures to disentangle banks' market power in the lending and deposit markets from all markets involved.

Third, I contribute to the literature by examining how the market power of banks with different sizes reacts differently to the changes of the degree of diversification by splitting my sample into two subsamples with small and large banks. This analysis could provide information on whether the effect of bank diversification on market power differs by bank size. Large and small banks differ in their capabilities of managing relatively complex non-traditional activities, so their revenues and/or costs could exhibit different reactions towards the diversification of activities. Therefore, this process could lead to different changes in banks' market power.

I find that there exists an inverse U-shaped relationship between revenue diversification and banks' market power, and this observed association holds for banks' market power in both lending and funding markets. In addition, this inverse U-shaped relationship is much more pronounced in large banks than in small banks, which indicates that it is dominated by large banks. My results remain consistent with those in my baseline analyses by using an instrumental variable approach to mitigate the potential endogeneity between diversification and banks' market power. In addition, my results are robust for considering other particular forms of diversification indicators. My findings are important for bank managers to understand how to proactively manage banks' market power through engaging in diversified activities. Moreover, this study may help regulators and policymakers to evaluate the potential impact of diversification on the banking market structure.

The remainder of this chapter is structured as follows. Section 4.2 presents an overview of the relevant literature. Sections 4.3 and 4.4 introduce the data, measures and methodology employed. My empirical findings and robustness tests are presented in Sections 4.5 and 4.6, respectively. Section 4.7 concludes and discusses the main implications of my study.

4.2 Literature review

A large body of literature investigates the impacts of diversification on different issues in banking. For instance, previous studies link diversification to bank valuation (Berger and Ofek, 1995; Laeven and Levine, 2007; Elsas, Hackethal, and Holzhäuser, 2010), bank performance and risk profile (DeYoung and Roland, 2001; Stiroh, 2004a; Stiroh and Rumble, 2006; Baele, De Jonghe, and Vennet, 2007; Mercieca, Schaeck, and Wolfe, 2007; Chiorazzo, Milani, and Salvini, 2008; Lepetit et al., 2008b; Berger, Hasan, and Zhou, 2010; Li and Zhang, 2013; Delis, Kokas, and Ongena, 2017) and bank stability (Lepetit et al., 2008a; De Jonghe, 2010; Wagner, 2010; Sanya and Wolfe, 2011; DeYoung and Torna, 2013; Williams, 2016; Abuzayed, Al-Fayoumi, and Molyneux, 2018).

A few studies link to bank revenues and margins to market power (Maudos and Fernández de Guevara, 2004; Valverde and Fernández, 2007; Nguyen, Skully, and Perera, 2012a). Maudos and Fernández de Guevara (2004) study the determinants of bank margins based on a sample of European banks. They show that market power is positively associated with bank interest margins while this effect can be cancelled out by the effect of changes in other determinants of bank interest margins. Thus, a decrease in interest margins could be compatible with an increase in banks' market power under the condition that the effect of increasing market power is offset by a reduction in operating costs, interest rate risk and credit risk. Despite these findings, their study does not investigate whether market power changes with banks' diversification strategy. Valverde and Fernández (2007) find that banks are able to seek new sources of market power in non-traditional business, which can serve as a compensation for the decrease of market power in traditional banking activities. Nevertheless, their study does not directly address the diversification-market power issue but just investigates the relationship between bank margins and market power. Nguyen, Skully, and Perera (2012a) find a significant non-linear relationship between bank market power and revenue diversification based on the evidence from Southeast Asian countries. However, the results in this study may be subject to the reverse causality from diversification to market power given that diversification could also be a source or determinant of banks' market power.

One point worth mentioning is that the studies mentioned above only employ ratio-based measures to represent bank fee-based activities or revenue diversification. This form of indicators only shows the proportion of one specific source of revenues in total incomes but cannot fully reflect the information on the overall level of diversification among different income-generating activities that include both traditional interest-based activities and different types of non-traditional income-generating activities. Thus, it is necessary to construct more informative bank diversification measures to precisely reflect banks' diversification activities from different perspectives and further confirm that the association between diversification and market power is not driven by specific forms of diversification measures employed.

Other studies provide some useful discussions and insights for this chapter regarding the understanding of the potential effect of diversification on banks' market power. Buch, Koch, and Koetter (2012) study the influence of bank internationalization on market power. They find that banks with a higher share of foreign assets exhibit higher market power since banks can exploit private information generated from international branches to increase revenues and/or decrease costs in the domestic market. On the other hand, banks' market power can be eroded due to increasing complexities in management and control if banks over-expand into too many foreign markets.

4.3 Data and measures

4.3.1 Data

I construct a large dataset that includes nearly all U.S. commercial and bank holding companies (BHCs) that are compiled by Bureau van Dijk (BvD) BankFocus. This provides a comprehensive data coverage in terms of the number of banks (9,991 banks with over 120,000 observations) and sample periods (27 years from 1991 to 2017), which is essential to draw more general conclusions regarding the relationship between diversification and banks' market power.

This study focuses on U.S. banks because the U.S. banking market has a significant presence in the world banking market and provides grounds for investigating banks' diversification activities from traditional interest-based towards non-traditional activities due to its highly developed nature. Moreover, as U.S. banks have become more diversified with respect to product mix and geographic exposure over the last decades of deregulation in the banking market, a large number of them have diverse business lines for both traditional and non-traditional banking services. This allows me to construct more informative diversification measures than those in countries with specialized banking business models.

Accounting data based on bank balance sheet and income statement are collected from the BvD BankFocus database.[23] I filter the original sample by excluding banks with fewer than five yearly observations, and banks with no available data on key variables (such as total assets, fee and commission incomes or staff expenses).[24] To account for the influence of extreme values and outliers, all variables are winsorized so that the values of the bottom 1% and top 1% of observations for each variable are set equal to those with values in the 1st and 99th percentiles, respectively.

[23] BvD BankFocus has access to very detailed accounting information, which enables us to calculate different forms of bank market power and diversification measures.

[24] Before filtering, the original sample has 147,038 observations for 13,662 banks, which includes banks that have a relatively small number of observations. The specific criteria for refining my sample are as follows. First, banks are from the U.S. and are commercial banks and bank holding companies (BHCs). Second, all accounting data are organized in the consolidated form with codes 'C1' and 'C2' specified by BankFocus to avoid duplications in calculating measures. Third, I exclude banks with fewer than five yearly observations. Fourth, banks with no available data on key variables are excluded.

4.3.2 Market power measure

My study employs the Lerner Index as a proxy of banks' market power. This performance-based measure has been widely used in previous banking studies (Fernández de Guevara and Maudos, 2007; Berger, Klapper, and Turk-Ariss, 2009; Demirgüç-Kunt and Martinez-Peria, 2010; Koetter, Kolari, and Spierdijk, 2012; Beck, De Jonghe, and Schepens, 2013; Amidu and Wolfe (2013a); Anginer, Demirgüç-Kunt, and Zhu, 2014a). The Lerner Index is defined as the relative mark-up of banks' output price over associated marginal costs in production. The premise for this measure is that a bank's output price is equal to the marginal costs under a perfect competitive situation, and the output price rises above marginal cost as banks' market power grows. Compared with other proxies for market power such as concentration ratio and the Herfindahl-Hirschman Index (HHI), the Lerner Index has advantages in conducting parametric estimation at the bank-year level (Beck, De Jonghe, and Schepens, 2013), which makes this indicator more informative in capturing individual banks' market power. Second, the Lerner Index does not require strict assumptions on bank homogeneity and precise definitions of geographic and product market (Aghion et al., 2005). Third, the Lerner Index does not impose the assumption of long-term equilibrium as required by the Panzar and Rosse H-statistic (Panzar and Rosse, 1987). Fourth, the Lerner Index allows the calculation of market power for loans and deposits at the bank level separately (Forssbæck and Shehzad, 2014). The Lerner Index[25] is calculated as follows:

$$Lerner\ Index_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \quad (4.1)$$

[25] Koetter, Kolari, and Spierdijk (2012) proposed the adjusted Lerner Index to take into account the possibility of forgone monopoly profits due to the non-profit maximizing pricing of outputs. Their adjusted Lerner Index is constructed based on the background of deregulations in the U.S. banking industry during the 1980s, which provides grounds for testing the quiet life hypothesis (Hicks, 1935). However, my dataset does not cover the period of historic deregulations. Therefore, my study employs the Lerner Index as banks' market power indicator.

where subscripts i and t stand for bank *i* and time *t*, *respectively*. P represents the average price of bank outputs and is calculated as banks' total revenues that include both interest and non-interest revenues divided by total assets. Marginal cost MC cannot be directly obtained from the balance sheet and needs to be estimated by using the translog cost function (Berndt and Wood, 1975):

$$lnTC = \alpha + \alpha_1 lnQ + \frac{1}{2}\alpha_2 lnQ^2 + \sum_{j=1}^{3}\beta_{1j} lnW_j + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3}\beta_{2i,j} lnW_i lnW_j +$$

$$\frac{1}{2}\sum_{j=1}^{3}\gamma_{1j} QlnW_j + \tau_1 t + \frac{1}{2}\tau_2 t^2 + \tau_3 tlnQ + \sum_{j=1}^{3}\tau_{4j} tlnW_i + \theta_1 \times Year\ Dummy + \varepsilon \quad (4.2)$$

The translog cost function includes three inputs (W), one output (Q) and a time trend (t) that captures the effect of technology change. TC denotes banks' total costs that is the sum of interest expenses, personnel expenses, administrative expenses and other operating expenses. Q represents bank output and is proxied by bank total asset in millions of U.S. dollars.[26] W_j and W_i denote one of the three input prices: the input price of funding calculated as the ratio of interest expenses to total assets, the input price of labour, which is the ratio of personnel expenses to total assets, and the input price of fixed capital computed as the ratio of administrative and other operating expenses to total assets. All variables in the equation are expressed in the form of natural logarithm, and the coefficients are estimated using OLS regression. I also impose the following restrictions on the estimated coefficients to ensure the homogeneity of degree one in input prices:

$$\sum_{j}^{3}\beta_{1j} = 1;\ \sum_{j}^{3}\beta_{2i,j} = 0\ (for\ a\ given\ W_i);\ \sum_{j}^{3}\gamma_{1j} = 0 \quad (4.3)$$

Then the MC is estimated by the following equation:

[26] For the Lerner Index, as in Fernández de Guevara, Maudos, and Perez (2005), I use banks' total assets as the proxy for banking output without separating banking outputs into loans and deposits.

$$MC = \frac{\partial TC}{\partial Q} = \frac{TC}{Q} \times (\alpha_1 + \alpha_2 lnQ + \frac{1}{2}\sum_{j=1}^{3} \gamma_j lnW_j + \tau_3 t) \quad (4.4)$$

where α_1, α_2, γ_j and τ_3 are coefficients estimated by the translog cost function.

To investigate the effect of diversification on bank market power in the lending and deposit market separately, I further construct bank-year level loan and deposit markets power individually following Forssbæck and Shehzad (2014).[27] Based on the specification of the Lerner Index, I split a bank's output Q into two components – loans (L) and deposits (D) – and then compute the marginal cost for loans and deposits separately through the equation:

$$lnTC = \alpha + \alpha_3 lnL + \alpha_4 lnD + \frac{1}{2}\alpha_5 lnL^2 + \frac{1}{2}\alpha_6 lnD^2 + \frac{1}{2}\alpha_7 lnLlnD + \sum_{j=1}^{3} \beta_{3j} lnW_j + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} \beta_{4i,j} lnW_i lnW_j + \frac{1}{2}\sum_{j=1}^{3} \gamma_{2j} LlnW_j + \frac{1}{2}\sum_{j=1}^{3} \gamma_{3j} DlnW_j + \tau_5 t + \frac{1}{2}\tau_6 t^2 + \tau_7 tlnL + \tau_8 tlnD + \sum_{j=1}^{3} \tau_{9j} tlnW_i + \theta_2 \times Year\ Dummy + \varepsilon \quad (4.5)$$

where E represents banks' total equity. The marginal costs for loans (MC_L) and deposits (MC_D) are given by:[28]

$$MC_L = \frac{\partial TC}{\partial L} = \frac{TC}{L} \times (\alpha_3 + \alpha_5 lnL + \frac{1}{2}\alpha_7 lnD + \frac{1}{2}\sum_{j=1}^{3} \gamma_{2j} lnW_j + \tau_7 t) \quad (4.6)$$

$$MC_D = \frac{\partial TC}{\partial D} = \frac{TC}{D} \times (\alpha_4 + \alpha_6 lnD + \frac{1}{2}\alpha_7 lnL + \frac{1}{2}\sum_{j=1}^{3} \gamma_{3j} lnW_j + \tau_8 t) \quad (4.7)$$

Finally, the bank-year level Lerner Index for loans (LI_L) and deposits (LI_D) is calculated as:

$$LI_L = \frac{r_L - r_M - MC_L}{r_L} \quad (4.8)$$

[27] Berger, Klapper, and Turk-Ariss (2009) also consider separate indicators to reflect banks' loans and deposit market power. However, their measures are based on country-level Herfindahl-Hirschman Index (HHI) indicators, which are less informative compared with a bank-level market power indicator.
[28] Although I disaggregate bank outputs into loans and deposits, the inputs for generating these two outputs remain the same as in the estimation of the marginal cost for the Lerner Index, which includes borrowed funds, fixed capital, and labour.

$$LI_D = \frac{r_M - r_D - MC_D}{r_D} \quad (4.9)$$

where r_L is the lending rate calculated as the ratio between interest income and total earning asset. r_D is the deposit rate computed as the ratio between interest expense and deposits and money market funding. r_M is the U.S. 3-month Treasury Bill rate representing the money market rate.

4.3.3 Diversification measures

Previous studies typically use two forms of measures to represent bank diversification: the ratio-based (Baele, De Jonghe, and Vennet, 2007; Lepetit et al., 2008a; Nguyen, Skully, and Perera, 2012b) and the HHI-based measures (Stiroh and Rumble, 2006; Berger, Hasan, and Zhou, 2010; Elsas, Hackethal, and Holzhäuser, 2010; Abuzayed, Al-Fayoumi, and Molyneux, 2018). The ratio-based measures involve the ratios of bank non-interest incomes over total assets, or ratios of specific types of non-interest incomes (e.g. commissions and fees, trading incomes) over total assets or total operating incomes. One potential issue related to ratio-based diversification measures is that ratios only depict the absolute proportions of one type of bank revenues, which no longer reveals information on the extent of distributions or relative proportions among different sources of bank revenues. Compared with ratio-based measures, the HHI-based measures take into account different types of bank revenues and each HHI-based indicator combines the information regarding relative proportions of different types of bank revenues.

I employ the diversification measure proposed by Elsas, Hackethal, and Holzhäuser (2010) to reflect the overall extent of bank diversification among four types of revenues. This HHI-based bank overall diversification (*OD*) measure is calculated as:

$$OD_{\mathrm{i,t}} = 1 - \left[\left(\frac{|INT_{i,t}|}{|TOR_{i,t}|}\right)^2 + \left(\frac{|COM_{i,t}|}{|TOR_{i,t}|}\right)^2 + \left(\frac{|TRD_{i,t}|}{|TOR_{i,t}|}\right)^2 + \left(\frac{|OTOP_{i,t}|}{|TOR_{i,t}|}\right)^2\right] \quad (4.10)$$

I use gross rather than net values for bank interest income (INT), fees and commission income (COM), trading income (TRD) and other operating income ($OTOP$) to avoid distortions regarding the profitability of banks' interest-based and non-interest-based activities. I also take the absolute values of all specific revenues to compute the total operating income (TOR) to make the final diversification measure not largely influenced by banks' business unit performance.[29] Moreover, since I am more interested in the size of each activity rather than whether these activities are profitable or not, taking absolute values instead of net values will better show the extent to which cannot fully reflect in different activities. To generate a more straightforward diversification measure, I modify this diversification measure by using one minus the original form of the HHI measure. Under this modification, a high value of my diversification measure indicates a high degree of diversification.

In addition, following Mercieca, Schaeck, and Wolfe (2007), I build up another two diversification indicators, revenue diversification (*RD*) [30] and non-interest income diversification (*ND*). *RD* captures the degree of bank diversification *across* interest and non-interest activities. This measure is calculated as follows:

[29] Net revenues have both positive and negative streams, so the values of diversification measures could take on large negative values in the case that the sum of total operating revenues is smaller than its single component given that negative revenues compensate for positive ones. This would be contrary to the normal case, and it would be hard to interpret the meaning of the HHI-based measure with a value far below zero.
[30] Although the *RD* has been introduced and employed as a control variable in Chapter 2, I treat *RD* as one of the key variables of interest in this chapter.

$$RD_{i,t} = 1 - \left[\left(\frac{|NON_{i,t}|}{|TOP_{i,t}|} \right)^2 + \left(\frac{|INT_{i,t}|}{|TOP_{i,t}|} \right)^2 \right] \quad (4.11)$$

where subscripts i and t denote bank i and year t. NON is bank non-interest income and INT is interest income. TOP is operating income and $TOP = |NON| + |INT|$. *ND* reflects the degree of bank diversification *within* bank non-interest activities that include activities generating fees and commissions, trading and other operating incomes. *ND* is calculated as:

$$ND_{i,t} = 1 - \left[\left(\frac{|COM_{i,t}|}{|NON_{i,t}|} \right)^2 + \left(\frac{|TRD_{i,t}|}{|NON_{i,t}|} \right)^2 + \left(\frac{|OTOP_{i,t}|}{|NON_{i,t}|} \right)^2 \right] \quad (4.12)$$

where COM stands for banks' fees and commission income, TRD represents banks' trading income and $OTOP$ is banks' other operating income. NON denotes banks' non-interest income, $NON = |COM| + |TRD| + |OTOP|$.

In summary, these three diversification measures, *OD*, *RD* and *ND*, show information on the degree of bank diversification activities with different focuses: *OD* reflects the diversification *among* all types of bank revenues, *RD* shows diversification information *between* interest income and non-interest income-generating activities, and *ND* reveals information on diversification *within* banks' non-interest income-generating activities. Therefore, this group of diversification measures with different specifications are supplementary to each other and allow a relatively comprehensive measurement of bank diversification.

4.3.4 Control variables

Following De Jonghe (2010), Anginer, Demirgüç-Kunt and Zhu (2014a) and Leroy and Lucotte (2016), my models consider several bank-specific control variables that may influence the effect of diversification on bank market power. These variables include bank size

(*BankSize)*, capitalization (*Capitalization*), profitability (*ROA*), cost-to-income ratio (*Cost/Income Ratio*) and fixed asset ratio (*Fixed Asset Ratio*). *BankSize* equals the natural logarithm of total bank assets in millions of U.S. dollars, and controls for the effect that banks may seek market power relying on their scale. *Capitalization* is the equity-to-total asset ratio that controls for the effect of differences in capitalization among banks on their pricing capability. Profitability, measured by return on assets ratio, is included to control for the possibility that more profitable banks are able to seek greater market power. *ROA* controls for the differences in costs among banks. *Fixed Asset Ratio* is used to control for the influence of long-term investments (e.g. branch networks) on banks' ability of deriving pricing power in the short term. Table 4.1 shows the definitions of all variables used in this study.

Table 4.1. Definitions of Variables

Variables	Definitions
Market power measures	
Lerner Index (*LI*)	The bank-level market power measure that represents the divergence between bank output prices and marginal cost of production, reflecting the profit that a bank gains due to its pricing power in the market. Calculated as the divergence between bank price of output and marginal cost divided by the price of output (Demirgüç-Kunt and Martinez-Peria, 2010). *Source*: BankFocus and authors' calculation.
Lerner Index for loans (LI_L)	The bank-level market power in the lending market. *Source*: BankFocus and authors' calculation.
Lerner Index for deposits (LI_D)	The bank-level market power in the funding market. *Source*: BankFocus and authors' calculation.
Diversification measures	
Bank overall diversification (*OD*)	Measure of bank diversification at the overall level among interest incomes and three types of non-traditional incomes (Elsas, Hackethal, and Holzhäuser, 2010). *Source*: BankFocus and authors' calculation.
Revenue diversification (*RD*)	Measure of bank diversification between interest incomes and overall non-interest incomes (Mercieca, Schaeck, and Wolfe, 2007). *Source*: BankFocus and authors' calculation.
Non-interest income diversification (*ND*)	Measure of bank diversification within bank non-interest activities (Mercieca, Schaeck, and Wolfe, 2007). *Source*: BankFocus and authors' calculation.
Asset diversity (*AD*)	Alternative diversification measure for diversification across bank assets (Laeven and Levine, 2007). *Source*: BankFocus and authors' calculation.
Income diversity (*ID*)	Alternative diversification measure for diversification across different sources of bank incomes (Laeven and Levine, 2007). *Source*: BankFocus and authors' calculation.
Deposit diversification (*DD*)	Alternative diversification measure for diversification across different types of banks' deposits. *Source*: BankFocus and authors' calculation.
Loan diversification (*LD*)	Alternative diversification measure for diversification across different types of banks' loans. *Source*: BankFocus and authors' calculation.
Bank-specific control variables	
Bank Size (*BankSize*)	Natural logarithm of bank total assets. *Source*: BankFocus
Equity to total assets ratio (*Capitalization*)	The ratio of total equity to total assets. *Source*: BankFocus
Return on assets (*ROA*)	The ratio of net income to total assets. *Source*: BankFocus
Cost-to-income ratio (*Cost/Income Ratio*)	The ratio of operating expenses to operating income. *Source*: BankFocus
Fixed asset ratio (*Fixed Asset Ratio*)	The ratio of bank fixed assets to total assets. *Source*: BankFocus

Note: I retrieve accounting data on an annual basis from BankFocus compiled by the Bureau van Dijk to calculate market power, bank diversification and the bank-specific control variables.

4.4 Methodology

To investigate the relationship between bank diversification and market power, I employ the fixed effect model to control for unobserved bank and time fixed effects. Fixed effect models have been widely used in the banking literature to control for unobserved time-invariant variables (Mercieca, Schaeck, and Wolfe, 2007; Anginer, Demirgüç-Kunt, and Zhu, 2014a; Leroy and Lucotte, 2016; Goetz, 2017). My model is specified as follows:

$$MarketPower_{i,t} = \alpha_{1i} + \beta_1 DIV_{i,t-1} + \delta_1 {DIV_{i,t-1}}^2 + \gamma_1 X_{i,t-1} + \mu_i + \nu_t + \varepsilon_{i,t} \quad (4.13)$$

where *DIV* denotes one specific form of bank diversification measures that include revenue diversification (*RD*), non-interest income diversification (*ND*) and overall diversification (*OD*) for each bank-year observation. *MarketPower* denotes one specific form of the Lerner Index that consists of the Lerner Index (*LI*), the Lerner Index for loans (LI_L) and the Lerner Index for deposits (LI_D). *X* is a vector of bank-specific control variables. μ_i captures bank fixed effects and ν_t captures time fixed effects. $\varepsilon_{i,t}$ is the error term. I employ the lagged forms of diversification variables to mitigate the endogeneity issue due to bidirectional causality because lagged diversification and current banks' market power are less likely to be jointly determined. In addition, the inclusion of bank fixed effects reduces the possibility that my key findings are driven by potential omitted time-invariant variables.

4.5 Results

4.5.1 Summary statistics

Table 4.2 and 4.3 present the descriptive statistics of the variables used in this chapter and pairwise correlations among variables, respectively. My diversification variables (*RD*, *ND*, *OD*, *AD*, *ID*, *DD* and *LD*)[31] have values in their expected range between 0 and 1. The maximum values of *RD*, *ND*, *AD*, *ID*, *DD* and *LD* are 0.498, 0.662, 0.993, 0.934, 0.666 and 0.750, respectively, which are very close or equal to their maximum theoretical values (0.500 for *RD*, 0.667 for *ND* and *DD*, 0.750 for *LD*, and 1.000 for *AD* and *ID*). As for my three market power variables, *LI*, LI_L, and LI_D take both positive and negative values. The negative values of market power variables indicate the occasion where the average price of outputs is lower than the marginal cost.

In Table 4.3, I find significant positive pairwise correlations between my seven diversification variables except for *ND-AD*, *ID-DD*, and *DD-LD*. This indicates that different diversification indicators used in my study reflect relatively consistent information on the degree of diversification in terms of revenues, loans, and deposits. As for the correlations between diversification and market power, I find significant positive correlations between most diversification variables and *LI* except for *LI-ID*, which suggest a positive association between diversification and banks' overall market power. The majority correlations between diversification variables and LI_L are also positive but with negative correlations for LI_D. In the next section, I will investigate the relationships between diversification and market power by running regressions after controlling a group of variables.

[31] *AD*, *ID*, *DD*, and *LD* are alternative diversification indicators that are used in the robustness tests. They represent asset diversity, income diversity, deposit diversification, and loan diversification, respectively. Detailed definitions of these variables are introduced in Section 4.6.1 of this chapter.

Table 4.2. Descriptive Statistics

Variables	N	Mean	SD	Min	Median	Max
LI	133,753	0.225	0.133	-0.499	0.234	0.573
LI_L	133,271	0.687	0.202	-0.063	0.744	1.036
LI_D	133,237	0.057	0.513	-3.657	0.216	1.058
RD	134,989	0.220	0.105	0.005	0.210	0.498
ND	134,839	0.414	0.147	0	0.457	0.662
OD	134,989	0.232	0.117	0.005	0.216	0.601
AD	134,978	0.535	0.252	0	0.531	0.993
ID	134,989	0.271	0.166	0.005	0.237	0.934
DD	134,090	0.070	0.093	0	0.034	0.666
LD	133,646	0.570	0.126	0	0.602	0.750
BankSize	135,135	12.14	1.509	8.707	12.020	18.52
Capitalization	135,135	0.110	0.063	0.005	0.099	0.814
ROA	135,135	0.008	0.011	-0.083	0.009	0.054
Cost/Income Ratio	135,020	0.704	0.232	0.02	0.678	9.482
Fixed Asset Ratio	135,135	0.018	0.014	0	0.016	0.471

Note: This table presents information on the descriptive statistics of all variables throughout the chapter. *N* represents the number of observations for each variable. *SD* is the standard deviation of each variable. *Mean*, *Min*, *Median*, and *Max* indicate the mean, minimum, median, and maximum value of each variable, respectively. Detailed information on each variable's definition and calculation are reported in Table 4.1. The criteria for selecting banks are as follows. First, banks are from the U.S. and are commercial banks and bank holding companies (BHCs). Second, all accounting data are organized in the consolidated form with codes 'C1' and 'C2' specified by BankFocus to avoid duplications in calculating measures. Third, I exclude banks with less than five yearly observations. Fourth, banks with no available data on key variables are excluded. To account for the influence of extreme values and outliers, all variables are winsorized and the bottom 1% and top 1% of observations for each variable are set respectively to the values of the 1^{st} and 99^{th} percentiles. *Source*: BankFocus and authors' calculation.

Table 4.3. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) *LI*	1.000														
(2) LI_L	0.186*	1.000													
(3) LI_D	-0.002	-0.357*	1.000												
(4) *RD*	0.041*	0.031*	-0.301*	1.000											
(5) *ND*	0.034*	0.254*	-0.062*	0.026*	1.000										
(6) *OD*	0.039*	0.027*	-0.330*	0.986*	0.042*	1.000									
(7) *AD*	0.034*	0.008*	-0.307*	0.979*	-0.016*	0.974*	1.000								
(8) *ID*	-0.014*	0.265*	-0.110*	0.117*	0.129*	0.105*	0.087*	1.000							
(9) *DD*	0.020*	-0.236*	0.097*	0.135*	0.031*	0.140*	0.146*	-0.048*	1.000						
(10) *LD*	0.036*	-0.076*	0.082*	0.124*	0.026*	0.108*	0.091*	0.055*	0.002	1.000					
(11) *BankSize*	0.201*	-0.205*	-0.030*	0.355*	0.081*	0.358*	0.350*	-0.057*	0.417*	0.042*	1.000				
(12) *Capitalization*	0.124*	0.033*	-0.120*	-0.152*	-0.212*	-0.102*	-0.113*	-0.109*	-0.105*	-0.197*	-0.196*	1.000			
(13) *ROA*	0.685*	-0.036*	0.009*	0.017*	-0.111*	0.031*	0.023*	-0.008*	0.007*	0.005	0.024*	0.222*	1.000		
(14) *Cost/Income Ratio*	-0.798*	-0.014*	-0.164*	0.063*	0.004	0.068*	0.066*	0.015*	-0.067*	-0.040*	-0.169*	-0.018*	-0.611*	1.000	
(15) *Fixed Asset Ratio*	-0.239*	-0.025*	-0.020*	0.142*	0.013*	0.143*	0.120*	-0.125*	-0.060*	0.091*	-0.033*	-0.032*	-0.110*	0.193*	1.000

Note: This table presents the pairwise correlations of all key variables. *LI* denotes the Lerner Index. LI_L and LI_D are Lerner Index for loans and deposits, respectively. *RD* is the revenue diversification measure, *ND* is bank non-interest income diversification measure, *OD* is bank overall diversification measure, *AD* is asset diversity measure, *ID* is income diversity measure, *DD* is deposit diversification measure, and *LD* is loan diversification measure. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *ROA* is the ratio of net income to total assets. *Cost/Income Ratio* is the ratio of operating expenses to operating income. *Fixed Asset Ratio* is the ratio of bank fixed assets to total assets. * indicates statistical significance at the 5% or less.

4.5.2 The relationship between diversification and banks' overall market power

This section presents the regression results of my baseline model that examines the relationship between diversification and banks' market power. I employ three forms of bank diversification measures that consist of revenue diversification (*RD*), non-interest income diversification (*ND*) and overall diversification (*OD*), corresponding to the regressions in columns (1)-(2), (3)-(4), and (5)-(6) in Table 4.4, respectively. I note from columns (1), (3) and (5) that the direct relationship between diversification and banks' market power is negative and significant, indicating that banks with a higher level of diversification tend to have lower market power. This could be due to greater costs incurred from engaging in much more complex non-interest income-generating activities, which erodes banks' capability of setting a higher mark-up price over marginal costs. Those results only show the linear relationship between bank diversification and market power, but there still exists a potential non-linear relationship between them conditional on the extent to which banks diversify among interest and non-interest activities. Therefore, I add quadratic terms of diversification measures into the regressions to investigate this relationship in a relatively full picture.

Table 4.4. The relationship between diversification and banks' market power

	Dependent Variable: Lerner Index					
	(1)	(2)	(3)	(4)	(5)	(6)
RD	-0.0514***	0.123***				
	(0.00736)	(0.0221)				
RD^2		-0.337***				
		(0.0411)				
ND			-0.00156	0.0347***		
			(0.00311)	(0.0110)		
ND^2				-0.0493***		
				(0.0137)		
OD					-0.0552***	0.101***
					(0.00667)	(0.0190)
OD^2						-0.275***
						(0.0322)
BankSize	0.0337***	0.0337***	0.0342***	0.0342***	0.0335***	0.0336***
	(0.00193)	(0.00194)	(0.00195)	(0.00195)	(0.00193)	(0.00194)
Capitalization	0.146***	0.155***	0.156***	0.158***	0.146***	0.155***
	(0.0247)	(0.0248)	(0.0241)	(0.0241)	(0.0248)	(0.0248)
ROA	3.386***	3.391***	3.343***	3.341***	3.393***	3.396***
	(0.134)	(0.135)	(0.135)	(0.135)	(0.134)	(0.134)
Cost/Income Ratio	-0.108***	-0.108***	-0.110***	-0.110***	-0.108***	-0.108***
	(0.0107)	(0.0107)	(0.0108)	(0.0108)	(0.0106)	(0.0107)
Fixed Asset Ratio	-1.057***	-1.069***	-1.083***	-1.083***	-1.052***	-1.069***
	(0.0645)	(0.0647)	(0.0656)	(0.0658)	(0.0646)	(0.0649)
Constant	-0.113***	-0.132***	-0.123***	-0.128***	-0.111***	-0.130***
	(0.0266)	(0.0267)	(0.0271)	(0.0271)	(0.0265)	(0.0267)
No. of Obs	123,097	123,097	123,064	123,064	123,097	123,097
R-squared	0.360	0.361	0.359	0.360	0.360	0.362
No. of banks	9,991	9,991	9,990	9,990	9,991	9,991
Bank fixed effect	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES

Note: This table presents the regression results from the baseline model on the relationship between diversification and banks' market power. The dependent variable is the Lerner Index that captures banks' market power, which is calculated as the divergence between bank price of output and marginal cost divided by the price of output. Specifications (1) and (2) use bank revenue diversification measure (*RD*), specifications (3) and (4) use non-interest income diversification (*ND*), and specifications (5) and (6) use bank overall diversification measure (*OD)* as the key independent variables. To investigate the potential non-linear relationship between diversification and banks' market power, I construct the quadratic terms, *RD^2, ND^2* and *OD^2* for these three forms of bank diversification measures. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *ROA* is the ratio of net income to total assets. *Cost/Income Ratio* is the ratio of operating expenses to operating income. *Fixed Asset Ratio* is the ratio of bank fixed assets to total assets. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. *** indicate statistical significance at 1% level.

The results in columns (2), (4) and (6) confirm the existence of a non-linear relationship between diversification and banks' market power, which implies an optimal degree of diversification activities from the perspective of gaining banks' market power. I find the coefficients of quadratic terms of diversification measures *RD*, *ND* and *OD* are negative and significant while their associated coefficients of the linear terms become positive compared with the results in specifications with only linear terms. To interpret these results, I need to take the first derivative of the diversification functions:

$$\partial Market\ Power/\partial RD = 0.123\text{-}2\times 0.337\times RD \quad (4.14)$$

$$\partial Market\ Power/\partial ND = 0.0347\text{-}2\times 0.0493\times ND \quad (4.15)$$

$$\partial Market\ Power/\partial OD = 0.101\text{-}2\times 0.275\times OD \quad (4.16)$$

These expressions indicate that the marginal effect of diversification on banks' market power changes with the level of bank diversification. Their associated critical points are $RD = 0.182$, $ND = 0.352$, $OD = 0.184$, respectively, which means that bank diversification is positively associated with market power when the values of diversification measures are below their corresponding critical points while negatively related when above the critical points. The values of these critical points of *RD* and *ND* are below their corresponding median values (0.210 and 0.457), which demonstrates that more than half of the observations of *RD* and *ND* are in the range in which exhibits a negative relationship between diversification and market power. The critical point of *OD* is above its median of 0.216, indicating that over 50% of the observations of *OD* are in the range in which shows a positive diversification-market power relationship.

My findings suggest that the relationship between diversification and banks' market power is conditional on the degree of bank diversification. When the level of diversification increases within a certain range, banks can increase their market power by engaging in more diversified activities. This is probably because banks can enjoy greater revenues from newly engaged-in activities through diversification, which banks can use to cross-subsidize the costs in price competition with rivals by lowering lending rates and increasing deposit rates as suggested by Valverde and Fernández (2007). This process enables diversified banks to obtain a new source of market power compared with specialized banks, especially in a situation where there are barriers of entry in the banking market. Amidu and Wolfe (2013b) also show similar results that diversifying into non-interest income activities enhances banks' market power.

However, when diversification reaches a relatively high level, banks' market power can be weakened due to greater costs incurred from much more complex activities. These increasing costs can occur from greater operating expenses on supporting the expansion of business lines, or from an increased exposure to the volatility of non-interest income activities (Stiroh and Rumble, 2006). In addition, banks that engage in multiple activities may suffer agency problems so that the economies of scale are not sufficient for banks to have a diversification premium (Laeven and Levine, 2007), which makes them less likely to have a lower marginal cost of production. Table 4.5 presents the results that support my speculations. I employ two indicators, cost-to-revenue ratio and marginal cost, to reflect banks' costs. I can find positive and significant coefficients of revenue diversification (in columns 1 and 4) and overall diversification (in columns 3 and 6) on these two cost measures, suggesting that banks tend to have a higher proportion of cost in revenues and greater marginal cost as their services become diverse among interest income and different types of non-traditional income-generating activities. Such positive association between diversification and banks' costs is consistent with the study of Wu et al. (2020) that shows a negative association of income diversification with banks' cost efficiency. I do not find consistent significant coefficients of non-interest income diversification on banks' cost indicators (in columns 2 and 5), which may suggest that the changes in banks' costs are more subject to diversification *between* interest and non-interest activities than that *within* non-interest income-generating activities.

With regard to control variables, I find that bank size is positively associated with banks' market power in Table 4.4, which indicates that larger banks tend to have higher market power. The significant positive coefficient of capital ratio indicates that well-capitalized banks have greater power. The positive and significant coefficient of ROA shows that banks can gain market power from greater profits. Cost-to-income ratio and fixed asset ratio are both negatively related to market power, suggesting that higher costs incurred from banks' total operating activities and long-term investments may hinder banks' market power.

Table 4.5. The relationship between diversification and banks' cost profile

Dependent Variables	Cost-to-Revenue Ratio			Marginal cost (MC)		
	(1)	(2)	(3)	(4)	(5)	(6)
RD	0.174***			0.0101**		
	(0.0237)			(0.00487)		
ND		0.0138			-0.00359**	
		(0.00853)			(0.00179)	
OD			0.154***			0.0156***
			(0.0211)			(0.00391)
Controls	YES	YES	YES	YES	YES	YES
No. of Obs	134,896	134,778	134,896	133,753	133,724	133,753
R-squared	0.098	0.102	0.098	0.116	0.117	0.116
No. of banks	10,081	10,078	10,081	9,991	9,991	9,991
Bank fixed effect	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES

Note: This table presents the regression results on the relationship between diversification and banks' cost profile. The dependent variables are cost-to-revenue ratio and marginal cost. Specifications (1) and (4) use bank revenue diversification measure (*RD*), specifications (2) and (5) use non-interest income diversification (*ND*), and specifications (3) and (6) use bank overall diversification measure (*OD*) as the main independent variables. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. ** and *** indicate statistical significance at 5% and 1% levels, respectively.

4.5.3 The relationship between diversification and banks' market power in loan and deposit markets

Table 4.6 shows the results on the relationship between diversification and banks' market power in loan and deposit markets, respectively. I find consistent statistically significant results as in my baseline model that uses the Lerner Index as the indicator of market power. There exists an inverse U-shaped relationship between diversification and banks' market power in both loan and deposit markets. When the degree of bank diversification is within a specific range, banks with greater diversification level in their activities tend to have higher market power in loan and deposit markets. However, banks' market power in loan and deposits markets is eroded when the degree of bank diversification goes beyond a certain level. I can follow similar reasoning as that used in Section 4.5.1 to explain the results concerning the overall market power.

Table 4.6. The relationship between diversification and banks' market power in lending and funding markets

Dependent Variables:	Lerner Index for loans						Lerner Index for deposits					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
RD	-0.110***	0.0437**					-2.221***	14.42***				
	(0.00799)	(0.0214)					(0.463)	(1.241)				
RD^2		-0.297***						-32.08***				
		(0.0429)						(2.579)				
ND			0.0198***	0.0432***					0.930***	1.820***		
			(0.00339)	(0.0138)					(0.169)	(0.593)		
ND^2				-0.0318**						-1.210*		
				(0.0159)						(0.690)		
OD					-0.110***	0.0441**					-3.496***	14.42***
					(0.00702)	(0.0187)					(0.372)	(1.085)
OD^2						-0.271***						-31.43***
						(0.0336)						(1.941)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
No. of Obs	122,634	122,634	122,612	122,612	122,634	122,634	122,614	122,614	122,592	122,592	122,614	122,614
R-squared	0.882	0.882	0.881	0.881	0.882	0.882	0.544	0.548	0.544	0.544	0.545	0.553
No. of banks	9,947	9,947	9,947	9,947	9,947	9,947	9,946	9,946	9,946	9,946	9,946	9,946
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table presents the regression results from the baseline model on the relationship between diversification and banks' market power. The dependent variables are the Lerner Index in the lending and funding markets, respectively. Specifications (1), (2), (7) and (8) use bank revenue diversification measure (*RD*), specifications (3), (4), (9) and (10) use non-interest income diversification (*ND*), and specifications (5), (6), (11) and (12) use bank overall diversification measure (*OD*) as the main independent variables. In order to investigate the potential non-linear relationship between bank diversification and market power, I construct the quadratic terms, RD^2, ND^2 and OD^2 for these three forms of bank diversification measures. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. ** and *** indicate statistical significance at 5% and 1% levels, respectively.

4.5.4 How bank size affects the relationship between diversification and banks' market power

Table 4.7 presents the results on the relationship between diversification and banks' market power for small and large banks. I divide the whole sample into two groups by the median value of average of total assets (ATA) of each panel group over time: small banks (ATA<$174.766 millions) and large banks (ATA>$174,766 millions). I note a significant inverse U-shaped relationship in the group of large banks based on the results in columns (8), (10) and (12). However, in the group of small banks, I do not find significant coefficients for both the linear and quadratic terms of diversification variables as shown in columns (2), (4) and (6). This indicates that my previously observed inverse U-shaped relationship for the whole sample is dominated by large banks, which implies that the market power of banks with different sizes could respond differently to their diversification activities. Compared with small banks, large banks tend to have better capabilities for managing relatively complex diversification activities, so large banks typically get involved in non-traditional activities to a deeper extent. This would make large banks more subject to changes in revenues and costs induced from newly engaged-in activities, and the reactions in terms of market power are much more pronounced for large banks.

Table 4.7. The relationship between diversification and banks' market power for small and large banks

	Dependent Variable: Lerner Index											
	Small Banks						Large Banks					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
RD	-0.0902***	0.0439					-0.0490***	0.209***				
	(0.0114)	(0.0343)					(0.0107)	(0.0309)				
RD^2		-0.274***						-0.476***				
		(0.0689)						(0.0543)				
ND			0.00607	0.0310					-0.00177	0.0538***		
			(0.00491)	(0.0190)					(0.00407)	(0.0134)		
ND^2				-0.0333						-0.0772***		
				(0.0226)						(0.0174)		
OD					-0.0902***	0.0310					-0.0569***	0.172***
					(0.0104)	(0.0300)					(0.00962)	(0.0262)
OD^2						-0.229***						-0.381***
						(0.0551)						(0.0416)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	60,165	60,165	60,139	60,139	60,165	60,165	62,932	62,932	62,925	62,925	62,932	62,932
R-squared	0.333	0.334	0.331	0.331	0.334	0.334	0.378	0.381	0.378	0.378	0.379	0.382
No. of banks	4,971	4,971	4,970	4,970	4,971	4,971	5,020	5,020	5,020	5,020	5,020	5,020
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table presents the regression results on the relationship between diversification and banks' market power based on two subsamples that include small and large banks, respectively. Specifications (1)-(6) and (7)-(12) correspond to the results for small and large banks, respectively. The dependent variable is the Lerner Index that captures banks' market power, which is calculated as the divergence between bank price of output and marginal cost divided by the price of output. Specifications (1), (2), (7) and (8) use bank revenue diversification measure (*RD*), specifications (3), (4), (9) and (10) use non-interest income diversification (*ND*), and specification (5), (6), (11) and (12) use bank overall diversification measure (*OD*) as the key independent variables. To investigate the potential non-linear relationship between diversification and banks' market power, I construct the quadratic terms, RD^2, ND^2 and OD^2 for these three forms of bank diversification measures. All regressions are controlled at bank-specific level. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. *** indicate statistical significance at 1% level.

4.6 Robustness check

4.6.1 Alternative bank diversification measures

I consider four alternative bank diversification measures to examine whether or not my findings hold for other dimensions of bank diversification. The first alternative diversification measure is income diversity (*ID*), which refers to diversification *across* different sources of bank incomes and the second one is asset diversity (*AD*), which measures diversification across different types of bank assets (Laeven and Levine, 2007). The third alternative diversification measure is deposit diversification (*DD*), which shows diversification across different types of deposits. The fourth alternative diversification measure is loan diversification (*LD*), which represents the degree of diversification among different types of loans. These four alternative diversification measures are calculated as follows:

$$Income\ Diversity_{i,t} = 1 - \left|\frac{Net\ Interest\ Income_{i,t}\text{-}Other\ Operating\ Income_{i,t}}{Total\ Operating\ Income_{i,t}}\right| \quad (4.17)$$

$$Asset\ Diversity_{i,t} = 1 - \left|\frac{Net\ Loans_{i,t}\text{-}Other\ Earning\ Assets_{i,t}}{Total\ Earning\ Assets_{i,t}}\right| \quad (4.18)$$

$$Deposit\ Diversification_{i,t} = 1 - \left[\left(\frac{CUSD_{i,t}}{DEPOSIT_{i,t}}\right)^2 + \left(\frac{BANKD_{i,t}}{DEPOSIT_{i,t}}\right)^2 + \left(\frac{OTHED_{i,t}}{DEPOSIT_{i,t}}\right)^2\right] \quad (4.19)$$

$$Loan\ Diversification_{i,t} = 1 - \left[\left(\frac{MTG_{i,t}}{LOAN_{i,t}}\right)^2 + \left(\frac{CUSL_{i,t}}{LOAN_{i,t}}\right)^2 + \left(\frac{CORL_{i,t}}{LOAN_{i,t}}\right)^2 + \left(\frac{OTHEL_{i,t}}{LOAN_{i,t}}\right)^2\right] \quad (4.20)$$

where $DEPOSIT = CUSD+BANKD+OTHED$, *CUSD* is customer deposit, *BANKD* is deposit from banks and *OTHED* is other deposits and short-term borrowing. $LOAN = MTG+CUSL+CORL+OTHEL$, *MTG* are mortgages, *CUSL* are customer loans, *CORL* are corporate loans and *OTHEL* are other loans.

Table 4.8 presents the results by using the four alternative diversification measures as independent variables. Although these four measures capture bank diversification from different perspectives, I can find consistent results to support the existence of the inverse U-shaped relationship between diversification and banks' market power according to the results in columns (1) and (9) that use *ID* and in columns (3) and (11) that employ *DD* as diversification measures.[32] However, I do not find consistent results with my main findings in the remaining regressions. This could be due to the different natures of these diversification measures. Among the four alternative diversification measures, *ID* is the closest one in terms of nature to *RD* and *OD* used in my baseline regressions, so I find consistent results using *ID*. As for *AD*, *DD*, and *LD*, these three indicators typically capture the degree of diversification from the perspective of banks' assets and liabilities, which produce different results from those using revenue-based diversification measures.

[32] The consistent results are based on the regressions that use the Lerner Index and Lerner Index for deposits as dependent variables.

Table 4.8. Robustness Check: Using alternative diversification measures

Dependent Variables	Lerner Index				Lerner Index for loans				Lerner Index for deposits			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ID	0.0230**				-0.0154				4.348***			
	(0.0116)				(0.0115)				(0.659)			
ID^2	-0.0730***				-0.0707***				-7.606***			
	(0.0131)				(0.0140)				(0.818)			
AD		-0.0665***				0.0720***				-0.778*		
		(0.00872)				(0.00898)				(0.452)		
AD^2		0.0201***				0.000978				-0.595		
		(0.00697)				(0.00728)				(0.389)		
DD			0.0224**				-0.116***				3.467***	
			(0.0110)				(0.0133)				(0.501)	
DD^2			-0.0829**				0.234***				-8.108***	
			(0.0330)				(0.0502)				(1.485)	
LD				0.0394				0.0371				-3.673
				(0.0343)				(0.0478)				(2.760)
LD^2				0.00919				-0.0456				5.906**
				(0.0321)				(0.0436)				(2.536)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
No. of Obs	123,097	123,124	123,012	122,728	122,634	122,688	122,604	122,569	122,614	122,668	122,584	122,549
R-squared	0.361	0.364	0.360	0.362	0.882	0.884	0.881	0.881	0.548	0.545	0.544	0.544
No. of banks	9,991	9,991	9,980	9,957	9,947	9,947	9,947	9,947	9,946	9,946	9,946	9,946
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table presents the regression results of robustness check by using four alternative diversification measures. The dependent variables are three different specifications of the Lerner Index that captures banks' market power, which is calculated as the divergence between bank price of output and marginal cost divided by the price of output. Columns (1)-(4), (5)-(8), and (9)-(12) correspond to the regressions that use Lerner Index, Lerner Index for loans, and Lerner Index for deposits, respectively. Specifications (1), (5) and (9) use bank income diversity (*ID*), specifications (2), (6) and (10) use asset diversity (*AD*), specifications (3), (7) and (11) use deposit diversification (*DD*), and specifications (4), (8) and (12) use loan diversification (*LD*) as the key independent variables. To investigate the potential non-linear relationship between diversification and banks' market power, I construct the quadratic terms, ID^2, AD^2, DD^2 and LD^2 for these alternative four bank diversification measures. All regressions are controlled at the bank-specific level. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

4.6.2 Instrumental variable analysis

My results may be subject to endogeneity as are most empirical studies in this field. Banks' decision on diversification is endogenous since there could be some omitted variables that affect both diversification choices and banks' market power. In addition, the choice of diversifying activities could also be affected by banks' market power. There exists the possibility that banks with strong market power may be less likely to engage in diversification to seek new sources of revenues because these banks can reap enough profits relying on their monopoly power in pricing from traditional lending activities.

To mitigate the endogeneity issue, I first employ the fixed effects estimators to simultaneously control for unobserved time-invariant bank-specific characteristics. Relevant results have been reported in the baseline model regressions (see Table 4.4). Second, I include lagged diversification variables in the baseline model regressions, which could partly address the potential issue of reverse causality. Third, in this section, I employ the instrumental variable approach using the two-stage least squares (2SLS) estimator to check whether my findings hold.[33]

In my 2SLS regressions, I construct the instrument for diversification by taking the difference between banks' cost efficiency in each particular year and the averaged cost efficiency of all banks in the market in the same period. Banks' cost efficiency reflects how close a bank is from achieving the minimum cost given a particular level of inputs and outputs (Farrell, 1957; Berger and DeYoung, 1997), which is potentially related to the bank's diversification decision.[34] This is because banks with higher cost efficiency may have better capability of

[33] I also consider employing the Generalized Method of Moments (GMM) to mitigate the endogeneity issue. However, the result of the Sargan test that is run to check the validity of the instruments considered does not support the use of the GMM estimator with the particular instruments tested.

[34] Detailed steps in the calculation of the banks' cost efficiency are presented in the Appendix.

managing resources among multiple businesses and controlling the necessary costs in operations of diversified activities. Then I conduct the Durbin-Wu-Hausman (DWH) test (Durbin, 1954; Wu, 1973; Hausman, 1978) to check the existence of an endogeneity problem. According to the statistics of the DWH test reported in Tables 4.9, 4.10 and 4.11, I do reject the null hypothesis that the potential endogenous variables are exogenous at the 5% confidence level, suggesting that my original results may be subject to an endogeneity problem. To verify the relatedness of the instrumental variable (IV) with diversification, I use the *F-statistics* in the first stage of the 2SLS regressions to test the hypothesis that the coefficients of instrumental variables are zero (Angrist and Pischke, 2008).[35] According to the results shown in Tables 4.9, 4.10 and 4.11, I find the values of the *F-statistics* are higher than their relevant critical values, which rejects the null hypothesis that the coefficients of instruments are zero and supports the validity of the instrument. In addition, for most regression results, the negative and positive significant coefficients for the linear and quadratic terms of IV respectively imply that the IV is positively associated with bank diversification in a certain range. Since the IV for each bank-year observation includes the information on cost efficiency of all banks in the market, I can assume that this IV has no direct relation with the market power and other unobserved factors specific for each bank. I also calculated the correlations of cost efficiency with three forms of banks' market power measures (Lerner Index, Lerner Index for loans and Lerner Index for deposits), and their associated correlation values are 0.2484, 0.1381 and 0.2174, respectively. These values indicate relatively low correlations between the instruments and dependent variables, which suggests a low possibility that my instruments affect market power directly. According to the 2SLS regression results reported in columns (2), (4), (6) in Tables 4.9, 4.10

[35] According to Stock and Watson (2003), the IV estimates will be biased if the endogenous variable and its instrumental variable are weakly correlated.

and 4.11, I find a consistent inverse U-shaped relationship between diversification and banks' market power.

Table 4.9. Robustness Check: Using the instrumental variable approach for banks' overall market power

Dependent Variable	**Lerner Index**					
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A-First Stage			
IV	-0.9752***	-1.3738***	0.0630***	-0.1327***	-1.1111***	-1.4994***
	(0.0052)	(0.0101)	(0.0081)	(0.0174)	(0.0059)	(0.0114)
IV^2		3.8978***		1.9138***		3.7967***
		(0.0933)		(0.1667)		(0.1066)
Controls	YES	YES	YES	YES	YES	YES
Observations	132,477	132,477	132,471	132,471	132,477	132,477
F-statistics	9499.58	9611.09	221.07	202.12	9354.77	9489.80
			Panel B-Second Stage			
RD	-0.0731***	3.826***				
	(0.0114)	(0.607)				
RD^2		-7.755***				
		(1.222)				
ND			1.132***	3.027***		
			(0.211)	(0.793)		
ND^2				-4.781***		
				(1.494)		
OD					-0.0641***	1.425***
					(0.0100)	(0.160)
OD^2						-2.709***
						(0.301)
Controls	YES	YES	YES	YES	YES	YES
Observations	132,477	132,477	132,471	132,471	132,477	132,477
DWH test	512.518	273.146	37.6184	45.284	528.85	285.286
	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)

Note: This table presents the regression results of robustness check by using the instrumental variable approach. Panel A and Panel B present the results of the first and second stages, respectively. The dependent variable is the Lerner Index that captures banks' market power, which is calculated as the divergence between bank price of output and marginal cost divided by the price of output. *IV* is the instrument for diversification that is calculated as the difference between banks' cost efficiency and the average of cost efficiency of all banks in the market. Specifications (1) and (2) use bank revenue diversification measure (*RD*), specifications (3) and (4) use non-interest income diversification (*ND*), and specifications (5) and (6) use bank overall diversification measure (*OD*) as the main independent variables. To investigate the potential non-linear relationship between bank diversification and market power, I construct the quadratic terms, RD^2, ND^2 and OD^2 for these three forms of bank diversification measures. The F-statistics in the first-stage of the 2SLS regressions is to test the hypothesis that the coefficients of the instrumental variables are zero. The Durbin–Wu–Hausman (DWH) test is to check the existence of endogeneity. All regressions are controlled at bank-specific level. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. *** indicate statistical significance at the 1% level.

Table 4.10. Robustness Check: Using the instrumental variable approach for banks' market power in the lending market

Dependent Variable	Lerner Index for loans					
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A-First Stage			
IV	-0.9789***	-1.3652***	0.0650***	-0.1429***	-1.1157***	-1.4880***
	(0.0052)	(0.0100)	(0.0081)	(0.0174)	(0.0058)	(0.0112)
IV^2		3.7927***		2.0419***		3.6547***
		(0.0915)		(0.1610)		(0.1040)
Controls	YES	YES	YES	YES	YES	YES
Observations	132,274	132,274	132,268	132,268	132,274	132,274
F-statistics	9773.21	9669.99	216.71	200.86	9659.45	9549.17
			Panel B-Second Stage			
RD	-.4911117***	11.10***				
	(.0121625)	(1.482)				
RD^2		-23.05***				
		(2.968)				
ND			7.405***	26.70***		
			(0.902)	(5.388)		
ND^2				-47.14***		
				(10.58)		
OD					-0.431***	3.928***
					(0.0106)	(0.374)
OD^2						-7.922***
						(0.690)
Controls	YES	YES	YES	YES	YES	YES
Observations	132,274	132,274	132,268	132,268	132,274	132,274
DWH test	3417.88	1727.27	1657.07	854.716	3460.64	1805.43
	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)

Note: This table presents the regression results of robustness check by using the instrumental variable approach. Panel A and Panel B present the results of the first and second stages, respectively. The dependent variable is the Lerner Index for loans. *IV* is the instrument for diversification that is calculated as the difference between banks' cost efficiency and the average of cost efficiency of all banks in the market. Specifications (1) and (2) use bank revenue diversification measure (*RD*), specifications (3) and (4) use non-interest income diversification (*ND*), and specifications (5) and (6) use bank overall diversification measure (*OD*) as the main independent variables. In order to investigate the potential non-linear relationship between bank diversification and market power, I construct the quadratic terms, RD^2, ND^2 and OD^2 for these three forms of bank diversification measures. The F-statistics in the first-stage of the 2SLS regressions is to test the hypothesis that the coefficients of the instrumental variables are zero. The Durbin–Wu–Hausman (DWH) test is to check the existence of endogeneity. All regressions are controlled at bank-specific level. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. *** indicate statistical significance at the 1% level.

Table 4.11. Robustness Check: Using the instrumental variable approach for banks' market power in the deposit market

Dependent Variable	**Lerner Index for deposits**					
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A-First Stage			
IV	-0.9789***	-1.3652***	0.0650***	-0.1429***	-1.1157***	-1.4880***
	(0.0052)	(0.0100)	(0.0081)	(0.0174)	(0.0058)	(0.0112)
IV^2		3.7927***		2.0419***		3.6547***
		(0.0915)		(0.1667)		(0.1040)
Control variables	YES	YES	YES	YES	YES	YES
Observations	132,274	132,274	132,268	132,268	132,274	132,274
F-statistics	9773.21	9669.99	216.71	200.86	9659.45	9549.17
			Panel B-Second Stage			
RD	-18.55***	234.7***				
	(0.352)	(34.95)				
RD2		-503.5***				
		(70.07)				
ND			279.3***	1,091***		
			(34.84)	(231.0)		
ND2				-1,985***		
				(453.0)		
OD					-16.28***	72.91***
					(0.302)	(8.340)
OD2						-162.1***
						(15.44)
Control variables	YES	YES	YES	YES	YES	YES
Observations	132,274	132,274	132,268	132,268	132,274	132,274
DWH test	220.123	123.719	2882.2	1568.23	122.476	85.2843
	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)	(p = 0.0000)

Note: This table presents the regression results of robustness check by using the instrumental variable approach. Panel A and Panel B present the results of the first and second stages, respectively. The dependent variable is the Lerner Index for deposits. *IV* is the instrument for diversification that is calculated as the difference between banks' cost efficiency and the average of cost efficiency of all banks in the market. Specifications (1) and (2) use bank revenue diversification measure (*RD*), specifications (3) and (4) use non-interest income diversification (*ND*), and specifications (5) and (6) use bank overall diversification measure (*OD*) as the main independent variables. To investigate the potential non-linear relationship between bank diversification and market power, I construct the quadratic terms, RD^2, ND^2 and OD^2 for these three forms of bank diversification measures. The F-statistics in the first-stage of the 2SLS regressions is to test the hypothesis that the coefficients of the instrumental variables are zero. The Durbin–Wu–Hausman (DWH) test is to check the existence of endogeneity. All regressions are controlled at bank-specific level. Robust standard errors are reported in parentheses below the coefficient estimates and are clustered at the bank level. *** indicate statistical significance at the 1% level.

4.7 Conclusions

This chapter investigates the relationship between diversification and banks' market power, which fills the gap in the literature that no prior study addresses the question about whether diversification is a determinant or source of banks' market power. Based on a large sample of U.S. banks over the period from 1991 to 2017, I find an inverse U-shaped relationship between diversification and banks' market power, which suggests that the relationship between diversification and banks' market power is conditional on the degree of bank diversification. When the level of diversification increases within a certain range, banks can increase their market power by engaging in more diversified activities. However, when diversification reaches a relatively high level, banks' market power can be weakened due to greater costs incurred from much more complex activities. In addition, the results are consistent for banks' market power in both lending and funding markets. This inverse U-shaped relationship is much more pronounced for large banks than for small banks, which indicates that this observed relationship is dominated by large banks. I also run robustness tests by taking into account alternative diversification measures and employing the instrumental variable approach to mitigate the potential endogeneity issue between diversification and banks' market power. The results of the robustness check remain consistent. The findings in this study provide important implications for bank managers, regulators, and policymakers. For bank managers, this study provides information on a potential source or determinant of banks' market power, which means that it is advisable for banks to proactively manage market power through properly engaging in diversifying their activities. For regulators and policymakers, this study helps them to better understand the potential influence of bank diversification across diverse business lines on the microstructure of the banking market.

Chapter 5: Market diversification and the competition-bank stability nexus

5.1 Introduction

Due to the importance of competition to the stability of the financial system, the relationship between competition and bank stability has been extensively explored in the literature. The literature shows mixed findings on the competition-stability nexus,[36] which includes competition-stability views (Boyd and De Nicoló, 2005; Schaeck, Čihák and Wolfe, 2009; Anginer, Demirgüç-Kunt and Zhu, 2014a), competition-fragility views (Keeley, 1990; Allen and Gale, 2004; Beck, Demirgüç-Kunt and Levine, 2006), and non-linear competition-stability relationships (Martinez-Miera and Repullo, 2010; Jiménez, Lopez and Saurina, 2013). The existence of mixed conclusions indicates the necessity of new evidence to further discuss the potential mechanisms behind the relationship between competition and bank stability.

In line with the influence of competition, the literature also suggests that diversification is an important factor in influencing bank stability (DeYoung and Roland, 2001; Stiroh and Rumble, 2006; Wagner, 2010; DeYoung and Torna, 2013). The degree of diversification in banking reflects the scope of activities that banks are allowed to engage in and the extent to which banks can generate revenues from different financial services.[37] However, little is known so far

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[36] The term 'competition-stability nexus' in this chapter only refers to the general relationship between competition and bank stability, and it should not be confused with expressions such as 'competition-stability' or 'competition-fragility' views that highlight the positive or negative relationship between competition and bank stability.

[37] The scope of banking activities typically changes according to financial regulations. For example, the Second Banking Directive of 1989 allowed European banks to provide cross-frontier banking, insurance, and investment services throughout the European Community on a single licence from their home country authorities. The Gramm-Leach-Bliley Act of 1998 repealed part of the Glass-Steagall Act of 1933 in the aspect of banks' scope of activities, and U.S. banks were allowed to engage in non-traditional banking activities such as investment banking, venture capital, securities brokerage, insurance underwriting and asset securitization. In response to the 2008 global financial crisis, the U.S. passed the Dodd-Frank Act in order to strengthen the financial regulations. Implemented as part of the Dodd-Frank Act, the Volcker Rule proposed the prohibitions on banks' speculative investments, especially bank proprietary trading.

regarding whether diversification is associated with competition in the process of determining bank stability. Investigating the associations between competition and diversification helps in understanding whether competition may have a different impact on bank stability under different degrees of diversification in the market. Moreover, such investigation may have important policy implications for the necessity of having interventions in the diversification strategy of banks to counteract possible negative influences on bank stability resulting from greater competition in the market. This study is motivated by this gap in the literature and aims to provide new empirical evidence regarding the role of diversification on the competition-bank stability nexus.

This chapter contributes to the literature in three aspects. First, this work examines the role of market diversification in the competition-stability nexus in the dimensions of both individual bank and systemic stability, which differentiates my study from previous research that only considers one dimension of bank stability (Berger, Klapper and Turk-Ariss, 2009; Anginer, Demirgüç-Kunt and Zhu, 2014a; Schaeck and Čihák, 2014). This investigation is important to reconcile the mixed conclusions regarding the competition-stability nexus in the literature by considering the potential changing associations between competition and bank stability conditional on different degrees of diversification in the market. Moreover, taking into account both individual bank and systemic risks helps to investigate whether the potential relationships equally hold in different dimensions of banks' risk-taking behaviours when responding to changes in the degree of bank competition.

Second, this chapter proposes a novel market-level bank diversification measure[38] and defines diversification from the perspective of the market. Building up the market-level diversification

[38] I build up the diversification indicator at the market level in this chapter, which is different from the country-level diversification indicators (used in Chapters 2 and 3). The former is calculated based on the information on a bank and its competitors in a specific market while the latter is computed using the information on all banks in a country.

measure serves as a supplement to the bank-level diversification measure (Laeven and Levine, 2007; Mercieca, Schaeck, and Wolfe, 2007) and provides a new perspective on showing the degree of diversification in a specific market that banks operate. Given that banks with different strategies in diversification are simultaneously operating in a same market, there are variations in the degree of diversification at the bank level. However, there is a lack of a diversification measure in the literature to reflect the whole environment of diversification that is jointly determined by diversification activities of all participants in the market. Hence, the market-level diversification indicator reflects the degree of diversification in banks' activities considering both an individual bank and its competitors, which extends the scope of information inherent in the diversification indicator and enables me to examine how banks' risk will respond to outside environment factors such as competition and diversification. To construct my market diversification indicator, I firstly identify the market in which each bank and its competitors operate by using the geographical information regarding banks' branches or subsidiaries. Second, for each bank-year observation, the corresponding market diversification measure can be calculated by taking the sum of each component of revenues of all banks that have branches/subsidiaries/headquarters in its corresponding market identified in the first step.

Third, this research contributes to the literature by investigating whether market diversification is associated with bank competition. This can be seen as a key point in understanding the role of diversification in the relationship between competition and bank stability because banks may engage in diverse financial activities to seek new sources of revenue in responding to market competition and this process may influence banks' risk contributions in either their idiosyncratic or systemic risk. I employ the Boone Indicator to capture the degree of bank competition (Boone, 2008; Van Leuvensteijn et al., 2011; Tabak, Fazio, and Cajueiro, 2012; Schaeck and Čihák, 2014; Leon, 2015) and this relatively new competition measure has advantages in terms of theoretical foundation and practical application compared with other traditionally employed competition proxies such as the Lerner Index and the Panzar-Rosse H statistic (Leon, 2015). To capture the degree of diversification, I use the Herfindahl-Hirschmann Index-based diversification indicators including revenue, non-interest income and overall diversification measures, which are more informative in terms of showing the distribution among different types of revenues than ratio-based measures such as the non-interest income ratio and trading income ratio (Baele, De Jonghe, and Vennet, 2007; Lepetit et al., 2008a; DeYoung and Torna, 2013).

Through an analysis based on 467 publicly listed U.S. banks from 1994 to 2017, I find that the negative relationship between competition and systemic stability is exacerbated when the market diversification is high while this negative competition-systemic stability relationship turns to be positive when market diversification is at a low level. However, I do not find evidence of the existence of a significant interacting effect of diversification on the competition-individual bank stability relationship. Lastly, I find a positive association between competition and market diversification, which suggests that restrictions in banks' diversification activities in a competitive environment may help in maintaining systemic stability.

The remainder of this chapter is organized as follows. Section 5.2 presents an overview of different strands of the relevant literature. Section 5.3 introduces the data and measures, and Section 5.4 shows the methodology employed in this research. In Section 5.5, I report the empirical findings, followed by robustness tests in Section 5.6. Section 5.7 concludes and discusses the main implications of my study.

5.2 Literature review

5.2.1 Studies on the competition-stability nexus

Competition-stability views claim that greater competition enhances bank stability. Nalebuff and Stiglitz (1983) claim that more competition makes banks more comparable and transparent, hence promoting banks' efforts in conducting screening and monitoring in financial services they provide. Boyd and De Nicoló (2005) put forward the 'risk-shifting' mechanism according to which more competition in the bank loan and deposit market lowers loan rates, decreases borrowers' default risk, and thus improves bank stability. Schaeck, Čihák, and Wolfe (2009) find that competitive banking systems are less likely to have systemic crisis. Amidu and Wolfe (2013a) investigate how competition affects diversification and bank insolvency risk and find that competition increases bank stability due to banks' decisions to take diversified portfolios in response to the competitive environment. Although Amidu and Wolfe (2013a) are closely relevant to my research, they do not examine this relationship in dimension of bank systemic stability and only view diversification at the bank level. Anginer, Demirgüç-Kunt and Zhu (2014a) empirically investigate the relationship between competition and bank systemic risk in a global sample of banks and find that greater competition encourages banks to engage in more diversified risks, thus enhancing bank systemic stability. However, the study of Anginer, Demirgüç-Kunt and Zhu (2014a) does not employ specific measures to capture the level of diversification, and my study aims to fill this gap by building up a group of new measures to show the degree of diversification at the market level. Goetz (2018) examines the impact of removing entry barriers to the U.S. bank market and concludes that reducing entry barriers significantly enhances bank stability.

In contrast, competition-fragility views argue that more competition decreases bank stability. The charter value views state that bank competition generates stability cost and erodes bank margins and charter values, which in turn causes banks to engage in riskier loan portfolios and provide non-traditional services (Marcus, 1984; Keeley, 1990; Hellmann, Murdock, and Stiglitz, 2000). Allen and Gale (2000) find that more competition makes banks earn lower information rents from relationship lending, thus reducing their incentives for undertaking screening and monitoring activities. Allen and Gale (2004) claim that a competitive banking market is detrimental to systemic stability since banks have greater exposure to contagions in a competitive market. Berger, Klapper, and Turk-Ariss (2009) show that greater bank competition leads to a greater risker portfolio, but this effect is reduced if banks increase their capital levels or use risk-mitigating techniques.

Other studies find non-linear relationships between bank competition and risk (Martinez-Miera and Repullo, 2010; Jiménez, Lopez and Saurina, 2013). To reconcile opposite findings on bank competition-stability nexus, Leroy and Lucotte (2017) investigate the competition-stability trade-off considering both individual bank and systemic dimensions of risk. Their results point towards opposite effects indicating that competition increases banks' overall individual risk while competition improves systemic stability by decreasing bank systemic risk.

5.2.2 Studies on the diversification-stability nexus

Deregulations in developed countries in the last decades have allowed banks to expand the scope of their revenue-generating activities. Some studies find that non-interest-generating activities, such as non-traditional fee-based activities, are associated with high volatilities and risks (DeYoung and Roland, 2001; Stiroh, 2004a; Stiroh, 2006; Stiroh and Rumble, 2006). Other researchers report different findings on the impact of diversification on bank stability (De Jonghe, 2010; Sanya and Wolfe, 2011; DeYoung and Torna, 2013). DeYoung and Torna (2013) argue that the impact of non-traditional activities on bank stability depends on the nature of bank activities. Asset-based non-traditional activities such as investment banking and securitization result in a higher probability of bank failures, whereas pure fee-based non-traditional activities such as brokerage positively affect bank performance. De Jonghe (2010) concludes that a diversity towards non-interest activities increases European banks' tail beta and decreases bank systemic stability. Focusing on small European credit institutions, Mercieca, Schaeck, and Wolfe (2007) find that there are no diversification benefits for small European banks and non-interest activities are negatively associated with bank performance. In contrast, some studies have found the risk-decreasing effect of diversification (Boyd, Graham, and Hewitt, 1993; Saunders and Walter, 1994). Sanya and Wolfe (2011) argue that diversification across and within bank interest and non-interest activities in emerging economies reduces bank insolvency risk. Wagner (2010) argues that diversification reduces a bank's individual probability of failure whereas it is more likely to cause systemic crisis.

Through reviewing the literature, we can see that the relationship between competition and bank diversification and the question on the role of market diversification on the competition-stability nexus in different dimensions of bank stability remains less discussed. My study attempts to answer these questions by providing new empirical evidence.

5.3 Data and measures

5.3.1 Data

This study builds up an unbalanced panel data set composed of 467 publicly listed U.S. banks covering the period from 1994 to 2017. I use annual bank-specific accounting information retrieved from BankFocus compiled by the Bureau van Dijk (BvD) to construct banks' competition and diversification indicators. To calculate bank systemic risk measures, I obtain daily banks' stock price information from CRSP and Datastream. I obtain the geographical information of U.S. banks from the Summary of Deposits (SoD) published by the Federal

Deposit and Insurance Corporation (FDIC) which provides detailed state-level information on the locations of branches or subsidiaries of U.S. banks. According to the SoD dataset, each branch or subsidiary has a unique number assigned by the Federal Reserve Board (FRB) and branches or subsidiaries affiliated to the same BHC or commercial bank are also assigned a unique number to their top regulatory institution, which allows me to identify the locations of an individual bank's all branches or subsidiaries operating in each state over the whole sample period.[39] I download the file PERMCO-RSSD links from the Banking Research Datasets compiled by the Federal Reserve Bank of New York to match the geographical information on states of operations from the SoD with the data obtained from other databases such as BvD BankFocus and CRSP.[40]

This study focuses on the U.S. because its banking market has a great presence in the banking market around the world. The data from BvD BankFocus indicates that the number of U.S. listed banks accounts for over 35% of the total number of listed banks in the world banking market and around 20% in terms of total assets over the last two decades.[41] Additionally, focusing on a single developed country helps in exploring the relationship between competition, diversification and bank stability under a relatively uniform market environment. The sample of this study consists of only publicly listed banks since we need market stock price data to measure bank systemic stability.

[39] The dataset of the Summary of Deposits includes the variables *RSSDID* representing the unique number assigned to each affiliated branch or subsidiary and *RSSDHCR* indicating the unique number assigned to the top regulatory banking institution.

[40] The file PERMCO-RSSD links is a dataset that connects regulatory identification numbers (RSSDID and RSSDHCR) assigned by the Federal Reserve Board to the permanent company number (PERMCO). The PERMCO is a unique number assigned to publicly listed institutions in CRSP.

[41] In terms of the number of banks, I find 1,821 U.S. listed banks and 3,164 non-U.S. listed banks recorded in the BvD BankFocus database. As for the proportion of U.S. listed banks' total assets, I take the average of proportions of the sum of U.S. listed banks' total assets in the sum of all BankFocus recorded listed banks' total assets in US dollars over the whole sample period.

5.3.2 Measure of bank competition

This chapter uses the Boone Indicator (Boone, 2008) to capture the degree of bank competition.[42] The Boone Indicator (*Boone*) is based on the efficient structure hypothesis that associates differences in bank efficiency with performance, suggesting that more efficient banks (banks with lower marginal costs) make higher profits or enjoy greater market shares at the expense of their less efficient counterparties (Demsetz, 1973). This argument is consistent with the industrial organization literature according to which competition promotes the reallocation of profits towards efficient firms (Olley and Pakes, 1996), which is confirmed by Stiroh (2000) in banking studies. In a theoretical work, Boone (2008) claims that the reallocation effect is monotonically increasing with the level of bank competition, so this measure captures the varying degree of bank competition. Van Leuvensteijn et al. (2011) are the first to apply this measure in an empirical banking study, and the Boone Indicator continues to be employed in this field (Tabak, Fazio, and Cajueiro, 2012; Schaeck and Čihák, 2014; Leon, 2015).

Compared with other competition measures, the Boone Indicator has two main advantages. On the one hand, the Boone Indicator is constructed based on strong theoretical foundations and captures the degree of bank competition through both the fall in entry barriers and more aggressive interactions between banks. On the other hand, this indicator can measure competition for specific product markets and different types of banks. To compute the Boone

[42] Other popular competition measures used in previous studies include concentration, the Lerner Index, and the Panzar-Rosse H Statistics. Concentration ratio has been criticized as a valid competition measure by Beck, Demirguc-Kunt and Levine (2006). The Lerner Index captures the degree of bank competition from the perspective of a bank's profits resulting from its pricing power in the market. The premise for this measure is that a bank's output price equals its marginal cost under a perfect competitive situation, and the output price rises above marginal cost as a bank's market power grows. Although the Lerner Index has been widely used as a bank competition measure in previous banking studies (Fernández de Guevara, Maudos, and Pérez, 2007; Berger, Klapper and Turk-Ariss, 2009; Demirgüç-Kunt and Martinez-Peria, 2010; Beck, De Jonghe, and Schepens, 2013; Amidu and Wolfe, 2013a, 2013b; Anginer, Demirguc-Kunt and Zhu, 2014b), it mainly reflects a bank's market power. Intuitively, it is less appropriate to use a bank-level indicator to reflect a macro-level concept such as 'bank competition'. The implementation of the Panzar-Rosse H Statistics generally requires the assumption that the market stays in equilibrium, which is not necessarily true in empirical banking studies.

Indicator, I follow Tabak, Fazio, and Cajueiro (2012) and Schaeck and Čihák (2014) and include time dummies to allow for the time evolution of the level of competition. The calculation is as follows:

$$ln\left(\pi_{i,t}\right) = \alpha_i + \sum_{t=1}^{T} \beta_t d_t \, ln\left(c_{i,t}\right) + \sum_{t=1}^{T-1} \gamma_t d_t + \varepsilon_{i,t} \quad (5.1)$$

where π is the return on assets and c denotes the average costs for bank i in year t which is calculated as a ratio of operating cost to banks' total income, and cost components include interest, staff, administration and other operating expenses. β_t is the time-dependent Boone Indicator. d_t are the time dummies where d_t is equal to 1 in year t and 0 otherwise. T denotes the total number of years and $\varepsilon_{i,t}$ is the error term. Since the original form of the Boone Indicator is inversely proportional to the degree of bank competition (the more negative the Boone Indicator, the higher degree of competition), in each year, I multiply β_t by -1 to make this indicator directly proportional to bank competition.

5.3.3 Measures of bank stability

5.3.3.1 Individual stability

I use two individual bank stability measures: Z-Score and Distance-to-Default. The *Z-Score* (*Z-Score*) is an accounting-based bank stability measure and are used in previous banking studies (Laeven and Levine, 2009; Beck, De Jonghe, and Schepens, 2013; Ijtsma, Spierdijk, and Shaffer, 2017). The *Z-Score* can be interpreted as the number of standard deviations by which banks' realized returns have to decrease from their mean to wipe out all banks' equity (Boyd and Runkle, 1993). A high *Z-Score* implies a low probability of bank insolvency and a high degree of individual bank stability. The *Z-Score* is computed at the bank level as follows:

$$Z\text{-}Score_{i,t} = \frac{ROA_{i,t} + \frac{E_{i,t}}{A_{i,t}}}{\sigma(ROA_{i,t})} \quad (5.2)$$

where ROA is the return on assets for bank i at time t. E/A represents the equity to asset ratio. I use a three-year rolling time window, rather than the whole sample period, to compute the standard deviation of return on assets, $\sigma(ROA)$, to allow for time variations in the denominator of the *Z-Score*. This approach avoids that the variations in *Z-Score* within banks over time are exclusively driven by the variations in the levels of capital and profitability (Schaeck and Čihák, 2010). I take the natural logarithm of *Z-Score* to mitigate the influence from the high skewedness of this measure.

Alternatively, I use a market-based bank stability measure, the distance-to-default (*DtD*), to measure the default risk of a bank. The *DtD* is defined as the difference between the market value of assets of a firm and the face value of its debt, divided by the standard deviation of the firm's market asset values (Merton, 1974). Thus, a high *DtD* means that a bank keeps a long distance away from the default point and that the bank has a low probability of default. The market value of a firm's equity is modelled as a call option on the firm's assets.

$$DtD_{i,t} = \frac{ln\left(\frac{V_{A\ i,t}}{X_{i,t}}\right)+\left(\mu-\frac{\sigma^2_{A\ i,t}}{2}\right)T}{\sigma_{A\ i,t}\sqrt{T}} \quad (5.3)$$

where V_A is the bank's assets value, X is the book value of bank's debt that matures at time T. μ is the expected return and σ_A is the standard deviation of bank assets. In practice, the estimation of the *DtD* faces great difficulties in calculating the bank's asset value (V_A) and its associated parameters (Duan and Wang, 2012). Different estimation methodologies are implemented in the literature to estimate bank asset value.[43] This chapter retrieves the data on

[43] Methodologies include Campbell, Hilscher, and Szilagyi (2008) that obtain asset values and asset volatility by solving option-based equations simultaneously, the Moody's KMV approach introduced by Crosbie and Bohn (2003), the total asset value proxy approach described by Brockman and Turtle (2003) and other relevant approaches.

banks' *DtD* directly from the Credit Research Initiative (CRI) platform maintained by the National University of Singapore.[44]

5.3.3.2 Systemic stability

I use two measures to capture bank systemic risk: the marginal expected short-fall and the $\Delta CoVaR$. Proposed by Acharya et al. (2010, 2017), the marginal expected shortfall (*MES*) is used to measure a bank's contribution to systemic risk. *MES* is defined as the average of a bank's stock returns during the 5% worst trading days of the overall market return in a financial year. A high value of *MES* indicates a low bank's systemic risk contribution.[45] The *MES* for a given bank-year observation is calculated as follows:

$$MES_{i,t} = \frac{\sum R_i}{N_{worst\ days}} \quad (5.4)$$

where R_i denotes the daily stock return of bank *i* during the 5% market's worst trading days in year *t*. *N* is the number of 5% worst days of the market return. Following Bisias et al. (2012), I use the CRSP Value Weighted Index as the proxy for market return.

Alternatively, this chapter employs another systemic risk measure, the conditional value-at-risk ($\Delta CoVaR$), proposed by Adrian and Brunnermeier (2016). $\Delta CoVaR$ is constructed by computing the value-at-risk (*CoVaR*) of the banking system conditional on a financial institution being in distress. In this case, a bank's contribution to systemic risk is defined as the difference between the *CoVaR* of the banking market conditional on this bank being in distress and the banking market's *CoVaR* in the median state of this bank. The systemic risk contribution of bank i to the overall bank market *M* is defined as:

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[44] The platform Credit Research Initiative (CRI) can be accessed via the link https://www.rmicri.org. The estimation methodology implemented by this platform is the transformed-data maximum likelihood estimation approach proposed by Duan (1994).

[45] In this study, I keep the original form of the marginal expected shortfall (MES). Typically, it has a negative value and a low value captures a high systemic risk contribution.

$$\Delta CoVaR_q^{M|i} = CoVaR_q^{M|i} - CoVaR_{50\%}^{M|i} \quad (5.5)$$

where $CoVaR_q^{M|i}$ represents the *VaR* of banking system M when the asset returns of bank i are at the *qth* percentile, and $CoVaR_{50\%}^{M|i}$ denotes the *VaR* of the market returns conditional on the bank i being in its median state. The term $\Delta CoVaR_q^{M|i}$ captures how much a bank contributes to the overall systemic risk. The conditional market *CoVaR* is calculated as follows:

$$X_t^i = \alpha^i + \gamma^i M_{t-1} + \epsilon_t^i \quad (5.6)$$

$$X_t^M = \alpha^{M|i} + \beta^{M|i} X_t^i + \gamma^{M|i} M_{t-1} + \epsilon_t^{M|i} \quad (5.7)$$

where X_t^i is the growth rate of market-value total assets of bank i, and relevant data required are daily market-value total equity and quarterly book-value total assets and equity. The daily market-value data and quarterly book-value data have to be converted to a weekly frequency. X_t^M is the market capitalization weighted average of each bank's asset returns. M_{t-1} denotes a vector of lagged state variables that capture time variation in the conditional moments of asset returns. The state variables include weekly change of 3-month T-bill rate, term spread, market return (computed from S&P 500 return), and VIX (Chicago Board Options Exchange Volatility Index). The parameters α, β, and γ are estimated by using quantile regression on the weekly basis. The *CoVaR* of the banking system is computed by using the estimated parameters in the above equations:

$$VaR_t^i = \alpha^i + \gamma^i M_{t-1} \quad (5.8)$$

$$CoVaR_t^{M|i} = \alpha^{M|i} + \beta^{M|i} VaR_t^i + \gamma^{M|i} M_{t-1} \quad (5.9)$$

Δ*CoVaR* for bank i is calculated as:

$$\Delta CoVaR_t^i(q) = CoVaR_t^i(q) - CoVaR_t^i(50\%) = \beta^{M|i}[VaR_t^i(q) - VaR_t^i(50\%)] \quad (5.10)$$

In this study, I compute $\Delta CoVaR$ at both q=1% and q=5% levels to help with checking the robustness of my results.

5.3.4 Measures of diversification

In line with Mercieca, Schaeck, and Wolfe (2007) and Elsas, Hackethal, and Holzhäuser (2010), I build up three diversification measures to capture banks' diversification at both bank and market levels. Diversification measures are computed by constructing the Herfindahl-Hirschmann Index (*HHI*) based on bank accounting data.

5.3.4.1 Bank-level diversification measures

At the bank level, I build up three diversification measures, revenue diversification (*RD*), non-interest income diversification (*ND*) and overall diversification (*OD*), which captures bank diversification activities from different perspectives. The calculations of *RD*, *ND*, and *OD* have been introduced in Chapter 4. To avoid repetitions, I do not show details in computations of them in this chapter.

5.3.4.2 Market-level diversification measures

I further build up three new diversification measures, market-level revenue diversification (*MRD*), non-interest income diversification (*MND*) and overall diversification (*MOD*) to capture the degree of diversification in the overall banking market. Taking into account the impact of market-level diversification on the competition-stability nexus is one of this chapter's contributions since previous studies examine the effect of diversification only at the bank level. The construction of the market-level diversification measure serves as a supplement to the bank-level diversification measure and provides a new perspective of showing the whole environment of diversification in the market.

My motivation for constructing market-level bank diversification measures is based on the fact that banks with different degrees of diversification are simultaneously operating in the same market. In the existing literature, there is a lack of a diversification measure to reflect the degree of overall market diversification that is jointly determined by diversification activities of all participants in the market. Therefore, market-level diversification measures show the level of diversification in banks' activities considering both an individual bank and its competitors, which extends the scope of information inherent in the diversification indicator and allows me to investigate how banks' risk will respond to outside environment factors such as competition and diversification.

To construct banks' market-level diversification indicators, we need to define the scope of the market in which each bank and its competitors operate. Let S be the set of 50 U.S. states, and N be the set of all banks in the sample. For any $i \in N$, $S(i)$ is the set of states in which bank i operates. Bank j is *connected* to bank i, if $S(i) \cap S(j) \neq \emptyset$. I define $N(i)$ by the set of banks connected to bank i. That is, set $N(i)$ consists of bank i and its (direct) competitors, and bank j represents a particular bank in $N(i)$. Therefore, $N(i)$ can be viewed as the market in which bank i and its competitors are operating. In year t, for each form of diversification measure, bank i's market-level diversification measure can be constructed by taking the sum of each component of revenues of all banks that have branches/subsidiaries/headquarters in its corresponding market $N(i)$, with reference to the main approach of bank-level diversification measures introduced in Section 4.3.3. A high value of this new market-level indicator indicates a high market diversification level. The SoD dataset reports detailed information on states of operations for each bank over the whole sample period, which allows me to construct time-varying market-level diversification measures for a given bank. Based on the structure of bank-level diversification measures (Mercieca, Schaeck, and Wolfe, 2007; Laeven and Levine, 2007;

Elsas, Hackethal, and Holzhäuser, 2010), I calculate my market diversification indicators, *MRD*, *MND* and *MOD*, as follows:

$$MRD_{i,t} = 1 - \left[\left(\frac{\sum_{j \in N(i)} |INT_{j,t}|}{\sum_{j \in N(i)} |TOP_{j,t}|} \right)^2 + \left(\frac{\sum_{j \in N(i)} |NON_{j,t}|}{\sum_{j \in N(i)} |TOP_{j,t}|} \right)^2 \right] \quad (5.11)$$

$$MND_{i,t} = 1 - \left[\left(\frac{\sum_{j \in N(i)} |COM_{j,t}|}{\sum_{j \in N(i)} |NON_{j,t}|} \right)^2 + \left(\frac{\sum_{j \in N(i)} |TRD_{j,t}|}{\sum_{j \in N(i)} |NON_{j,t}|} \right)^2 + \left(\frac{\sum_{j \in N(i)} |OTOP_{j,t}|}{\sum_{j \in N(i)} |NON_{j,t}|} \right)^2 \right] \quad (5.12)$$

$$MOD_{i,t} = 1 - \left[\left(\frac{\sum_{j \in N(i)} |INT_{j,t}|}{\sum_{j \in N(i)} |TOP_{j,t}|} \right)^2 + \left(\frac{\sum_{j \in N(i)} |COM_{j,t}|}{\sum_{j \in N(i)} |TOP_{j,t}|} \right)^2 + \left(\frac{\sum_{j \in N(i)} |TRD_{j,t}|}{\sum_{j \in N(i)} |TOP_{j,t}|} \right)^2 + \left(\frac{\sum_{j \in N(i)} |OTOP_{j,t}|}{\sum_{j \in N(i)} |TOP_{j,t}|} \right)^2 \right]$$

(5.13)

All variables used to construct these market-level diversification measures are defined in Section 4.3.3.

5.3.5 Control variables

Following Demirgüç-Kunt, Laeven, and Levine (2004), Laeven and Levine (2009), and Berger, Klapper and Turk-Ariss (2009), I use several bank-specific control variables that possibly affect bank stability. These control variables include bank-level diversification indicators (*RD*, *ND*, and *OD*), bank size (*Bank Size*), capitalization (*Capitalization*), profitability (*ROA*), non-performing loans (*NPL*), and liquidity (*Liquidity*). *Bank Size* equals the natural logarithm of total bank assets in millions of U.S. dollars, and controls for the effect that larger banks expect to be more stable than smaller ones because of economies of scale in transaction costs, monitoring, and information management. *Capitalization* equals the equity to total asset ratio and is included considering the fact that better capitalized banks face lower bankruptcy costs and are less vulnerable to market shocks. *Profitability*, measured by return on assets ratio (*ROA*), is included to control for the possibility that less profitable banks seek revenues from riskier activities. *Liquidity*, measured by the ratio of bank liquid assets over bank deposits and short-term funding, is used to control for the risk from less liquid banks. I use the non-performing loans ratio (*NPL*) to control for bank credit risk since banks with bad quality of loan portfolio typically face higher probability of default. Table 5.1 presents the definitions of all variables used in this chapter.

Table 5.1. Definitions of Variables

Variables	Definitions
Bank stability measures	
Marginal expected shortfall (*MES*)	Bank systemic stability measure and is calculated as the average of a bank's stock return during the 5% worst trading days for the overall market return in one financial year (Acharya et al., 2017). *Source*: CRSP, Datastream, and authors' calculation.
ΔCoVaR (Δ*CoVaR*)	Alternative systemic risk measure that is defined as the difference between the CoVaR of the banking market conditional on this bank being in distress and the banking market's CoVaR in the median state of this bank (Adrian and Brunnermeier, 2016). *Source*: CRSP, Datastream, Compustat North America, and authors' calculation.
Z-Score (*Z-Score*)	Individual bank stability measure and is calculated as the sum of return on assets and the equity ratio divided by the standard deviation of bank return on assets. *Source*: BankFocus and authors' calculation.
Distance-to-default (*DtD*)	Alternative individual bank stability measure that is defined as the difference between the market value of assets of a firm and the face value of its debt, divided by the standard deviation of the firm's market asset values. *Source*: Credit Research Initiative (CRI).
Competition measure	
Boone Indicator (*Boone*)	Bank competition measure calculated as the elasticity of bank profits to marginal costs (Boone, 2008). *Source*: BankFocus and authors' calculation.
Diversification measures	
Revenue diversification (*RD*)	Measure of bank diversification between interest income and non-interest income (Mercieca, Schaeck, and Wolfe, 2007). *Source*: BankFocus and authors' calculation.
Non-interest income diversification (*ND*)	Measure of bank diversification within bank non-interest activities (Mercieca, Schaeck, and Wolfe, 2007). *Source*: BankFocus and authors' calculation.
Overall diversification (*OD*)	Measure of overall bank diversification between interest income, fees and commission, trading and other operating incomes (Elsas, Hackethal, and Holzhäuser, 2010). *Source*: BankFocus and authors' calculation.
Market revenue diversification (*MRD*)	Market-level measure of bank diversification between interest income and non-interest income. *Source*: BankFocus and authors' calculation.
Market non-interest diversification (*MND*)	Market-level measure of bank diversification within bank non-interest activities. *Source*: BankFocus and authors' calculation.
Market overall diversification (*MOD*)	Market-level measure of overall bank diversification between interest income, fees and commission, trading, and other operating incomes. *Source*: BankFocus and authors' calculation.
Income diversity (*ID*)	Alternative diversification measure for diversification across different sources of bank incomes (Laeven and Levine, 2007). *Source*: BankFocus and authors' calculation.
Market income diversity (*MID*)	Market-level income diversity. *Source*: BankFocus and authors' calculation.

Table 5.1 (continued). Definitions of Variables

Variables	Definitions
Bank-specific control variables	
Bank Size (*Bank Size*)	Natural logarithm of bank total assets. *Source*: BankFocus.
Equity to total assets ratio (*Capitalization*)	The ratio of total equity to total assets. *Source*: BankFocus.
Non-performing loans ratio (*NPL*)	The ratio of bank impaired loans to total gross loans. *Source*: BankFocus.
Return on assets (*ROA*)	The ratio of net income to total assets. *Source*: BankFocus.
Liquidity ratio (*Liquidity*)	The ratio of bank liquid assets over bank deposits and short-term funding. *Source*: BankFocus.

Notes: This chapter use accounting data on an annual basis to calculate competition and bank diversification measures from BankFocus compiled by the Bureau van Dijk and from Compustat North America. To calculate systemic risk measures, I retrieve daily market data on banks' stock prices and returns from Datastream and CRSP. Data for all bank control variables are retrieved from BankFocus. Accounting- and market-based measures have been converted to the same data frequency before conducting the regression analyses.

5.4 Methodology

5.4.1 The relationship between competition, diversification, and bank stability

To investigate the association of bank diversification with the relationship between competition and bank stability, I run regressions by employing the fixed effects estimator to control for unobserved time-invariant bank-specific fixed effects.[46] Fixed effect models have been widely used in the banking literature to control for unobserved time-invariant variables (Mercieca, Schaeck, and Wolfe, 2007; Anginer, Demirgüç-Kunt, and Zhu, 2014a; Leroy and Lucotte, 2016; Goetz, 2017). My model is specified as follows:

$$Bank\ stability_{i,t} = \alpha_1 + \beta_1 \times Boone_t + \delta \times Market\ diversification_{i,t} + \theta \times Boone_t \times Market\ diversification_{i,t} + \gamma_1 X_{i,t} + T + \mu_i + \varepsilon_{i,t} \quad (5.14)$$

where subscripts i and t denote bank i and time t. *Bank stability* stands for one of the individual bank stability measures, *Z-Score* and *DtD*, or one of the bank systemic stability measures, *MES* and Δ*CoVaR*. *Boone* is my bank competition measure. *Market diversification* denotes one of market-level diversification measures: *MRD*, *MND* and *MOD*. *Boone*×*Market diversification* is the interaction term of competition with market-level diversification. A bank-level diversification indicator is also included into the regression since each individual bank contributes to the market diversification, which implies that market-level diversification measures are mechanically related to their bank-level indicators. Therefore, the estimations could be inconsistent if individual banks' diversification variables are omitted. In addition, the inclusion of bank-level diversification can control for the possibility of inducing biased information on the degree of diversification in a market if the distribution of each individual bank's interest and different types of non-interest revenues used for constructing my different

[46] Since my competition measure is at the country level and the sample includes only one country, the models in this study do not consider the time fixed effects to avoid the possibility that variations in *Boone* are absorbed by the time effects.

specifications of market diversification measures is not considered.[47] $X_{i,t}$ is a vector of bank control variables. Time effect T is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017. T is computed as the difference between the current year and the starting year 1994. μ_i captures bank fixed effects. $\varepsilon_{i,t}$ is the error term. α, β, and γ are the parameters to be estimated.

I also separately examine the direct relationship between competition and bank stability by using Equation (5.15) below, which provides the foundations for undertaking analyses on the role of market diversification in the competition-bank stability relationship.

$$Bank\ stability_{i,t} = \alpha_2 + \beta_2 \times Boone_t + \gamma_2 X_{i,t} + T + \mu_i + \varepsilon_{i,t} \quad (5.15)$$

5.4.2 The relationship between competition and market diversification

I also investigate the association of competition with market diversification, which aims to reflect the information on the corresponding diversification level for a specific degree of competition in the market. I specify the following model for this analysis:

$$Diversification_{i,t} = \alpha_3 + \beta_3 \times Boone_t + \gamma_3 X_{i,t} + T + \mu_i + \varepsilon_{i,t} \quad (5.16)$$

diversification represents one of bank- or market-level diversification measures that include *RD*, *ND*, *OD*, *MRD*, *MND* and *MOD*. The other variables and terms are defined as before.

5.5 Results

5.5.1 Summary statistics

The descriptive statistics of the variables used in this chapter are presented in Table 5.2 and the

[47] Consider two extreme situations regarding the distributions of interest and non-interest revenues of two banks in a market. Assuming that these two banks have the same total operating revenues (the sum of interest and non-interest revenues), in situation one, one bank is fully concentrated on interest incomes while the other one on non-interest incomes, and, in situation two, the distribution of revenues of these two banks is perfectly balanced between interest and non-interest revenues. The values of market-level diversification will be the same under these two extreme situations according to my specification. Therefore, it is necessary to include the bank-level diversification into the regressions to distinguish these two situations.

correlation matrix for all variables is shown in Table 5.3. *Boone* has a mean of 0.039 and a standard deviation of 0.012, with minimum and maximum values of 0.011 and 0.054, respectively. Especially, its median (0.043) is very close to its maximum values, which indicates that competition in the U.S. keeps at a relatively high level in most years in my sample. The means of *MES* (-0.017) and Δ*CoVaR* (-0.050) are negative while *Z-Score* (3.791) and *DtD* (2.917) are positive, which is in accordance with the natures of these risk indicators in terms of calculation. As for my market diversification indicators, *MRD*, *MND* and *MOD* have means of 0.453, 0.499 and 0.524, respectively, and their maximum values (0.500 for *MRD*, 0.644 for *MND*, and 0.681 for *MOD*) are equal or very close to their theoretical maximum values (0.500 for *MRD*, 0.667 for *MND*, and 0.750 for *MOD*). As for the pairwise correlations among the key variables, *Boone* is negatively correlated with the two systemic risk indicators, which is consistent with the negative relationship between competition and bank systemic stability suggested in the literature. *Boone* is also negatively correlated with the two idiosyncratic risk measures, which suggests a negative association between competition and banks' standalone risk. In the next section, I will investigate their relationships by considering the role of market diversification after controlling for a group of variables.

Table 5.2. Descriptive Statistics

Variables	N	Mean	SD	Min	25th percentile	Median	75th percentile	Max
Boone	7,535	0.039	0.012	0.011	0.035	0.043	0.045	0.054
MES	6,479	-0.017	0.020	-0.141	-0.022	-0.013	-0.004	0.038
Δ*CoVaR*	4,558	-0.050	0.019	-0.124	-0.063	-0.041	-0.036	-0.023
DtD	2,982	2.917	1.561	-1.185	1.823	2.860	3.914	8.781
Z-Score	6,976	3.791	1.217	-3.469	3.142	3.869	4.583	7.018
RD	7,533	0.265	0.109	0.024	0.186	0.257	0.339	0.500
ND	7,533	0.397	0.151	0	0.300	0.434	0.503	0.662
OD	7,533	0.282	0.126	0.024	0.190	0.266	0.360	0.648
MRD	7,418	0.453	0.045	0.149	0.437	0.468	0.484	0.500
MND	7,418	0.499	0.083	0.096	0.482	0.519	0.549	0.644
MOD	7,418	0.524	0.071	0.153	0.488	0.540	0.576	0.681
ID	7,533	0.342	0.190	0.024	0.207	0.303	0.433	0.981
MID	7,418	0.725	0.132	0.162	0.645	0.746	0.823	0.990
Bank Size	7,535	14.293	1.629	11.017	13.163	13.907	15.074	21.254
Capitalization	7,535	0.098	0.026	0.001	0.298	0.082	0.095	0.298
NPL	7,534	0.014	0.019	0	0.004	0.008	0.016	0.200
ROA	7,535	0.008	0.010	-0.092	0.006	0.009	0.012	0.038
Liquidity	7,534	0.072	0.087	0.009	0.032	0.049	0.078	1.866

Notes: This table contains information on the descriptive statistics of all variables throughout the chapter. *N* represents the number of observations for each variable. *SD* is the standard deviation of each variable. *Mean*, *Min*, *25th percentile*, *Median*, *75th percentile*, and *Max* indicate the mean, minimum, 25th percentile, median, 75th percentile, and maximum value of each variable, respectively. Detailed information on each variable's definition and calculation are reported in Table 5.1. The criteria for selecting banks are as follows. First, banks are from the U.S. and consist of commercial banks and bank holding companies (BHCs). Second, all accounting data are organized in the consolidated form with code 'C1' and 'C2' specified by BvD BankFocus to avoid duplications in calculating measures. Third, the dataset includes both listed and delisted banks to mitigate survivorship bias. Fourth, this study excludes banks with less than three consecutive years of observations. To account for the influence of extreme values and outliers, all variables are winsorized and the bottom 1% and top 1% of observations for each variable are set respectively to the value of the 1st and 99th percentiles. *Source*: BankFocus, CRSP, Datastream and authors' calculations.

Table 5.3. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) *Boone*	1.000																	
(2) *MES*	-0.102*	1.000																
(3) Δ*CoVaR*	-0.512*	0.398*	1.000															
(4) *DtD*	-0.212*	0.254*	0.341*	1.000														
(5) *Z-Score*	-0.532*	0.189*	0.499*	0.430*	1.000													
(6) *RD*	-0.192*	-0.214*	0.014	-0.023	0.224*	1.000												
(7) *ND*	-0.059*	-0.110*	-0.030*	-0.130*	-0.000	-0.007	1.000											
(8) *OD*	-0.200*	-0.236*	0.012	-0.034*	0.231*	0.983*	0.031*	1.000										
(9) *MRD*	-0.415*	-0.152*	0.034*	-0.085*	0.200*	0.220*	0.252*	0.235*	1.000									
(10) *MND*	-0.173*	-0.274*	-0.200*	-0.165*	0.095*	0.177*	0.295*	0.191*	0.689*	1.000								
(11) *MOD*	-0.435*	-0.173*	0.023	-0.101*	0.200*	0.233*	0.254*	0.252*	0.980*	0.735*	1.000							
(12) *ID*	-0.180*	-0.214*	0.011	-0.038*	0.216*	0.974*	-0.033*	0.968*	0.214*	0.166*	0.226*	1.000						
(13) *MID*	-0.480*	-0.142*	0.072*	-0.078*	0.214*	0.235*	0.234*	0.255*	0.963*	0.654*	0.985*	0.228*	1.000					
(14) *Bank Size*	-0.256*	-0.410*	0.059*	0.042*	0.299*	0.470*	0.145*	0.516*	0.230*	0.211*	0.245*	0.480*	0.239*	1.000				
(15) *Capitalization*	-0.191*	-0.079*	0.060*	0.159*	0.271*	0.001	-0.065*	0.017	0.077*	0.077*	0.100*	0.009	0.102*	0.103*	1.000			
(16) *NPL*	-0.146*	0.251*	0.322*	0.517*	0.483*	0.078*	-0.081*	0.080*	-0.064*	-0.102*	-0.074*	0.075*	-0.068*	0.107*	0.264*	1.000		
(17) *ROA*	0.106*	-0.315*	-0.309*	-0.475*	-0.361*	0.088*	0.129*	0.093*	0.170*	0.244*	0.205*	0.088*	0.191*	0.055*	-0.130*	-0.566*	1.000	
(18) *Liquidity*	-0.011	-0.119*	0.003	-0.082*	0.070*	0.181*	-0.048*	0.261*	0.060*	0.029*	0.083*	0.220*	0.088*	0.280*	0.135*	-0.017	0.082*	1.000

Notes: This table presents the pairwise correlations of main variables. *Boone* is the competition measure. *MES* is the main bank systemic risk measure that is the average of a bank's stock return during the 5% worst trading days for the overall market return in one financial year. Δ*CoVaR* is the alternative systemic risk measure. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. *DtD* is an alternative individual bank stability measure that is defined as the difference between the market value of assets of a firm and the face value of its debt, divided by the standard deviation of the firm's market asset values. *RD*, *ND* and *OD* are bank-level revenue, non-interest income and overall diversification measures. *MRD*, *MND* and *MOD* are market-level revenue, non-interest income and overall diversification measures, respectively. *ID* is an alternative bank diversification measure, defined as income diversity. *MID* is the market-level asset and income diversity, respectively. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. * indicates statistical significance at the 5% level.

5.5.2 The relationship between competition, diversification, and bank stability

Table 5.4 shows the results on the role of market diversification in the relationship between competition and bank systemic stability. I employ both the *MES* and $\Delta CoVaR$ to capture banks' contributions to systemic risk. The results in columns (1) and (5) indicate a negative direct relationship between competition and bank systemic stability for both systemic risk indicators. This can be explained by the charter value views which states that banks are likely to engage in riskier portfolios and non-traditional activities in response to their eroded charter values (Marcus, 1984; Keeley, 1990; Hellmann, Murdock, and Stiglitz, 2000). The negative influence of competition on bank systemic stability is also consistent with Allen and Gale (2004). I further find that the coefficients of competition measures switch signs and become positive after taking into account the interacting effects of market diversification according to the results shown in the remaining columns in Table 5.4. The corresponding market diversification measures, *MRD*, *MND* and *MOD*, are positive and significant, and their interaction terms with competition measure, $Boone \times MRD$, $Boone \times MND$ and $Boone \times MOD$, are negative and significantly different from zero in columns (2)-(4) and (6)-(8). This implies that competition may have two-way effects on bank systemic stability depending on the level of diversification in the market.

Table 5.4. Relationship between competition, diversification and bank systemic stability

Dependent Variables	*MES*	*MES*	*MES*	*MES*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Boone	-0.796***	5.182***	0.981***	2.476***	-0.917***	5.150***	2.484***	2.216***
	(0.0388)	(0.398)	(0.205)	(0.262)	(0.0239)	(0.494)	(0.241)	(0.315)
RD		-0.0177***				-0.0324***		
		(0.00456)				(0.00480)		
MRD		0.614***				0.511***		
		(0.0418)				(0.0489)		
Boone×MRD		-12.52***				-12.66***		
		(0.858)				(1.033)		
ND			0.00125				0.00432*	
			(0.00205)				(0.00227)	
MND			0.146***				0.204***	
			(0.0193)				(0.0217)	
Boone×MND			-3.407***				-6.172***	
			(0.417)				(0.462)	
OD				-0.0158***				-0.0278***
				(0.00400)				(0.00393)
MOD				0.287***				0.199***
				(0.0229)				(0.0272)
Boone× MOD				-5.819***				-5.537***
				(0.485)				(0.559)
Bank Size	-0.00369***	-0.00458***	-0.00367***	-0.00434***	-0.00457***	-0.00495***	-0.00359***	-0.00494***
	(0.000713)	(0.000748)	(0.000746)	(0.000742)	(0.000867)	(0.000881)	(0.000894)	(0.000875)
Capitalization	-0.1000***	-0.0966***	-0.102***	-0.0979***	-0.149***	-0.154***	-0.154***	-0.151***
	(0.0162)	(0.0160)	(0.0163)	(0.0161)	(0.0165)	(0.0170)	(0.0173)	(0.0168)
ROA	0.458***	0.450***	0.454***	0.448***	0.440***	0.485***	0.458***	0.487***
	(0.0585)	(0.0587)	(0.0584)	(0.0588)	(0.0353)	(0.0357)	(0.0370)	(0.0361)
NPL	-0.0901***	-0.0793***	-0.0948***	-0.0866***	-0.185***	-0.140***	-0.179***	-0.135***
	(0.0258)	(0.0260)	(0.0260)	(0.0263)	(0.0209)	(0.0206)	(0.0211)	(0.0206)
Liquidity	0.0176***	0.0176***	0.0170***	0.0184***	0.0242***	0.0234***	0.0203***	0.0258***
	(0.00452)	(0.00448)	(0.00445)	(0.00466)	(0.00634)	(0.00644)	(0.00662)	(0.00614)
T	-0.00153***	-0.00168***	-0.00146***	-0.00165***	0.000137	0.000507***	0.000763***	0.000616***
	(9.98e-05)	(0.000107)	(0.000105)	(0.000109)	(9.38e-05)	(9.98e-05)	(9.96e-05)	(0.000100)
Constant	0.0927***	-0.181***	0.0150	-0.0536***	0.0625***	-0.175***	-0.0751***	-0.0455**
	(0.00969)	(0.0214)	(0.0138)	(0.0160)	(0.0124)	(0.0250)	(0.0165)	(0.0187)

Table 5.4 (continued). Relationship between competition, diversification, and bank systemic stability

No. of Observations	6,478	6,381	6,381	6,381	4,558	4,489	4,489	4,489
No. of Banks	467	462	462	462	349	344	344	344
R-squared	0.367	0.392	0.376	0.390	0.378	0.419	0.430	0.419
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Sign-switch point	n/a	0.4139	0.2879	0.4255	n/a	0.4068	0.4025	0.4002

Notes: This table presents the regression results from the baseline model on the relationship between competition, diversification, and bank systemic stability. *Boone* is the competition measure calculated as the elasticity of bank profits to marginal costs. *MES* is the bank systemic risk measure that is the average of a bank's stock returns during the 5% worst trading days for the overall market return in one financial year. $\Delta CoVaR$ is another systemic risk measure that is defined as the difference between the *CoVaR* of the banking market conditional on the bank being in distress and the banking market's *CoVaR* in the median state of the bank. *RD*, *ND*, and *OD* are bank-level revenue, non-interest income, and overall diversification measures. *MRD*, *MND*, and *MOD* are market-level revenue, non-interest income, and overall diversification measures, respectively. $Boone \times MRD$, $Boone \times MND$ and $Boone \times MOD$ are corresponding interaction terms between competition and market diversification. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect T is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017 and is computed as the difference between the current year and the starting year 1994. The estimating method is the fixed effects model that considers bank-specific fixed effects. The dependent variables reflect bank systemic stability (measured by *MES* and $\Delta CoVaR$). Independent variables consist of bank competition measure (*Boone Indicator*), bank diversification measures and bank-specific control variables. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

To identify the cut-off points for splitting the two-way effects, I have calculated and reported the values of each market diversification measure at which the relationship between competition and systemic stability switches sign in relevant regressions as shown in Table 5.4. For example, based on the results in column (2), the cut-off point value of *MRD* is calculated by taking the first derivative of Equation (5.14) with respect to *Boone* and making it equal to zero, which is $\frac{\Delta MES}{\Delta Boone} = \beta_1 + \theta \times MRD = 0$. I have the equation $5.182 - 12.52 \times MRD = 0$ and the corresponding threshold of *MRD* is 0.4139. Then I can further compute the range of *MRD* at which competition positively influences bank systemic stability as *MRD*=[0.149, 0.4139].[48] A one standard deviation increase in *Boone* for a bank at the 5th *MRD* percentile leads to an increase in the *MES* of 0.00715, which accounts for a 43% increase in *MES* on average in the sample.[49] This marginal effect of *Boone* on *MES* is economically significant, taking into consideration the interacting effect of market diversification. Given that the value of *MRD* at the cut-off point that splits the two-way effects of competition on systemic stability is below its 25th percentile values, I can conclude that competition has a positive influence on bank systemic stability only when the market diversification is low.

Such beneficial effect of market diversification on the negative relationship between competition and systemic stability can be due to banks' higher extent of engagements in traditional activities when the degree of market diversification is low. A low market diversification indicates that banks are less likely to engage in diversified activities and thus concentrate on a few assets or activities. Under this situation, less volatile and more stable traditional interest-based activities would be the first choice to meet their risk-averse demands. Previous literature suggests that non-traditional activities are much more volatile (DeYoung

[48] The lower limit value of *MRD* is set to this variable's minimum value (0.149) in the sample as shown in Table 5.2.
[49] The standard deviation of *Boone* is 0.0118. The 5th percentile of *MRD* is 0.3655 in the sample. Then I can calculate the rise in the *MES* as follows: 0.0118×(5.182-12.52×0.3655)=0.00715.

and Roland, 2001; Stiroh, 2004a; Stiroh, 2006; Stiroh and Rumble, 2006), and can induce tail risks that are detrimental to systemic stability (De Jonghe, 2010). To verify this explanation, I undertake additional analyses that examine the associations between market diversification and banks' revenue ratios. According to the results in Table 5.5, I find negative associations between my three market diversification indicators (*MRD*, *MND* and *MOD*) and two revenue ratios (*Interest Revenue Ratio* and *Fee and Commission Ratio*).[50] With respect to the diversification between interest and non-interest revenues, the *Interest Revenue Ratio* increases as *MRD* and *MOD* decline (in columns 1 and 3), which shows that banks tend to engage in more traditional interest-income-generating activities when the market diversification is low. As for diversification within banks' non-interest revenues, the *Fee and Commission Ratio* grows with the decrease in *MND* as shown in column 2, which indicates that banks generate more income from less volatile fee-based activities than from more volatile activities such as trading activities when the degree of market non-interest diversification is low. These results imply that an appropriate control for banks' diversification in the market may benefit the systemic stability in a competitive market.

[50] I construct the *Interest Revenue Ratio* to capture the proportion of the total interest incomes from the total operating revenues in the market where a particular bank and its competitors operate. *Fee and Commission Ratio* is built up to capture the proportion of fees and commissions from the total non-interest revenues in the market where a particular bank and its competitors operate.

Table 5.5. Relationship between diversification and banks' revenue ratio

Dependent Variables	Interest Revenue Ratio	Fee and Commission Ratio	Interest Revenue Ratio
	(1)	(2)	(3)
MRD	-1.288***		
	(0.0261)		
MND		-1.009***	
		(0.0127)	
MOD			-0.912***
			(0.00967)
Bank Size	0.00550***	0.00427***	0.00362***
	(0.000948)	(0.00155)	(0.000652)
Capitalization	-0.0375*	-0.0459**	-0.000215
	(0.0217)	(0.0231)	(0.0162)
ROA	-0.0927***	-0.104***	-0.00784
	(0.0351)	(0.0386)	(0.0217)
NPL	-0.0903***	-0.111***	0.0763***
	(0.0320)	(0.0397)	(0.0267)
Liquidity	-0.0210***	-0.00992*	-0.00835**
	(0.00626)	(0.00534)	(0.00369)
T	-0.00165***	0.000863***	-0.000470***
	(0.000168)	(0.000295)	(0.000148)
Constant	1.168***	1.088***	1.068***
	(0.0185)	(0.0239)	(0.0113)
No. of Observations	7,416	7,416	7,416
No. of Banks	462	462	462
R-squared	0.873	0.893	0.927
Bank fixed effect	YES	YES	YES

Notes: This table shows the regression results on the relationship between diversification and banks' revenue ratios. *MRD, MND,* and *MOD* are market-level revenue, non-interest income, overall diversification measures, respectively. I construct the Interest Revenue Ratio to capture the proportion of the total interest incomes from the total operating revenues in the market where a particular bank and its competitors operate. Fee and Commission Ratio is built up to capture the proportion of fees and commissions from the total non-interest revenues in the market where a particular bank and its competitors operate. The means of Interest Revenue Ratio and Fee and Commission Ratio are 0.637 and 0.649, respectively. This indicates that banks' interest incomes account for the majority of total operating revenues over total non-interest incomes (36.3%), and banks' fees and commissions make up the majority of total non-interest incomes over trading and other operating incomes (35.1% in total). Regressions (1) and (3) use the Interest Revenue Ratio as dependent variables and regression (2) uses the Fee and Commission Ratio as dependent variable. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect *T* is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017, and is computed as the difference between the current year and the starting year 1994. The estimating method is the fixed effects model that considers bank-specific fixed effects. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

When the value of *MRD* is within the range of $[0.4139, 0.500]$, competition will have a negative impact on systemic stability, and this negative effect is exacerbated with an increase in the value of market diversification.[51] This result implies that, under a competitive market environment, banks have motivations to engage in diversified activities, and the resulting greater diversification in the market makes banks become more similar to each other in terms of holding portfolios and engaging in financial activities (Wagner, 2008; 2010), which makes banks have more systemic risk contributions when exposed to market shocks. Eventually, the joint effect of competition and diversification leads to a detrimental effect on systemic stability.

After computing all sign-switch points of *Boone*, I find that *Boone* is only positively associated with *MES* or Δ*CoVaR* when the degree of market diversification remains at a low level. The threshold values of *MRD*, *MND* and *MOD* at which *Boone* has positive and significant coefficients are all below their 25th percentile values. However, competition turns to have a negative effect on systemic stability for over 75% of observations of these three market diversification indicators, and this competition-systemic fragility relationship is exacerbated with the increase in diversification in the market.

In terms of bank-specific control variables, I find that bank size is negatively associated with bank systemic stability in all specifications. This implies that larger banks may contribute more to systemic risk due to their systemic importance in the market in terms of total assets. The coefficients of capitalization are negative and significant, which shows that better capitalized banks may contribute more to systemic risks due to their incentives in more risk-taking activities since they are holding sufficient buffers to absorb potential shocks. The negative and significant coefficients of *NPL* implies that banks with bad quality of loans contribute more to systemic risks. The coefficients of *ROA* are positive and significant both for *MES* and Δ*CoVaR*,

[51] The maximum value of *MRD* in the sample is 0.500 as shown in Table 5.2.

which implies that more profitable banks contribute less to systemic instability. The coefficients of time trends do not appear to be consistent for *MES* and Δ*CoVaR*, which indicates that the time trend leads to mixed effects on the changes in different bank systemic stability indicators.

Table 5.6 presents the results on the relationship between competition, diversification, and individual bank stability. I use both the *DtD* and *Z-Score* to capture individual bank stability. In line with systemic stability, I find a negative direct relationship between competition and individual bank stability according to the results of columns (1) and (5) in Table 5.6. However, I do not find consistently positive and significant effects of market diversification on the competition-individual bank stability relationship even though the coefficients of *Boone* switch signs in particular regressions (as shown in columns 3, 6 and 8), which indicates that low correlations among banks due to their concentration on their own portfolios in a lower market diversification may not contribute to the enhancement in bank stability at the individual level. This implies that the source of bank standalone risk is more related to the insolvency condition of each individual bank and is less attributed to exposures to common shocks among banks.

Table 5.6. Relationship between competition, market diversification and individual bank stability

Dependent Variables	*Z-Score*	*Z-Score*	*Z-Score*	*Z-Score*	*DtD*	*DtD*	*DtD*	*DtD*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Boone	-26.14***	-41.57	11.49	-26.45	-53.97***	117.7***	-32.86	58.07**
	(1.905)	(27.42)	(17.08)	(18.00)	(2.897)	(39.62)	(25.24)	(27.40)
RD		-2.084***				0.0797		
		(0.283)				(0.535)		
MRD		-2.073				17.55***		
		(2.739)				(3.996)		
Boone×MRD		31.47				-358.8***		
		(57.71)				(84.34)		
ND			-0.481***				0.782***	
			(0.114)				(0.238)	
MND			2.673*				3.656*	
			(1.465)				(2.176)	
Boone×MND			-67.40**				-54.07	
			(32.84)				(48.96)	
OD				-1.899***				0.206
				(0.245)				(0.484)
MOD				-0.438				9.542***
				(1.463)				(2.305)
Boone× MOD				0.227				-198.1***
				(32.02)				(49.37)
Bank Size	0.0964*	0.0565	0.121**	0.0568	-0.0648	-0.100	-0.157	-0.0893
	(0.0531)	(0.0531)	(0.0545)	(0.0530)	(0.0950)	(0.101)	(0.0990)	(0.0997)
Capitalization	4.786***	4.868***	4.427***	4.936***	0.312	0.118	0.921	0.0166
	(0.958)	(0.947)	(0.963)	(0.947)	(1.943)	(1.964)	(1.921)	(1.972)
ROA	44.43***	46.54***	44.99***	46.77***	36.59***	35.81***	33.62***	35.67***
	(2.784)	(2.740)	(2.843)	(2.717)	(5.415)	(5.402)	(5.428)	(5.384)
NPL	-15.99***	-14.65***	-16.12***	-14.42***	-19.66***	-19.81***	-20.31***	-20.11***
	(1.677)	(1.694)	(1.694)	(1.686)	(2.390)	(2.410)	(2.471)	(2.392)
Liquidity	-1.079*	-0.980*	-1.118*	-0.927	0.232	0.178	0.320	0.165
	(0.589)	(0.574)	(0.608)	(0.566)	(0.486)	(0.476)	(0.516)	(0.472)
T	-0.0367***	-0.0200***	-0.0288***	-0.0189***	0.0300***	0.0243**	0.0132	0.0244**
	(0.00656)	(0.00669)	(0.00692)	(0.00667)	(0.0110)	(0.0120)	(0.0116)	(0.0120)
Constant	3.303***	5.182***	1.582*	4.378***	5.544***	-2.218	5.203***	0.575
	(0.704)	(1.415)	(0.906)	(1.025)	(1.380)	(2.105)	(1.612)	(1.770)

Table 5.6 (continued). Relationship between competition, market diversification and individual bank stability

No. of Observations	6,976	6,872	6,872	6,872	2,981	2,958	2,958	2,958
No. of Banks	467	462	462	462	168	167	167	167
R-squared	0.347	0.359	0.351	0.360	0.475	0.478	0.483	0.478
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the regression results from the baseline model on the relationship between competition, diversification, and individual bank stability. *Boone* is the competition measure calculated as the elasticity of bank profits to marginal costs. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. *DtD* is another individual bank stability measure that is defined as the difference between the market value of assets of a firm and the face value of its debt, divided by the standard deviation of the firm's market asset values. *RD*, *ND* and *OD* are bank-level revenue, non-interest income, and overall diversification measures. *MRD*, *MND* and *MOD* are market-level revenue, non-interest income and overall diversification measures, respectively. $Boone \times MRD$, $Boone \times MND$ and $Boone \times MOD$ are interaction terms between competition and market diversification. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect T is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017 and is computed as the difference between the current year and the starting year 1994. The estimating method is the fixed effects model that considers bank-specific fixed effects. The dependent variables reflect individual bank stability (measured by *Z-Score* and *DtD*). Independent variables consist of bank competition measure (*Boone Indicator*), bank diversification measures and bank-specific control variables. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5.5.3 The relationship between competition and diversification

After analyzing the association of market diversification with the relationship between competition and bank stability, I further examine the potential association between competition and diversification. Although this part of my analyses does not aim to identify the causality between competition and diversification, investigating this relationship helps me to understand the corresponding diversification level for a particular degree of competition in the market, which might give hints on whether restrictions are needed to control banks' diversification activities in a competitive environment in order to maintain systemic stability. According to the results reported in Table 5.7, I find positive associations between competition and diversification by using both bank- and market-level diversification indicators as shown in columns (1) to (6). These results are consistent with Anginer, Demirgüç-Kunt, and Zhu (2014a), according to whom greater competition encourages banks to take on more diversified risks. Looking back on my findings in Section 5.5.2, I can infer that, as the level of market diversification increases, the influence of competition on bank systemic stability becomes negative. This is perhaps due to more similarities in portfolios that banks hold when market diversification is high. Therefore, the result of a positive association between competition and diversification suggests that interventions in restricting banks to engaging in diversified activities may be necessary when competition is at a high level, at which point the degree of market diversification is also high. This may help to reduce the similarities of portfolios that banks hold and limit the accumulation of correlated risks among banks' financial activities, which eventually would be beneficial for maintaining bank systemic stability.

Table 5.7. The relationship between competition and market diversification

Dependent Variables	*RD*	*MRD*	*ND*	*MND*	*OD*	*MOD*
	(1)	(2)	(3)	(4)	(5)	(6)
Boone	0.617***	0.512***	3.650***	3.307***	0.763***	0.911***
	(0.132)	(0.0446)	(0.248)	(0.0961)	(0.149)	(0.0623)
Bank Size	-0.0211***	0.00792***	0.0502***	0.0209***	-0.0223***	0.00911***
	(0.00448)	(0.00191)	(0.00728)	(0.00346)	(0.00505)	(0.00255)
Capitalization	0.0607	-0.126***	-0.568***	-0.140***	0.0972	-0.137***
	(0.0706)	(0.0319)	(0.128)	(0.0531)	(0.0812)	(0.0431)
ROA	0.699***	0.295***	0.664**	0.346***	0.844***	0.507***
	(0.191)	(0.0512)	(0.280)	(0.0982)	(0.223)	(0.0817)
NPL	0.316***	0.0418	-0.187	-0.0187	0.404***	0.206***
	(0.113)	(0.0334)	(0.178)	(0.0554)	(0.129)	(0.0477)
Liquidity	0.0314	0.00597	-0.0296	-0.0304**	0.0541*	0.0223**
	(0.0233)	(0.00632)	(0.0278)	(0.0131)	(0.0277)	(0.00896)
T	0.00753***	0.00460***	0.00642***	0.00889***	0.00867***	0.00800***
	(0.000448)	(0.000205)	(0.000827)	(0.000348)	(0.000504)	(0.000286)
Constant	0.437***	0.275***	-0.487***	-0.0212	0.445***	0.269***
	(0.0614)	(0.0266)	(0.0998)	(0.0490)	(0.0689)	(0.0352)
No. of observations	7,025	6,921	7,025	6,921	7,025	6,921
No. of banks	467	462	467	462	467	462
R-squared	0.240	0.450	0.135	0.438	0.254	0.502
Bank fixed effect	YES	YES	YES	YES	YES	YES

Notes: This table shows the regression results on the relationship between competition and diversification. *Boone* is the competition measure calculated as the elasticity of bank profits to marginal costs. *RD*, *ND*, and *OD* are bank-level revenue, non-interest income, overall diversification measures, respectively. *MRD*, *MND*, and *MOD* are their corresponding market-level indicators. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect *T* is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017, and is computed as the difference between the current year and the starting year 1994. The estimating method is the fixed effects model that considers bank-specific fixed effects. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5.6 Robustness tests

5.6.1 Endogeneity

To reinforce the credibility of my conclusions, the potential endogeneity between competition and bank stability needs to be considered.[52] Knowing the causality from competition to bank stability enables me to understand how banks' risks will respond to changes in competition, which will confirm that my bank-level risk indicator is affected by the country-level competition measure, not the opposite. Moreover, this analysis mitigates the concern that omitted variables that could jointly determine competition and bank risk. In addition, identifying the competition-bank stability causality is the foundation in interpreting the results on how market diversification is associated with the competition-bank stability relationship.[53] Since my essential objective is to show how the relationship between competition and bank stability changes with market diversification, the causality from competition to bank stability needs to discussed before introducing the moderating role of market diversification.

Identifying the influence of competition on bank stability is empirically challenging due to endogeneity concerns. Firstly, there could be omitted variables that jointly drive competition and bank risk. Although this study conducts the fixed-effect estimations in the baseline models to control for unobserved time-invariant bank-specific fixed effects, there could also exist omitted time-varying variables. Secondly, the risk levels of individual banks could inversely affect banks' decision to undertake monopolistic behaviours. The potential reverse causality from bank risk to competition may not be a concern in my case because my competition variable is calculated at the country level by using all banks' cost and profit information in my sample, and, therefore, my bank-level risk indicators could hardly reversely affect this country-

[52] The endogeneity issue to be treated here is related to the relationship between competition and bank stability, which is analyzed by using the Equations (5.14) and (5.15).
[53] This chapter is only concerned about the association of diversification with the competition-bank stability nexus. The causality from diversification to bank stability is beyond the scope of this chapter.

level competition indicator. Therefore, this chapter does not use the time-lagged competition indicators in the baseline regressions in Equations (5.14) and (5.15).

To check the existence of an endogeneity problem between competition and bank stability, I first conduct the Durbin-Wu-Hausman (DWH) test to testify the use of the IV-2SLS. According to the statistics of the DWH test reported in Table 5.8, we do reject the null hypothesis that the potential endogenous variables are exogenous, suggesting that my original results may be subject to the endogeneity problem. I then use the two-stage least squares (2SLS) estimator to mitigate the endogeneity between competition and bank stability. In empirical banking studies, it is typically difficult to identify instrumental variables that are correlated with an endogenous variable, bank competition in my case, but not to the other endogenous variables, bank stability or other omitted factors influencing those two variables. Previous studies use regulatory and institutional environment factors, such as Banking Freedom, Activity Restriction, and Entry Restriction, as instruments for bank competition in cross-country studies (Berger, Klapper and Turk-Ariss, 2009; Schaeck and Čihák, 2012). However, these types of instruments would not work in my case since the competition measure, the Boone Indicator, is constructed at the country level and my sample only consists of U.S. banks. Using country-level instruments for competition will result in the same instruments for all banks in a given year, which would not be as appropriate as using bank-level instruments. Therefore, we need to use bank-level variables as instruments for competition.

Following Schaeck and Čihák (2014), I employ an interaction term of loan growth rate and market share as the instrument for the Boone Indicator. This interaction term decreases whenever loan growth and/or market share decreases. Such decreases signal higher competition that results in the erosion of monopoly power of large banks with great market shares and reduction of benefits from the relationship lending relying on monopoly power. Loan growth rate and market share could be related to potential omitted factors such as risk appetite and market strategies. My study assumes that these potential factors take constant values in my sample, and these factors will be absorbed by fixed effects, which makes this instrument hardly related to omitted factors. In addition, I employ a novel instrument, banks' cost efficiency score[54], as the second instrument for competition. Based on the efficient structure hypothesis, more efficient banks (banks with lower marginal cost) will achieve greater performance in terms of higher profits at the expense of less efficient ones. This effect is monotonically related to the degree of bank competition. Therefore, we can justify the relevance of banks' cost efficiency scores with competition. As for the exogeneity of this instrument, I assume that cost efficiency score is mainly related to banks' profitability because the cost profile of banks is an important determinant of bank profits. To control for this potential factor, I include *ROA* into my regression model. I undertake several statistical tests to check the relevance and the exogeneity conditions for a valid instrument discussed by Stock and Watson (2003).

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[54] Details on the calculation of banks' efficiency scores are presented in the Appendix.

Table 5.8. Robustness check: Results based on two-stage least squares (2SLS) regressions

Dependent Variables	*MES*	*MES*	*MES*	*MES*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*	*ΔCoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A-First Stage								
Cost efficiency	-0.04968***	-0.47498***	-0.10836***	-0.40885***	-0.47124***	-0.50397***	-0.12310***	-0.42025***
	(0.03094)	(0.02388)	(0.01449)	(0.02006)	(0.03789)	(0.02871)	(0.01754)	(0.02409)
Market share×Loan growth	-0.02137**	-0.01160**	-0.00839*	-0.01323**	-0.04405**	-0.02313**	-0.01660**	-0.02730**
	(0.01039)	(0.00506)	(0.00449)	(0.00600)	(0.01764)	(0.00944)	(0.00848)	(0.01083)
Bank-Level Controls	YES	YES	YES	YES	YES	YES	YES	YES
F-statistic	129.55***	21.41***	48.93***	42.87***	79.58***	36.89***	39.06***	37.69***
Panel B-Second Stage								
Boone	-1.010***	13.20***	-2.219***	3.277***	-0.715***	74.12***	0.0170	21.62***
	(0.0953)	(3.474)	(0.706)	(1.263)	(0.138)	(28.41)	(1.035)	(4.605)
RD		-0.0168***				0.000285		
		(0.00425)				(0.0164)		
MRD		1.396***				7.045***		
		(0.329)				(2.693)		
Boone×MRD		-29.30***				-151.6***		
		(7.069)				(57.45)		
ND			0.00145				0.000576	
			(0.00219)				(0.00242)	
MND			-0.0971				-0.0713	
			(0.0732)				(0.102)	
Boone×MND			2.235				-0.579	
			(1.525)				(2.156)	
OD				-0.0154***				-0.00748
				(0.00374)				(0.00682)
MOD				0.363***				1.680***
				(0.0975)				(0.353)
Boone× MOD				-7.470***				-37.35***
				(2.121)				(7.584)

Table 5.8 (continued). Robustness check: Results based on two-stage least squares (2SLS) regressions

Bank Controls	YES	YES	YES	YES	YES	YES	YES	YES
No. of observation	6,153	6,062	6,062	6,062	4,448	4,382	4,382	4,382
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
DWH test	58.43***	32.72***	72.05***	55.13***	14.00**	2.53	13.36**	16.82***
Hansen J statistic	0.591	0.375	0.617	0.561	2.268	1.671	1.967	2.159
Hansen J statistic (p-value)	0.442	0.550	0.432	0.454	0.132	0.196	0.1607	0.1417

Notes: This table presents the results of robustness check by using the two-stage least squares regressions. Panel A reports the results in the first stage and Panel B represents the results in the second stage. *Boone* is the bank competition measure. *MES* is the bank systemic risk measure that is the average of a bank's stock returns during the 5% worst trading days for the overall market return in one financial year. Δ*CoVaR* is another systemic risk measure that is defined as the difference between the *CoVaR* of the banking market conditional on the bank being in distress and the banking market's *CoVaR* in the median state of the bank. *Cost efficiency* represents banks' cost efficiency score. *Market share×Loan growth* is the interaction of term of banks' market share and loan growth ratio. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect *T* is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017, and is computed as the difference between the current year and the starting year 1994. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

To check the relevance of instruments with the endogenous variable, I report the *F-statistic* in the first-stage results of the 2SLS regressions to test the hypothesis that the coefficients of instrumental variables are zero. According to the results of the first-stage regressions as shown in Panel A, the values of the *F-statistics* are higher than their relevant critical values at 1% significance level, which rejects the null hypothesis and indicates the relevance of my instruments with respect to the competition measure. The coefficients of instruments are negative and significant, which is in line with my hypotheses regarding the potential association between instruments and bank competition measure. To check the validity of instruments, I undertake the overidentification test and report the *Hansen J statistic*.[55] As reported in Table 5.8, the p-values of *Hansen J statistic* in all regressions exceed 0.1, indicating that we cannot reject the null hypothesis that all instruments are uncorrelated with the error term. Based on the second-stage results in Panel B, I find a consistent significant negative direct relationship between competition and individual bank and systemic stability (in columns 1 and 5). The results in columns (2), (4), (6) and (8) confirm my findings in the baseline results that competition has a significant positive effect on bank systemic stability when the market diversification level is low. In sum, the IV-2SLS regression results confirm that my baseline results are relatively robust even though the coefficients of interaction terms of competition and market-level non-interest income diversification (*MND*) are not statistically significant in columns (3) and (7).[56]

[55] I use the heteroskedasticity robust standard errors in 2SLS regressions. Otherwise, I need to report the *Sargan J statistic* when taking the overidentification test.
[56] I do not report the results of IV-2SLS regressions that use individual stability (*Z-score* and *DtD*) as dependent variables since my main findings regarding the role of market diversification in the competition-bank stability nexus are only valid in the dimension of bank systemic stability. Results focusing on the dimension of idiosyncratic risk are available upon request.

5.6.2 Alternative diversification measure

This study takes into account one alternative bank diversification measure, income diversity (*ID*), to examine whether or not my findings hold for using another specification of diversification. *ID* measures diversification *across* different sources of bank incomes (Laeven and Levine, 2007). I also build up a market-level income diversity (*MID*) measure to reflect the overall degree of diversification in the banking market. *ID* and *MID* are calculated as:

$$ID_{i,t} = 1 - \left|\frac{Interest\ Income_{i,t} - Noninterest\ Income_{i,t}}{Total\ Operating\ Income_{i,t}}\right| \quad (5.17)$$

$$MID_{i,t} = 1 - \left|\frac{\sum_{j \in N(i)} Interest\ Income_{j,t} - \sum_{j \in N(i)} Noninterest\ Income_{j,t}}{\sum_{j \in N(i)} Total\ Operating\ Income_{j,t}}\right| \quad (5.18)$$

where $Noninterest\ Income_{j,t}$ includes fees, commissions, and other operating incomes. $Total\ Operating\ Income_{j,t} = Interest\ Income_{i,t} + Noninterest\ Income_{i,t}$. According to the results shown in columns (1) and (2) in Table 5.9, I have consistent findings with my baseline results according to which competition has a significant positive impact on bank systemic stability when the degree of market income diversity maintains within a certain range. This positive interacting effect of market diversification still leads no significant effects on the relationship between competition and individual bank stability as shown in columns (3) and (4).

Table 5.9. Robustness check: Results based on alternative diversification measure

Dependent Variables	*MES*	*ΔCoVaR*	*Zscore*	*DtD*
	(1)	(2)	(3)	(4)
Boone	1.031***	0.657***	-23.91*	14.92
	(0.148)	(0.176)	(12.40)	(18.15)
ID	-0.00941***	-0.0157***	-1.084***	0.171
	(0.00241)	(0.00260)	(0.159)	(0.290)
MID	0.115***	0.0625***	-0.151	3.859***
	(0.00878)	(0.0104)	(0.702)	(1.057)
Boone×MID	-2.259***	-1.979***	-3.306	-84.34***
	(0.192)	(0.220)	(15.37)	(22.80)
Bank Size	-0.00413***	-0.00502***	0.0594	-0.0760
	(0.000729)	(0.000857)	(0.0534)	(0.0985)
Capitalization	-0.0972***	-0.148***	4.926***	-0.0560
	(0.0161)	(0.0167)	(0.947)	(1.969)
ROA	0.458***	0.484***	46.67***	36.26***
	(0.0587)	(0.0363)	(2.750)	(5.382)
NPL	-0.0861***	-0.135***	-14.45***	-19.92***
	(0.0265)	(0.0208)	(1.697)	(2.389)
Liquidity	0.0173***	0.0246***	-0.987*	0.175
	(0.00453)	(0.00665)	(0.579)	(0.467)
T	-0.00165***	0.000556***	-0.0210***	0.0280**
	(0.000107)	(9.73e-05)	(0.00664)	(0.0118)
Constant	0.0112	0.0166	4.080***	2.560
	(0.0124)	(0.0146)	(0.891)	(1.562)
No. of Observations	6,381	4,489	6,872	2,958
No. of Banks	462	344	462	167
R-squared	0.387	0.409	0.358	0.478
Bank fixed effect	YES	YES	YES	YES

Notes: This table reports the regression results of robustness check by using alternative bank diversification measure. *Boone* is the competition measure calculated as the elasticity of bank profits to marginal costs. *ID* is the alternative bank diversification measure, defined as income diversity. *MID* is the market-level income diversity. $Boone \times MID$ is the interaction term between competition and market diversification. The estimating method is the fixed effects model that considers bank-specific fixed effects. *MES* is the bank systemic risk measure that is the average of a bank's stock returns during the 5% worst trading days for the overall market return in one financial year. Δ*CoVaR* is another systemic risk measure that is defined as the difference between the *CoVaR* of the banking market conditional on the bank being in distress and the banking market's *CoVaR* in the median state of this bank. *Z-Score* is individual bank stability measure that is the sum of return on assets and the equity ratio divided by the standard deviation of bank return on asset. *DtD* is another individual bank stability measure that is defined as the difference between the market value of assets of a firm and the face value of its debt, divided by the standard deviation of the firm's market asset values. I use the same control variables as in baseline regressions. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5.6.3 Checking whether the results are driven by the financial crisis

I also check whether my results are driven by the 2008-2009 financial crisis by running subsample regressions in the pre-crisis period (1994-2007) and the post-crisis period (2010-2017), separately. The financial crisis may lead to some structural changes in the competitive nature in the market and further affect the scope of activities that banks engage in. According to the results shown in Tables 5.10 and 5.11, I find consistent results with baseline results regarding the interacting effect of market diversification on the relationship between competition and bank systemic stability (measured by *MES* and $\Delta CoVaR$ in separate tables) in both pre- and post-crisis subsamples, which confirms that my results are not driven by the financial crisis.[57]

[57] I do not report regression results that focus on the dimension of individual bank stability since my main findings regarding the role of market diversification in the competition-bank stability nexus are only valid in the dimension of bank systemic stability. Results will be available upon request.

Table 5.10. Robustness check: Testing the influence of the financial crisis

Dependent Variables	*MES*	*MES*	*MES*	*MES*	*MES*	*MES*	*MES*	*MES*
	Pre-crisis	*Post-crisis*	*Pre-crisis*	*Post-crisis*	*Pre-crisis*	*Post-crisis*	*Pre-crisis*	*Post-crisis*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Boone	-0.267***	-1.189***	1.678***	3.877***	1.317***	2.412***	2.501***	1.241***
	(0.0307)	(0.0617)	(0.382)	(1.284)	(0.236)	(0.391)	(0.621)	(0.281)
RD			-0.00545	0.0155**				
			(0.00442)	(0.00636)				
MRD			0.208***	0.0976				
			(0.0389)	(0.0825)				
Boone×MRD			-4.192***	-10.35***				
			(0.833)	(2.537)				
ND					-0.00244	0.00313		
					(0.00159)	(0.00301)		
MND					0.148***	0.0885***		
					(0.0216)	(0.0196)		
Boone×MND					-3.186***	-5.510***		
					(0.472)	(0.643)		
OD							0.0113**	-0.00504
							(0.00555)	(0.00387)
MOD							0.0967***	0.141***
							(0.0336)	(0.0244)
Boone× MOD							-5.865***	-2.807***
							(0.965)	(0.534)
Bank Size	-0.000991	-0.0139***	-0.00137	-0.0143***	-0.000814	-0.0121***	-0.0140***	-0.00141
	(0.000857)	(0.00139)	(0.000925)	(0.00137)	(0.000901)	(0.00142)	(0.00135)	(0.000925)
Capitalization	-0.0485***	0.0258	-0.0461***	0.0304	-0.0499***	0.0352*	0.0346*	-0.0471***
	(0.0153)	(0.0191)	(0.0154)	(0.0191)	(0.0156)	(0.0202)	(0.0193)	(0.0154)
ROA	0.0359	0.113*	0.0371	0.115*	0.0281	0.119*	0.111*	0.0352
	(0.0548)	(0.0610)	(0.0568)	(0.0618)	(0.0556)	(0.0621)	(0.0623)	(0.0569)
NPL	-0.115***	-0.0336	-0.123***	-0.0372	-0.124***	-0.0347	-0.0424	-0.125***
	(0.0397)	(0.0278)	(0.0409)	(0.0281)	(0.0405)	(0.0282)	(0.0281)	(0.0409)
Liquidity	0.0226***	0.0102***	0.0219***	0.0129***	0.0210***	0.00962***	0.0139***	0.0220***
	(0.00718)	(0.00346)	(0.00726)	(0.00370)	(0.00713)	(0.00367)	(0.00411)	(0.00730)
T	-0.00112***	-0.00272***	-0.00120***	-0.00235***	-0.00114***	-0.000433	-0.00125**	-0.00121***
	(0.000117)	(0.000319)	(0.000119)	(0.000535)	(0.000124)	(0.000339)	(0.000512)	(0.000120)
Constant	0.0280**	0.269***	-0.0611***	0.214***	-0.0466***	0.135***	0.175***	-0.0393**
	(0.0112)	(0.0194)	(0.0216)	(0.0553)	(0.0158)	(0.0229)	(0.0357)	(0.0180)

Table 5.10 (continued). Robustness check: Testing the influence of the financial crisis

No. of observation	3,583	2,248	3,519	2,226	3,519	2,226	2,226	3,519
No. of banks	390	374	383	370	383	370	370	383
R-squared	0.195	0.326	0.203	0.351	0.207	0.391	0.367	0.204
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the regression results from the baseline model on the relationship between competition, diversification, and bank systemic stability. *Boone* is the competition measure calculated as the elasticity of bank profits to marginal costs. *MES* is the bank systemic risk measure that is the average of a bank's stock returns during the 5% worst trading days for the overall market return in one financial year. *RD*, *ND* and *OD* are bank-level revenue, non-interest income and overall diversification measures. *MRD*, *MND* and *MOD* are market-level revenue, non-interest income and overall diversification measures, respectively. $Boone \times MRD$, $Boone \times MND$ and $Boone \times MOD$ are interaction terms between competition and market diversification. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect T is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017, and is computed as the difference between the current year and the starting year 1994. The estimating method is the fixed effects model that considers bank-specific fixed effects. The dependent variables reflect bank systemic stability (measured by *MES* and $\Delta CoVaR$). Independent variables consist of bank competition measure (*Boone Indicator*), bank diversification measures and bank-specific control variables. *Pre-crisis* covers the periods from 1994 to 2007 and *Post-crisis* covers the period from 2010 to 2017. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 5.11. Robustness check: Testing the influence of the financial crisis

Dependent Variables	$\Delta CoVaR$	$\Delta CoVaR$	$\Delta CoVaR$	$\Delta CoVaR$	$\Delta CoVaR$	$\Delta CoVaR$	$\Delta CoVaR$	$\Delta CoVaR$
	Pre-crisis	*Post-crisis*	*Pre-crisis*	*Post-crisis*	*Pre-crisis*	*Post-crisis*	*Pre-crisis*	*Post-crisis*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Boone	-0.500***	-1.304***	6.631***	-0.832	4.317***	2.770***	4.749***	1.127*
	(0.0318)	(0.0301)	(0.739)	(1.044)	(0.438)	(0.327)	(0.572)	(0.621)
RD			-0.0553***	0.0171***				
			(0.00872)	(0.00592)				
MRD			0.565***	-0.110				
			(0.0729)	(0.0727)				
Boone×MRD			-16.93***	-1.019				
			(1.609)	(2.068)				
ND					-0.0160***	0.00131		
					(0.00331)	(0.00162)		
MND					0.344***	0.137***		
					(0.0377)	(0.0207)		
Boone×MND					-9.727***	-6.439***		
					(0.847)	(0.580)		

Table 5.11 (continued). Robustness check: Testing the influence of the financial crisis

OD							-0.0498***	0.0120**
							(0.00719)	(0.00465)
MOD							0.368***	0.0595
							(0.0482)	(0.0370)
Boone× *MOD*							-11.33***	-3.785***
							(1.086)	(0.991)
Bank Size	-0.0124***	-0.0204***	-0.00582***	-0.0206***	-0.00717***	-0.0186***	-0.00560***	-0.0209***
	(0.00167)	(0.00133)	(0.00151)	(0.00147)	(0.00145)	(0.00126)	(0.00136)	(0.00144)
Capitalization	-0.158***	-0.0388*	-0.123***	-0.0379	-0.127***	-0.0258	-0.113***	-0.0346
	(0.0350)	(0.0228)	(0.0252)	(0.0240)	(0.0277)	(0.0249)	(0.0237)	(0.0237)
ROA	-0.258**	0.0975***	-0.255**	0.0887***	-0.145	0.0814***	-0.240**	0.0854***
	(0.126)	(0.0251)	(0.106)	(0.0263)	(0.109)	(0.0240)	(0.104)	(0.0255)
NPL	-0.258***	-0.0238	-0.304***	-0.0256	-0.249***	-0.0258	-0.306***	-0.0265
	(0.0744)	(0.0167)	(0.0649)	(0.0171)	(0.0597)	(0.0166)	(0.0625)	(0.0172)
Liquidity	0.0124	0.0129*	0.000791	0.0148**	-0.00108	0.0134*	0.00401	0.0159**
	(0.0101)	(0.00766)	(0.0115)	(0.00723)	(0.00922)	(0.00746)	(0.0103)	(0.00737)
T	0.00293***	-0.000637***	0.00349***	-0.000649*	0.00396***	0.00174***	0.00356***	0.000707*
	(0.000159)	(0.000230)	(0.000141)	(0.000344)	(0.000133)	(0.000331)	(0.000133)	(0.000370)
Constant	0.147***	0.312***	-0.175***	0.363***	-0.105***	0.149***	-0.112***	0.248***
	(0.0230)	(0.0168)	(0.0380)	(0.0441)	(0.0290)	(0.0211)	(0.0306)	(0.0316)
No. of Observations	2,534	1,525	2,495	1,505	2,495	1,505	2,495	1,505
No. of Banks	302	281	295	277	295	277	295	277
R-squared	0.288	0.746	0.504	0.752	0.472	0.810	0.519	0.763
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table presents the regression results from the baseline model on the relationship between competition, diversification, and bank systemic stability. *Boone* is the competition measure calculated as the elasticity of bank profits to marginal costs. $\Delta CoVaR$ is another systemic risk measure that is defined as the difference between the *CoVaR* of the banking market conditional on the bank being in distress and the banking market's *CoVaR* in the median state of the bank. *RD*, *ND* and *OD* are bank-level revenue, non-interest income and overall diversification measures. *MRD*, *MND* and *MOD* are market-level revenue, non-interest income and overall diversification measures, respectively. $Boone \times MRD$, $Boone \times MND$ and $Boone \times MOD$ are interaction terms between competition and market diversification. *Bank Size* is the natural logarithm of bank total assets. *Capitalization* is the ratio of total equity to total assets. *NPL* is the ratio of bank impaired loans to total gross loans. *ROA* is the ratio of net income to total assets. *Liquidity* is the ratio of bank liquid assets over bank deposits and short-term funding. Time effect T is included to control for the gradual changes in the regulatory and economic environments over the long period from 1994 to 2017, and is computed as the difference between the current year and the starting year 1994. The estimating method is the fixed effects model that considers bank-specific fixed effects. The dependent variables reflect bank systemic stability (measured by *MES* and $\Delta CoVaR$). Independent variables consist of bank competition measure (*Boone Indicator*), bank diversification measures and bank-specific control variables. *Pre-crisis* covers the periods from 1994 to 2007 and *Post-crisis* covers the period from 2010 to 2017. Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5.7 Conclusions

This study contributes to the important debate among academics and policymakers regarding the relationship between competition and bank stability. I build up new market-level diversification measures that are supplementary to traditional bank-level diversification measures to examine how the influence of competition on bank stability changes with the degree of diversification in the whole market. By focusing on a sample of U.S. banks, I show that the negative relationship between competition and systemic stability is exacerbated when the market diversification is high while this negative competition-systemic stability relationship turns to be positive when the market diversification is low. However, I do not find evidence of the existence of a significant interacting effect of diversification on the competition-individual bank stability relationship. Lastly, I find a positive association between competition and market diversification, which suggests that diversified activities should be properly controlled in a competitive environment in order to maintain systemic stability. My results are robust to several robustness tests such as using instrumental variable regression, employing alternative diversification indicators, and considering the influence of the financial crisis.

My results provide important insights and implications for bank regulation and policymaking. Promoting competition in the banking market would have mixed relations to bank stability. The banking market becomes less stable in a more competitive environment from the perspectives of both individual bank and systemic stability. In addition, my findings suggest that policymakers should consider the interacting effect between competition and market diversification in the process of formulating the pro-competition policy because competition may enhance systemic stability if bank diversification activities in the market are controlled at a low level. Studies using an international sample based on more available detailed banks' geographical information should be conducted in the future in order to figure out whether my findings would change under different region and market settings.

Chapter 6: Conclusions

6.1 Summary

My thesis consists of four empirical studies that investigate bank diversification in the context of bank stability, market power, and competition. In Chapter 2, I undertake an empirical analysis to test the theory of Wagner (2010) regarding the effects of diversification on bank idiosyncratic and systemic risk. My results confirm Wagner's theory that an increase in diversification leads to more systemic risk but less idiosyncratic risk. That is, a higher diversification indicates that banks hold more similar portfolios, which makes them suffer systemic risks that are common to all banks in the market. My results imply that policies encouraging bank diversification may be beneficial to individual bank stability but could deteriorate systemic stability in the meantime.

In Chapter 3, I extend my findings in Chapter 2 regarding the direct diversification-bank stability relationship and show evidence of the moderating effects of regulatory environments and banks' essential characteristics on this relationship. Based on my results of significant moderating effects of four country-level regulatory variables, I can conclude that the negative relationship between diversification and systemic stability is mitigated in countries with powerful supervisory agencies, higher stringency of capital regulations, more restrictions on the scope of banks' activities, and more private monitoring. In addition, according to my results of significant moderating effects of two bank-level characteristics, I draw the conclusion that larger and well-capitalized banks are less subject to systemic risk when diversification in a country is high. The heterogeneity in the diversification-bank stability relationship depending on a country's regulatory environments and banks' own characteristics provides important implications for policymaking and bank management. Policymakers should take account of cross-country variations in regulatory environments when formulating policies that regulate banks' diversified activities. Bank managers should evaluate the potential idiosyncratic and systemic risk inherent from the activities that banks may engage in and take account of the size and capital levels of their institutions when setting their diversification decisions.

In Chapter 4, I investigate the relationship between diversification and banks' market power and answer the research question about whether diversification can be a determinant or source of market power of banks. My results show that there is an inverse U-shaped relationship between diversification and banks' overall market power. That is, as the level of diversification increases within a certain range, banks possibly enjoy greater revenues from newly engaged-in activities, and banks can use these incomes to cross-subsidize the costs in price competition, which makes banks gain market power. However, banks' market power can be eroded due to greater costs incurred from much more complex activities if bank diversification reaches a high level. My findings provide insights for bank managers to proactively manage market power by engaging in diversification. My study is advisable for regulators and policymakers to understand the potential effect of bank diversification on the microstructure of the banking market.

In Chapter 5, I investigate the role of market diversification in the relationship between competition and bank stability, which provides a new empirical analysis to reconcile the mixed findings regarding the competition-stability nexus in the literature. Based on my results, I conclude that the negative relationship between competition and systemic stability is exacerbated when the market diversification is high while this negative competition-systemic stability relationship turns out to be positive when the market diversification is low. Moreover, the positive association between competition and diversification suggests that restrictions in banks' diversification activities in a competitive environment may help in maintaining systemic stability. My findings suggest that policymakers should consider the moderating effect of market diversification on the process of formulating the pro-competition policy since competition may enhance systemic stability if bank diversification activities are appropriately managed.

6.2 Limitations and future research

My thesis may have some limitations due to data restrictions, limited forms of essential indicators employed, and insufficient investigation on underlying causality and channels in particular relationships. This implies that my studies can be improved by future research taking into account above restrictions.

I construct the market diversification indicators based on a sample of listed U.S banks in Chapter 5. Future research can be conducted if data on banks' geographic information (e.g. locations of banks' headquarters and branches) in more countries are publicly available and accessible to researchers. The inclusion of more detailed banks' geographic information across countries would allow me to construct a market diversification indicator for a particular bank in a given country, which would help in exploring and comparing within- and cross-country variations in the degree of diversification in a specific market where a particular bank and its competitors operate. Future studies based an international sample of banks could also help in figuring out whether my findings would change under different region and market settings.

Moreover, my study can be further improved by considering other dimensions of a country's regulatory framework (i.e. deposit insurance scheme and bank governance) and institutional environment (i.e. property rights, information sharing, and stock market development) in Chapter 4. As for banks' market power indicators, future research can construct alternative forms of market power indicators employed in the literature (Maudos and Fernández de Guevara, 2007; Koetter, Kolari, and Spierdijk, 2012) to obtain more general findings.

Lastly, my findings that diversification leads to more systemic risk while less standalone risk imply a desired degree of diversification among banks from the perspective of society. Therefore, future research can be conducted to find out the optimal degree of diversification to achieve relatively greater social welfare. The potential causality from the regulatory framework and banks' risk determinants to the relationship between diversification and bank stability could also be investigated. My research suggests that diversification can influence banks' market power through leading potential changes to revenue and cost profiles of banks in Chapter 4. Admittedly, there could exist other channels behind the influence of diversification on banks' market power. Therefore, future studies may be needed to explore alternative mechanisms to support my observed findings.

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Appendix

1. Calculation of bank-level diversification measure

The bank-level revenue diversification (*RD*) is computed as follows:

$$RD_{i,t} = 1 - \left[\left(\frac{INT_{i,t}}{TOP_{i,t}} \right)^2 + \left(\frac{NON_{i,t}}{TOP_{i,t}} \right)^2 \right]$$

where subscripts i and t denote bank i and year t. $NON_{i,t}$ is bank's non-interest income and $INT_{i,t}$ is interest income. $TOP_{i,t}$ is total operating income, $TOP_{i,t} = |INT_{i,t}| + |NON_{i,t}|$.

2. Estimating banks' cost efficiency

Bank efficiency is estimated based on the frontier efficiency (called X-efficiency in economic studies), which is the distance of a firm's observed behaviour from its best-practice behaviour implied by economic theory. The literature on the measurement of bank cost efficiency can be classified into two competing approaches: parametric and non-parametric approaches. The parametric approach such as the Stochastic Frontier Analysis (SFA) uses econometric techniques to estimate economic functions imposed by assumptions and the deviation of the efficient frontier. In contrast, the non-parametric approach represented by the Data Envelopment Analysis (DEA) employs linear programming techniques to calculate piecewise segments of the efficient frontier.

This study uses the standard SFA method proposed by Aigner, Lovell, and Schmidt (1977) to estimate cost efficiency for each bank-year observation. Under the SFA, I can extract the inefficiency from the error term of the cost function. In addition, the SFA offers a richer specification than the DEA, especially in the case of a panel dataset (Hjalmarsson, Kumbhakar, and Heshmati, 1996). This approach has widely been used in banking studies to estimate bank efficiency (Ferrier and Lovell, 1990; Maudos and Fernández de Guevara, 2007; Turk-Ariss, 2010). Compared with the parametric approach, the non-parametric approach such as the DEA is more sensitive to measurement errors and outliers (Fiorentino, Karmann, and Koetter, 2006).

Following Battese and Coelli (1992) and Fiordelisi, Marques-Ibanez, and Molyneux (2011),[58] I employ the time-varying stochastic frontier approach and construct the following translog cost function to estimate cost efficiency:

$$
\begin{aligned}
lnTC = \alpha_0 &+ \sum_{i=1}^{3} \alpha_{1i} lnY_i + \sum_{j=1}^{3} \beta_{1j} lnW_j + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} \alpha_{2ij} lnY_i lnY_j + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} \beta_{2ij} lnW_i lnW_j \\
&+ \sum_{i=1}^{3}\sum_{j=1}^{3} \gamma_{ij} lnY_i lnW_j + \delta_1 lnE + \frac{1}{2}\delta_2 (lnE)^2 + \sum_{i=1}^{3} \gamma_{2i} lnY_i lnE \\
&+ \sum_{i=1}^{3} \gamma_{3i} lnW_i lnE + \tau_1 t + \frac{1}{2}\tau_2 t^2 + \sum_{i=1}^{3} \tau_{3i} t lnY_i + \sum_{i=1}^{3} \tau_{4i} t lnW_i + \nu + \upsilon
\end{aligned}
$$

TC denotes total cost and E is equity capital. Y and W are vectors of outputs and inputs for each bank-year observation, respectively. An appropriate definition of bank inputs and outputs is an essential issue in the estimation of bank cost efficiency. I opt for the same three inputs, denoted by W_j and W_i, as in the functions that calculate market power, which consist of the costs of funding, labour and fixed capital. As for outputs, I choose total loans and other earning assets. ν is the random disturbance and assumed to be independently and identically distributed as $N(0, \sigma_\nu^2)$. υ, a non-negative random error, is assumed to be truncated or half normally distributed as $N(0, \sigma_\upsilon^2)$ and to capture the inefficiency level relative to the frontier. To impose the restriction of linear homogeneity in input prices, I divide the three input prices by the price of fixed capital (W_3).

[58] Different from the consistent definition of bank inputs in the literature, the choice of bank outputs is mixed in different studies.