Bank Market Structure, Bank Liquidity Creation and Economic Development

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Declaration

I declare that the work presented for assessment in this thesis is my own, that it has not previously been presented for another assessment, and I have attributed the source(s) according to the Rules for Submission of Thesis for Research Degrees.

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Abstract

Banks, as a key financial intermediary, have been found of playing a critical role in the healthy development of modern economies. In this thesis, focusing on the US banking industry, we provide an in-depth investigation of the impact of changing banking market structure on the product market competition, bank liquidity creation and wider economic development. Employing data from the US market over the period of 1997 to 2020, the first two essays focus on the role played by banking market structure in determining the product marker structure (Chapter 3) and bank liquidity creation (Chapter 4) and the third essay (Chapter 5) further investigates the effect of bank liquidity creation on firm innovation. In general, it can be concluded that the banking market structure can generate a significant impact on the structural characteristics of the product market and firm activities. A higher level of bank concentration may lead to a lower amount of credit created in the real economy, and hence reduced product market competition, but the impact can be different in different time periods and/or among firms with different external-financial dependence conditions. In addition, after controlling the characteristics of banks and the macroeconomic situation of different states, the results confirm that banks with stronger market power tend to create more liquidity. In particular, when the joint impact of bank market power and capital adequacy ratio is considered, they are found of contributing positively to banks' liquidity creation. It, therefore, indicates that tighter regulator control would increase market confidence, especially when the banks with high market power. Finally, regarding the role played by bank liquidity on the real economy, it is found that when increased liquidity is created by banks, firms are more willing to innovate as this may assist them to build up long-term sustained competitive advantages. In particular, such a positive relationship would be further consolidated when the market is competitive as monopolistic firms tend to have less incentive to innovate and are more willing to enjoy the status quo. Based on the conclusions reached, important policy implications could be drawn related to the further development of the banking sector. It is proposed that in countries like the US which has a well-developed financial sector and effective regulatory control, banking consolidation could be encouraged rather than restricted as it may contribute positively to effective resource allocation and the further promotion of economic growth.

Key Words: Bank Structure, Liquidity Creation, Firm Innovation, Financial-Growth Nexus

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Chapter 1 Introduction

1.1 Background

This thesis examines the role played by banks in the real economy. As the financial intermediary, banks are found of playing a key role in stimulating economic growth (Berger et al., 2020). They offer near-risk-free savings opportunities for the depositors and allocate scarce financial resources to different sectors, households and governmental organisations (Allen et al., 2008). Meanwhile, banks also create liquidity for the nonbank public by transforming relatively illiquid assets, such as long-term loans to informationally opaque businesses, into relatively liquid liabilities, such as time deposits. Banks also create significant liquidity by issuing off-balance sheet guarantees like loan commitments that allow customers to draw funds under predetermined conditions (Berger and Bouwman, 2009; Bouwman, 2019). Given the important role played by banks, a large number of empirical studies were conducted over the past decades trying to identify the role played by banks in stimulating economic growth, or the finance-growth nexus (King and Levine, 1993; Demirgüç-Kunt and Maksimovic, 1998; Levine, 1997; Levine and Zervos, 1998; Rajan and Zingales, 1998; Beck, 2009). The earlier studies mainly focused on examining the impact generated by the banking sector reform, or financial deregulation.

Over the past decades, the banking system in the US has undergone a series of consolidation and restriction waves (Muharam, 2018). Prior to 1970, the US commercial banking industry was heavily regulated and protected. Most states had laws prohibiting branching or imposing restrictions on branching, while interstate branching was completely banned in all states (DeYoung, 2012). Later, to inject more competition and improve the overall allocative efficiency of the banking sector, the US government initiated a series of banking reforms. During the 1970s, restrictions about intrastate branching were first removed in fourteen states but were retained among twelve other states. However, such state-level geographic deregulation failed to lead to the

immediate expansion of unrestricted interstate branching. It was until 1994 that the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) was enacted, and the unrestricted interstate banking and branching were finally approved in 1997.

The implementation of bank deregulation has offered an appropriate context for the study of the impact of state-level geographic deregulation on the performance of the commercial banking industry and the real economy. In terms of the influence on the real economy, on the one hand, Jayaratne and Strahan (1996) suggest that the geographic structure of banks and bank holding companies (BHCs) may play a major role in affecting economic growth. Similarly, Black and Strahan (2002) find that the rate of new incorporations increases following the removal of branching restrictions in the US. Rice and Strahan (2010) explain the positive impact brought about by banking deregulation from the perspective of liquidity supply. They conclude that the relaxation of geographical restrictions has effectively promoted banking expansion, and this is mainly due to the reduced cost of credit. Later, Krishnan et al. (2015) extend the previous research by investigating the effect of bank deregulation on firm productivity. Measured by total factor productivity (TFP), it is concluded that deregulations could generate a more positive impact on the performance of financially constrained firms. Nevertheless, some other studies also identify the negative impact generated by bank deregulation and it is mainly related to the increased market power (MP) of banks when they are allowed to expand freely across states (Evanoff and Fortier, 1988; Amel and Liang, 1992). For those large and financially unconstrained firms, they are found of being provided with increased funding opportunities, whereas for those smaller financially constrained firms, accessing to credit has become even more difficult (Berger et al., 2019).

In terms of the impact of banking deregulation on the performance of the banking sector, in general, it is agreed that the performance of banks has been improved in three major areas including, increased competition, improved service quality, and increased

operational efficiency (Merrick and Saunders, 1985). For example, according to Calem (1993), the liberalization of geographic banking has allowed banks to access a wider customer base and increased their profit potential. Dick (2004) finds that along with the removal of geographic restrictions, risks associated with the credit portfolio decrease due to greater geographic diversification and increased competition in the credit market. As the lifting of geographic restrictions has allowed the assets to be shifted away from low-profit to high-profit banks, this has therefore increased the average profitability of the banking industry (Stiroh and Strahan, 2003; Yildirim and Mohanty, 2010).

However, such geographical deregulation is also said of impacting large and small banks differently. On the one hand, Nippani and Washer (2005) point out that the return on assets (ROA) of small banks has fallen significantly below that of larger banks during the post-IBBEA period as the enactment of IBBEA has effectively placed small banks at a non-competitive position, making them become vulnerable targets for potential takeovers. Similar conclusions have also been reached by other studies. Liang and Rhoades (1991), who measure the performance of banks following geographic banking deregulation, reveal that larger BHCs can take advantage of wide branch networks to diversify loan portfolios more effectively. Later, Calem (1994) finds that small banks lose market share after the removal of intrastate branching restrictions. Nevertheless, the study of Nippani and Green (2002) also find that in practice, the performance of smaller banks may also improve as they are pressurised by large banks to deliver a higher level of operational efficiency or better customer services. Similarly, studies of Jayarathe and Strahan (1998) and Kroszner and Strahan (1999) find only small and inefficient local banks are the major beneficiaries of regulations that limit the geographic expansion of banks as the expansion of larger and more efficient banks are banned.

As a result, it can be found that the earlier studies mainly focus on examining the impact generated by the financial deregulation on the banking industry itself or the overall

economy. However, the broken out of the 2008 financial crisis has led scholars to rethink one major function played by banks, liquidity creation (LC). As LC considers off-balance sheet guarantees and derivatives, deposits and other liabilities, and equity in addition to assets, it is considered an advanced measurement of bank output (Berger and Sedunov, 2017). In 2009, Berger and Bouwman (2009) provid a comprehensive measurement of bank liquidity creation for the first time. However, since then, only a few studies including, Berger and Sedunov (2017), and Fidrmu et al. (2015), conduct to investigate the role played by banks in liquidity creation. Given the close relationship between bank liquidity creation, product market structure, firm performance, especially their R&D activities, and economic growth, a thorough understanding of such interrelationship is important and beneficial for policy makings. That is why in this thesis, I tried to investigate the relationship among banking market structure, product market structure, liquidity creation and firm innovations.

1.2 Development of Research Questions and Objectives

This thesis focuses on the US banking sector due to its importance for the global economy. The US is the largest economic entity in the world and its currency, the US dollar, is also the primary currency used in international trade and reserve. The country is considered of having an efficient financial market and its service industry is also well-developed. The US is widely regarded as the financial centre of the world due to its size and interconnection with the rest of the world. Over the past four decades, the US banking market has gone through a series of major structural changes, including state-wide deregulation, international financial integration and technological innovations. Motivated by the processes of the banking market changes in the US and the new comprehensive bank liquidity creation measurement proposed by Berger and Bouwan (2009), this thesis tries to investigate the relationship between bank market structure and bank liquidity creation and their role played in the real economy.

As the relationship between the banking market structure and the product market

structure remains a matter of debate, I, first of all, try to test empirically the relationship between the two. More specifically, in Chapter 3 (First essay), I examined how bank market structure affects the product market structure, in order to draw a general picture between these two. I employ the HHI, the CRn (bank concentration ratio) of the top three and five banks to capture the banking market structure, and the average firm size and the number of firms per capita to measure the competitiveness of the product market.

After carefully controlling the endogeneity issue, the results show that in general, a higher level of bank concentration may lead to a lower amount of credit created in the real economy, which is in line with market power hypothesis (MP). However, it has also been pointed out that such relationships could be affected by the characteristics of the respective industries as well. For industries with a higher level of external financial dependence, the increased bank concentration could effectively promote competition among companies, resulting in potential efficiency gains. Meanwhile, I also explore the role played by the neighbour-state banking sector on the local product market and the conclusions remain robust in general.

Besides the impact on the competition level of the product market, the banking market is also found of affecting bank liquidity creation. Therefore, in Chapter 4 (Second essay), I try to investigate how the bank market structure affects bank liquidity creation. Following the study of Delis et al. (2017), I use the Lerner index to measure the bank market power. After controlling the characteristics of banks and the macroeconomic situation of different states, the regression results confirm that banks with higher pricing power, tend to create more liquidity. This is in line with "competition-fragility" theory that competition undermines liquidity creation by increasing the fragility of banks. When the joint impact of bank competition and capital adequacy ratio is considered, they are found of contributing positively to banks' liquidity creation. It, therefore, indicates that tighter regulator control would increase market confidence, and this is especially the case when the banking sector is relatively concentrated. In addition, I

also take the size effect into consideration, and try to investigate whether the liquidity creation capacity of large-, medium- and small-sized banks are affected differently by the pricing power of banks and the capital ratios. It is found that the positive impact of pricing power on liquidity creation is greater for small- and medium-sized banks than for large-sized banks.

In the final part, after finding out the determinants of bank liquidity creation, I further explore the role played by bank liquidity on the real economy. In Chapter 5 (Third essay), the main question is how bank liquidity creation affects firm innovation. A positive relationship does find between bank liquidity creation and firm innovation as when firms could access to wide funding opportunities, they are more willing to innovate as this could help them build up competitive strength in the future. We then investigate the moderation effect played by market concentration on the above-tested positive relationship. It is concluded that when the innovation output is considered, a higher level of market concentration would weaken the positive impact generated by increased liquidity creation on firm innovation. This is expected as monopolistic firms tend to have less incentive to innovate as they are more willing to enjoy the status quo. While on the other hand, when the innovation is measured by the input, the R&D investments, a positive moderation effect would then be detected, suggesting that a higher level of market concentration would enhance the positive impact of increased liquidity on R&D investments. The results remain robust if we further decompose the liquidity creation into liability-side, asset-side, and off-balance liquidity creation, or use lagged value for the innovation measurements.

These three essays would provide us with a comprehensive understanding of the role played by the banking sector in shaping the structure of the product market, creating liquidity in the economy, and in affecting firms' innovation activities. The conclusions reached would be useful for the management of firms and also policymakers.

1.3 Contributions

This thesis makes several contributions to the literature, and it can be summarised as follows:

- First of all, this study extends existing literature about banking market structure and product market structure by providing more insights into how the neighbour-states banking market concentration may affect the structure of the local product market. Although the distance is an important factor in bank lending, it was largely neglected by previous studies (Cetorelli and Strahan, 2006). Our cross-industry-state level dataset allows us to measure the banking structure at both the local- and neighbour-state levels and hence provides more insights on this. In addition, taking advantage of the unique reform experience of US banking, this study employed a much larger data set for a more comprehensive analysis. Unlike most of the previous studies which focus on the manufacturing industry only, this study includes all non-financial industries in the analysis (except the agriculture industry). This would make the results generated more reliable and robust.

- Secondly, we also contribute to the literature on bank liquidity creation. Due to lack of comprehensive bank liquidity creation measures, only few studies were done empirically to investigate its determinants, e.g. equity ratio (Berger and Bouwman, 2009), corporate governance (Diaz and Huang, 2017), and real economic output (Berger and Sedunov, 2017). This study incorporates two major factors, bank competition and capital adequacy control, into consideration. Not only their individual impacts, but also their joint impact on liquidity creation would all be investigated employing the latest data of the US banking sector. As liquidity creation could be affected by a series of factors, influences from both of the market (competition) and regulatory control (capital adequacy) should be considered simultaneously when understanding the lending behaviours of banks. Such information can be useful for the

government in setting up policies, in particular during a market downturn and firms facing liquidity constraints.

- Thirdly, this research also enriches the finance and growth literature by investigating comprehensively the role played by bank liquidity creation in firms' innovation activities. To the best of my knowledge, this is the first study which considers the role played by product market structure in shaping the relationship between bank liquidity creation and innovation. Due to the close relationship between the competition level of firms and the profit potential of the industry, liquidity created by banks may generate diverse impact on firms' innovation capacity depending on their needs for funds. A highly competitive product market may squeeze the profit margin of firms, making liquidity created by banks more valuable. Therefore, in this paper, I also try to fill in this research gap by considering the moderated effect of product market concentration on the relationship between bank liquidity creation and firms' innovation. The effect of the product market on firm innovation is also of particular policy interest since compared with reforming a country's legal and financial institutions, adjusting the level of competition of the product market seems to be easier.

1.4 Limitations

The first limitation is the scope of this study. It focuses on a single and developed country but does not consider the situation in other developing countries. The second limitation is related to the choice of sample firms. Due to data availability, only data from listed firms are used. This may make the finding of this research of limited use for non-listed firms.

1.5 Structure of the Thesis

In total, this thesis has 6 chapters. The first chapter offers an overview of the thesis and

Chapter 2 reviews related literature. Chapter 3 is the first main chapter, and it tries to investigate the impact of the banking market structure played on the product market structure. This is followed by Chapter 4 which tries to study the relationship between bank competition, capital adequacy and banks' liquidity creation. Chapter 5 investigate the relationship between liquidity creation, product market concentration and firm innovation. Finally, Chapter 6 summarises the main findings from the three research papers and draws some general conclusions and policy implications. It also provides suggestions for further research.

Chapter 2 Literature review

Studies on corporate financial structure have looked into firms' choices between debt and equity for external financing (Harris and Raviv, 1991), while choices among different alternatives of debt such as bank debt, public debt, privately placed debt and others have only been mentioned until recently (Detragiache et al., 2000). This has led to the development of bank-firm relationships. A large strand of the literature has been done to explore the bank-firm relationships in detail (Boot and Thakor, 2000). Banks and firms have a lending–borrowing relationship, with banks gaining from the borrowers' side (Petersen and Rajan, 1995). Firms with close ties to banks have a strong advantage in securing additional capital (Hoshi et al., 1989). Banks' characteristics can also affect firms in different ways (Wang et al., 2020). In this thesis, we mainly discuss the role played by banks in shaping the product market structure and the provision of liquidity to the economy.

2.1 Background of US Banking Market

Prior to the 1970s, most states in the United States had limitations on intrastate bank branching, with some states even prohibiting banks from having more than one office (known as "unit banking"). Interstate banking was even more restricted, with no state allowing out-of-state banks to freely enter its market until the mid-1970s. However, from 1970 to 1994, state legislatures gradually relaxed restrictions on both intrastate branching and interstate banking. The Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 removed the remaining barriers to interstate banking by 1995 and interstate branching by 1997, although states had the option to opt-in or opt-out of the interstate branching provisions. In Zhang's (2017) analysis, the regulation of banks in the US initially served to generate tax revenue for public finance, leading to states reducing competition to gain tax monopoly funds and the establishment of "unit banking states". Later, the regulation of the banking sector became a conflict of political ideology between small community banks in rural areas and large banks in urban cities,

with rural banks exerting their influence to restrict expansionary activities of large banks through the McFadden Act of 1927, which prohibited interstate branching and restricted intrastate branching. Later, the deregulation trend took off in 1978 after Maine lifted the limitations on interstate branching, and this move was followed by Alaska and New York in 1982. This led to a chain reaction of similar actions. Later, in 1994, the Riegle-Neal Interstate Banking and Branching Efficiency Act was enacted, which eliminated the Douglas Amendment and gave Bank Holding Companies complete freedom to engage in interstate acquisitions and subsidiary mergers.

2.2 Banking Market Structure

2.2.1 The Influence of Banking Market Structure on Firm Performance

The important role played by banks in economic development and the recent banking deregulation have made the study of banking market structure a crucial and timely policy issue. Many studies have attempted to investigate the determinants of banking structure and its impact on the wider economy (Guzman, 2000; Shim, 2019). Nevertheless, the debate about the "optimal level" of concentration of the banking sector and its impact on firm performance has never reached an agreement. The conventional market power view suggests that any departure from perfect competition in the credit market introduces inefficiencies and this may harm firms' access to credit and thus, hindering growth (Berger and Hannan, 1998). The study of Claessens and Laeven (2005) is among the first few which try to estimate the level of competition in the banking sector. Using data from 16 countries, it is concluded that there is a positive relationship between the competition level of the banking industry and the growth of financially dependent industries, which are rely more on external finance. The later study by Love et al. (2015) reaches similar conclusions. Based on multi-year, firm-level surveys of 53 countries, it is concluded that low competition, as measured by high values on the Lerner index or Boone indicator, in the banking sector reduces firms' access to capital. In other words, increased competition in the banking sector would contribute positively to firms' efficiency improvement (Pagano,1993).

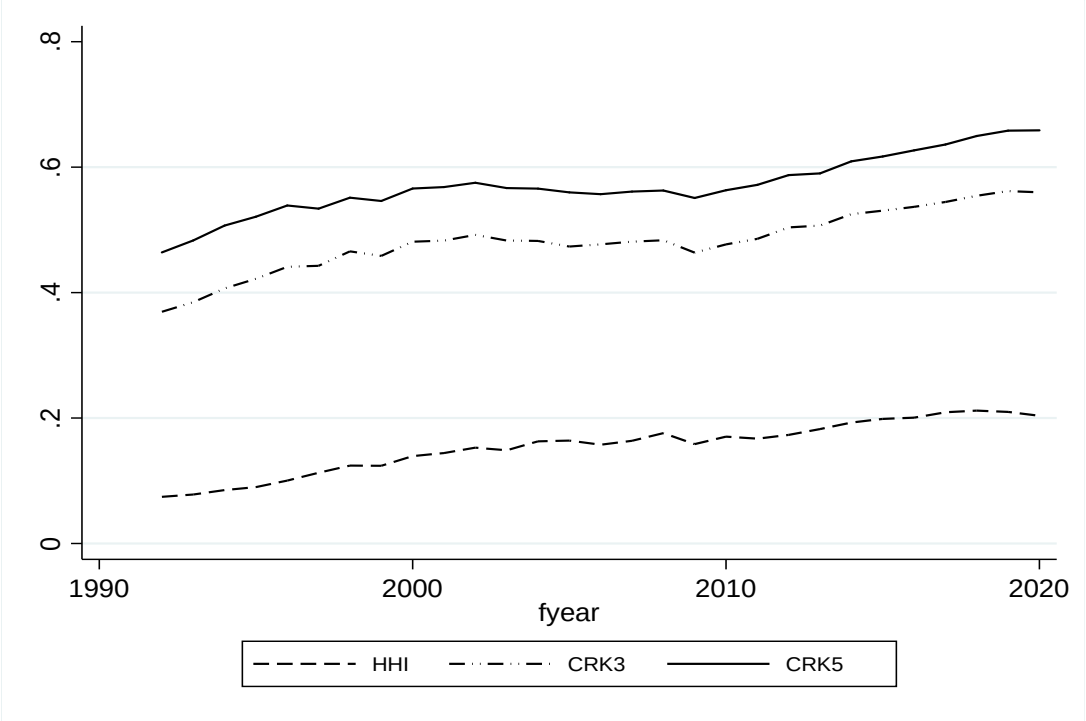
However, from the perspective of relationship lending, some other studies point out that banks with monopoly power are incentivised to establish a long-term relationship with client firms and such a relationship is mutually beneficial to both parties (Mayer, 1988, 1990). As suggested by Petersen and Rajan (1995), banks with monopoly power are more likely to invest in relationship building through the collection of soft information in the market. Consequently, more credit would become available. This is consistent with the information hypothesis which argues that with greater market power, banks are more likely to engage in relationship lending as shown by more long-term lending between banks and firms. In addition, it is also pointed out that larger banks may also be able to diversify the risk exposure of their loan portfolios more efficiently due to economies of scale, in particular, if they engaged in cross-border activities (Diamond, 1984, Boyd and Prescott, 1986).

Therefore, it seems that it is hard to predict the relationship between banking market structure and firm growth based on conclusions reached in earlier studies. Nevertheless, the close relationship between the banking sector and the real economy has been well documented. If the banking sector is not well functioning, it may lead to a waste of resources. The state-owned banks in China are a good example of this (Dai and Guo, 2020). On the other hand, Sylla (1969) argues that monopoly-enhancing regulation in the financial sector at the time of the Civil War contributed to industrialization in the US. By the same token, Mayer (1990) suggests that the post-war development of Japan could be said of being boosted by its main-bank system.

Figure 2-1 maps the changes in bank market structure in the US from 1997 to 2020. The bank market structure refers to the level of concentration or competition in the banking industry. It has been assessed through the concentration ratios, such as the n-bank concentration ratio (CRn) and Herfindahl-Hirschman Index (HHI) based on the structural approaches. The level of concentration demonstrates the extent to which the

largest banks contribute to the specific product market (deposit market). Normally, a higher level of concentration indicates that the largest banks have more market power. It can be found that over the past three decades, the concentration level of the US banking industry, in terms of deposit market, has increased continuously as a result of structural deregulation which allowed banks to merge and consolidate into larger megabanks.

Figure 2-1 The US banking market structure



Source: Federal Deposit Insurance Corporation (FDIC): https://www.fdic.gov/resources/

2.2.2 The Influence of Banking Market Structure on the Performance of Banks

In terms of the influence of banking market structure on the performance of banks, it is mainly built on the market power theory originated from the traditional "structure–conduct–performance" (SCP) paradigm (Bain, 1951). According to SCP, increased competition increases banks' risk-taking as it undermines the "charter value" of large banks. The influential study of Keeley (1990), which analyses the relaxation of state branching restrictions in the 1980s, concludes that due to increased competition, large US bank holding companies have increased their risk exposures, and this is evidenced

by the rising market capital-to-asset ratios and the actual interest costs on large certificates of deposits. Nevertheless, under such condition, the large banks are still found of having lower level of risk exposure due to the relatively large scale of diversification achieved (Boyd and Pescott, 1986; Méon and Weill, 2005). However, on the contrary, Jayaratne and Strahan (1998) find that deregulation was followed by sharp reductions in loan losses, contrasting Keeley's earlier result. In addition, the study of Boyd and De Nicolo (2005) also points out that, actually, increased competition may provide additional motivation to banks, and this in turn reduces bank failure. This is in line with the competition-stability view which argues that competition in the banking sector is desirable since it often generates a more efficient market (Beck, 2008). Later, Wang (2019) studies whether competition in the deposit and loan markets would lead to a more stable banking sector in the US, and again, it is found that the supply of loans increases when the banking market increases competition after out-of-state banks either acquired a local bank or established a new branch. Employing a sample of European countries, the study of Pradhan et al. (2019) also finds strong evidence to support that banking competition enhances the stability of banks and thus stimulates the long-term development of the stock market over the period of 1996 to 2016.

On the other hand, a large number of studies have analysed the link between market structure and bank profitability. The market power theory is often used to test this relationship. This theory consists of two hypotheses–the traditional structure conduct performance (SCP) hypothesis and the relative market power (RMP) hypothesis. The SCP theory posits that firms are able to earn a monopolistic profit in a highly concentrated market as they are likely to collude (Fred, 1984). Berger (1995) states that banks operating in a more concentrated market are able to charge less favourable prices to customers due to the competitive imperfection that exists in these markets. As a result, banks earn a higher profit by paying lower interest on deposits and charging higher interest on loans. Alternatively, the RMP hypothesis postulates that firms that have a large market share and offer distinctive products gain market power. This enables them

to charge premium pricing on their products and earn supernormal profits, regardless of the level of market concentration that is present (Shepherd, 1982). Under this hypothesis, the variance in performance can be attributed to efficiency and residual influence of market share that are related to market power and/or product differentiation. Even though both of these hypotheses relate higher concentration to lower consumer and producer surplus, they differ in terms of the source of the market power (Jeon and Miller, 2005). The SCP hypothesis attributes the market power to the collusive behaviour of the banks in the market while the RMP hypothesis attributes it to the individual bank's strategy.

Moreover, as liquidity creation is considered a core function of banks, many studies have also been done to investigate the relationship between bank market structure and liquidity creation (Grubel, 1977). Based on a sample of 25 OECD countries over the period of 2000-2010, the early study of Joh and Kim (2008) concludes that bank competition reduces market liquidity creation as intensified competition increases the funding costs of banks. For large banks, they are more willing to lend in a relatively concentrated banking market as a high level of concentration allows banks to enjoy increased monopolist profits. Similar conclusion has also been reached by the study of Horvath et al. (2016) based on a sample of Czech Republic banks. In support of the competition-fragility hypothesis, they argue that a competitive banking framework may limit banks' liquidity creation capacity as in fear of bank runs, competition may discourage banks' lending activities. More recently, the study of Ali et al. (2022) based on the Chinese banking sector also confirms the above findings. As competition reduces the deposits collected by banks, this in turn decreases the loan generated. However, it is also argued that even when the banking market is relatively concentrated, the creation of sufficient liquidity remains uncertain, in particular if large banks are found of exploiting their monopolist power by charging a higher interest margin (Berger and Hannan, 1989). The study of Corvoisier and Gropp (2002) confirms this finding based on all euro-area countries except Luxembourg. The lower interest rate set for demand

deposits and higher loan rate charged for lending have depressed both of the savers and borrowers, leading to reduced market liquidity.

Based on the discussion above, it seems that the structure of the banking market is a critical factor that may impact on the performance of banks and bank liquidity creation in the market. When it comes to the measurement of the variable, most of the earlier studies choose market concentration as a proxy for banking competition. It is argued that as competition and concentration are in contrast with each other, we should accept the theoretical proposition that a more concentrated market implies a lower level of competition due to the undesirable exercise of market power by banks (Shaffer and DiSalvo, 1994). However, some argue that market concentration may not necessarily be a good proxy for competition (Claessens and Laeven, 2004; Bikker, 2004). Instead, measurements like contestability, might work better as it is found to be positively correlated with financial stability (Barth et al. 2004). In the next part, I would provide a detailed review of the measurements used to capture the structure of the banking market.

2.2.3 The Relationship Between Bank Market Structure and Bank Market Power

The literature on the relationship between bank market structure and bank market power can be divided into three main streams, structure–conduct-performance (SCP) hypothesis the efficient structure hypothesis (ESH) and relative market power hypothesis. According to the SCP paradigm, a firm's market power increases with industry concentration, due to a direct link between industry structure and competitive conduct. As a result, when the banking industry has a higher level of concentration, this would indirectly lead to reduced competition and accordingly, higher margins and enhanced profitability (Vesala, 1995).

Until the late 1990s, the SCP paradigm was widely used in the banking literature, which

applies structural indicators to measure competition. However, it is pointed out that the above argument about the relationship between market structure and performance may disappear under alternative assumptions and in practice, there could be a non-linear relationship existing between the two. Baumol et al. (1982) show that competitive pricing can prevail, regardless of the number of firms in the market, if a firm from outside can attract customers by lowing price and recovering the cost of entry thereafter or abandon the market if existing firms retaliate by under-pricing. Friedman et al. (1971), however, show that a large number of firms may even tacitly collude to charge high prices if they think ahead, since the temporary profits one firm could gain by under-pricing its rivals could be offset by subsequent losses if its rivals follow the suit. Other scholars also argue that in practice, the pricing strategy of firms could be quite complicated and can be affected by other factors including interest rates, the cost of adjusting size or capacity, or unanticipated demand shocks (Rotemberg and Saloner, 1986; Worthington, 1990).

Another challenge to the SCP is the efficient structure hypothesis (ESH), proposed by Demsetz (1973) and Peltzman (1977). It suggests that a positive relationship between profitability and market concentration is not the result of market power, but the greater efficiency of firms with larger market share. The ESH includes two hypotheses according Berger (1995): the X-efficiency hypothesis, which suggests that firms with superior management may utilize their assets more effectively and efficiently, and thus incur lower costs and increased profits. The other one is the scale-efficiency hypothesis which suggests that if firms could achieve a more efficient scale of operation, they may have the potential to realise further cost reductions and faster growth. In other words, the superior performance of the market leaders endogenously determines the market structure, implying that higher efficiency produces both a higher concentration and greater profitability. Berger (1995) finds some evidence in support of the ESH in the US banking sector. However, as for the European banking sector, the SCP hypothesis is more relevant as the structural factors are found of playing a more significant role in

determining the profitability and the power of the banking sector.

The third hypothesis is relative market power hypothesis. Shepherd (1986) argues that performance variance can be attributed to both efficiency and the residual effect of market share. The "quiet life" hypothesis could be viewed as a unique variant of the market power hypothesis. Historically, empirical tests of this hypothesis have typically used measures of market concentration as a stand-in for market power.

In terms of the measurement of bank structure, there are two groups of measurements, the first one is the SCP paradigm, originally developed by Mason (1939) and Bain (1951), attempts to infer the degree of market power in industry from its structural features, through the establishment of a direct link from industry structure to firm conduct, and from firm conduct to industry performance. Therefore, using each bank's market share as a concentration ratio (HHI) or the combined market share of the top three or four banks (CR3 or CR4) is the typical ratio. In the banking industry, market share is usually determined by the total value of balance sheet assets or total loans. Incorporating these ratios into regression models serves as the initial stage in exploring the correlation between bank profitability and market power. However, most SCP studies do not take the behaviour of banks and the impact generated by bank performance on market structure into consideration, which has therefore triggered the development of the alternative non-structural methodologies to investigate firms' competitive behaviour, known as the new empirical industrial organization (NEIO) method. Instead of focusing on the structure of the market, the NEIO employs a variety of alternative methodologies to analyse the competitive conduct of market participants directly. Based on the oligopoly theory, the first generation of the non-structural models mainly include the Lerner index, the conjectural variation models (Iwata, 1974; Bresnahan, 1982; Lau, 1982) and the Panzar and Rosse (1987) model. Later, focusing on the market dynamics, some other non-structural models are also developed including the Persistence of Profits developed by Mueller (1977) and the Boone indicator recently

proposed by Boone (2008). Despite sharing the same strand of the theoretical framework, the conclusions reached by different empirical studies are divergent (Carbo-Valverde et al., 2009; Liu et al., 2013).

Amongst the various measurements, the Lerner index, which identifies the extent to which the price charged by the bank diverges from the price that would emerge in case of perfect competition, is one of the most widely used ones to predict banking competition (Carbó et al., 2009; Turk Ariss, 2010; Delis, 2012; Love and Martinez Peria, 2012; Beck et al., 2013; Berger et al., 2017). It is calculated as the difference between the actual price and the marginal cost, divided by the price. Under the assumption, the Lerner index should converge to zero when competition increases, and rise, up to the theoretical limit of one, along with increased market power of firms. In the banking context, the Lerner index captures the markup charged by banks from their customers by calculating the difference between loan interest rates and marginal costs and expressing it as a proportion of the former. As such, it is regarded as a direct measure of competition.

One major advantage of the Lerner index is that it can be measured both at the bank level and over time, so it may identify different behavioural patterns within the same market and/or between years. Moreover, as suggested by Beck et al. (2013), the index does not require a clear definition of the geographical market of the bank, either. In contrast to the market share or market concentration measures, the Lerner index allows market power to be measured separately for different banking markets via geographical locations or by products offered. In addition, according to Shaffer (2004), the Lerner index is also proven to be closely related to other NEIO measures of competition that are formally derived from profit-maximizing equilibrium conditions as well. In the study of Beck et al. (2013), it is found that their country-averaged Lerner indices are statistically positively related to other competition measures. Analogously, Delis (2012) finds a high correlation between the Lerner index and the Boone indicator for the

banking industries of several countries. It is, therefore concluded that the Lerner index is a valuable measurement of market power. Nevertheless, the measure is also found of having some limitations. For example, Guevara et al. (2005) point out that when banks' risk-taking is not accounted for, the Lerner index may overestimate the market power, as banks may devote more resources in generating loans in exchange for higher profit margins.

2.3 Liquidity Creation of Banks

2.3.1 Bank Liquidity Creation, Firm Innovation and Economic Growth

According to the modern theory of financial intermediation, banks are performing two major roles in an economy, liquidity creation (LC) and risk transformation. Banks create liquidity when they advance illiquid loans to borrowers while allowing depositors the liberty to withdraw funds at par value at an instant notice (Ali et al., 2019). For LC, it has effectively provided a comprehensive measurement of banks' outputs including all assets, liabilities, equity, and off-balance sheet guarantees and derivatives assigned with theoretically different weights.

The relationship between bank liquidity creation and economic growth has been extensively studied (Levine, 2005). Bank loans, a key component of LC, particularly to those financially constrained firms, are considered to be primary engines of economic growth (Levine and Zervos, 1998). Loans lent to small- and medium-sized firms through the monetary policy channel have generated a significant impact on their outputs (Berger and Bouwman, 2017; Kashyap and Stein, 2000). As for transactional deposits, another key component of LC, they are mainly used to provide liquidity and payments services and are found of contributing significantly to the well-functioning of the wider economy (Kashyap et al., 2002). For off-balance sheet guarantees, they act like loan commitments and standby letters of credit, allowing customers to expand their economic activities with increased confidence. This has effectively acted as a guarantee

ensuring that funds used for these expenditures are forthcoming in the future when needed (Boot et al., 1993). Moreover, they could also be used for other capital market financings, such as commercial paper and municipal revenue bonds. In this way, money from the capital markets could be better used in stimulating economic growth. Similarly, another main type of bank off-balance sheet activity, derivatives, is also widely used by firms to hedge against future market uncertainties brought about by interest rate changes, foreign exchange volatilities and other market price changes (Stulz, 2004).

The importance of innovation for economic growth is verified by previous studies (Solow 1957). The growth models of Aghion and Howitt (1992), Grossman and Helpman (1991), and Romer (1990) show that the financial system can affect steady-state growth by changing the rate of technological innovation. In addition to long-run economic growth, corporate innovation is also considered a source of competitive advantage for firms (Porter 1992). However, as for research investigating the relationship between bank liquidity creation and innovation, it is quite limited (Yasar, 2021).

Given the important role played by banks in liquidity creation, extensive studies have also been done to investigate the determinants of LC (Berger et al., 2016). Fungáčová et al. (2010), for example, consider the link between bank capital and liquidity creation by exploring how the implementation of a deposit insurance scheme affects this relationship. Taking advantage of Russia's experimental deposit insurance scheme implemented in 2004, they identified the existence of a negative relationship between bank capital and liquidity creation, but failed to offer a more detailed explanation about the channels through which liquidity is created. Berger et al. (2010) investigate the impacts of regulatory interventions and capital injections on liquidity creation using a sample of German universal banks and conclude that such interventions from the government may lead to reduced liquidity creation. Rauch et al. (2010) analyse the potential determinants of liquidity creation for a sample of German savings banks by

comparing the role of macroeconomic factors, such as monetary policy and unemployment, with bank-specific factors such as bank size and financial performance. Although their findings are in support of the conclusion that tightened monetary policy reduces liquidity creation, they failed to identify any significant relationship between bank-specific factors and liquidity creation. Pana et al. (2010) investigate the impact of bank mergers on the liquidity creation among US banks and identify the positive impact generated through merger activities on bank liquidity creation. As for the relationship between banking market competition and liquidity creation, the study of Ali et al., (2019) concludes that increased competition, as measured by the Lerner index, reduces the liquidity created by banks and this is explained by the financial fragility theory.

2.3.2 The Measurements of Bank Liquidity Creation

At the beginning, many empirical papers adopted relatively straightforward measurement, such as private credit, to measure bank liquidity creation (Kaminsky and Reinhart, 1999; Demirgüç-Kunt and Detragiache; 1998). Later, Deep and Schaefer (2004) introduced a more complicated measure for liquidity creation. They define the liquidity transformation gap or "LT gap" as (liquid liabilities−liquid assets)/total assets. All loans with maturity within one year or less are liquid, and all loan commitments and other off-balance sheet activities are excluded explicitly because of their contingent nature. In their study, 200 largest US banks are included, and it is concluded that these large banks do not appear to create much liquidity. However, there are some limitations related to this measurement. Firstly, it does not include off-balance sheet activities, although they are arguably important components for liquidity creation (Holmstrom and Tirole, 1998, Kashyap et al., 2002). Secondly, it only classifies the liquidity of balance-sheet activities based on maturity but in practice, business loans sometimes should be treated as illiquid regardless of their maturity because they cannot be easily disposed by banks to meet liquidity needs. On the other hand, residential mortgages and consumer loans should be treated as semiliquid as they could be securitized and sold to

meet demands for liquid funds.

To overcome these limitations, Berger and Bouwman (2009) proposed four measures for bank liquidity creation, incorporating both balance and off-balance sheet activities, and also two types of loan classifications, the category-based and the maturity-based measurements. In contrast, simple measures of private sector debt, or bank credit, do not account for the full liability structure of banks' balance sheet or the structure of liquid assets held by banks. And for measures that focus entirely on liquidity flows, such as the LT gap, they tend to be quite volatile and disregard other items of the balance sheet that contain useful information on banking fragilities, such as safe assets or market depth of other financial instruments on the balance sheet.

One major contribution of Berger and Bouwman's new measurement lies in its adoption of two classification criteria to categorise loans, category-based and maturity-based measurements. The Catfat measure classifies residential mortgages and loans as semi-liquid assets because they can be sold or securitized to meet the liquidity needs of banks, whereas business loans, irrespective of their maturity, are treated as illiquid assets as banks cannot dispose of them to settle their liquidity demands. The Catfat measure also includes both on and off-balance sheet items, making it a more advanced and comprehensive measure of liquidity creation. Although the liquidity creation measurement provided by Berger and Bouwman (2009) is considered of improved significantly from the earlier ones, it is widely modelled in a single-bank context only, as this micro-level measurement requires detailed and segmented balance sheet items which are data-dependent and country-specific.

On the other hand, some studies try to capture the liquidity creation of the banking system from both of the macro- and micro-levels. For example, Caballero and Krishnamurthy (2001) examine aggregate liquidity form a macro-prudential standpoint, showing that the private sector often creates excessive liquidity beyond the socially-optimal level. As a result, Brunnermeier et al. (2012) propose a formal model of bank

liquidity creation with reference to the Liquidity Mismatch Index (LMI), a theoretical metric that measures the liquidity creation of banks both at the micro and the macro levels, and embodies information on both on- and off-balance sheet commitments of banks. The LMI is obtained as a weighted average of liquid assets and liabilities. However, given the theoretical nature of the metric, the weights are not specified. Later, in order to construct a measurement of liquidity creation for data-poor countries, D'Avino et al. (2022) propose the Aggregate Bank Liquidity Creation (A-BLC) method which relies mainly on the macroeconomic, country-wide, banking systems' balance sheet data.

Despite of all the recent development of new measurement for bank liquidity creation, the one developed by Berger and Bouwman (2009) remains the most widely used one. In this research, as our sample is based on the US market and I want to analyse liquidity creation from different perspectives, the liability-side, asset-side and off-balance-liquidity creation, I would also adopt Berger and Bouwamn's liquidity measurement in my research.

Chapter 3 The Impact of Banking Market Structure on the Product Market Structure in the US

3.1 Introduction

The critical role played by the banking market structure on the product market has been widely acknowledged, in terms of its impact on corporate borrowing and investment (Zarutskie, 2006), innovation (Amore et al., 2013) and firm creation (Bonaccorsi di Patti and Dell'Ariccia, 2004). What is little known is how the product market structure reacts to the change in banking market structures, especially after banking market deregulation since the 1990s in the US. This question is worth to be explored due to the following reasons. First of all, since the 1990s, the US banking market has become less regulated following the Riegle–Neal Interstate Banking and Branching Efficiency Act (IBBEA). The IBBEA lowered barriers to entry for out-of-state banks, thereby increasing state-level bank competition. However, the IBBEA granted states the right to keep some of the barriers that prohibited competition from out-of-state banks. Such a change has significantly impacted corporate finance and decision makings, particularly for small business finance (Rice and Strahan, 2010). Secondly, as financial intermediaries, banks affect corporate decision makings via controlling credit supply ex-ante and monitoring borrowers ex-post. Therefore, businesses and industries that rely heavily on banking credit would inevitably affect their operations by the structural change in the banking market (Tian and Han, 2019). In addition, along with the banking market deregulation and the advancement of banking technologies, business have started to borrow remotely and across their state boundaries for cheaper and steady credit supply (Mi and Han, 2020). Last but not least, product market competition disciplines managers into making effective managerial decisions to maximize benefits and minimize costs. Studies show that firms in more competitive environments have greater incentive to gain a competitive edge by achieving economies of scale, enhancing productivity, developing new products, or creating new opportunities for new projects

(Nickell, 1996). Hart (1983) argues that managers seeking to increase management efficiency do their best in competitive industries. Thus, firms in competitive environments are expected to make good managerial decisions. For agency theory, product market competition is an a priori control mechanism that prevents managers from pursuing private interests and reduces the agency problem. Holmstrom (1982) and Schmidt (1997) argue that information asymmetry is mitigated in competitive industries because a firm's performance is easily comparable to that of many other firms in the same industry. Moreover, managers in highly competitive industries must bear high investment risks and bankruptcy costs, and their turnover sensitivity to performance is high. Therefore, they are less likely to display the agency problem through overinvestment (Griffith, 2001). Therefore, further investigation is necessary to understand the impacts generated by banking market restructure on the product markets across the geographical boundary.

While most of the earlier studies confirmed the positive impact generated by a well-established financial market on a nation’s economy (Schumpeter,1912), recent studies explore further how the characteristics of the financial market affect the product market and how such an impact varies due to different characteristics of the product market (Zarutskie, 2006; Kerr and Nanda, 2009; Dewi et al., 2019). For example, studies have been done to investigate the role played by banking concentration in shaping real economic activities, such as the distribution of firm size and the creation of firms in the nonfinancial industries (Cetorelli, 2001 and 2003; Bonaccorsi di Patti and Dell'Ariccia, 2004). Different from the conventional belief that a lack of competition in the banking industry may lead to inefficient resource allocation (Guzman, 2000), studies by Petersen and Rajan (1995) and Cetorelli and Peretto (2000) conclude that the concentration of the banking market power has, in fact, consolidated the role played by banks as an information collector and subsequently enhanced their scrutiny capabilities. As for the product market, it is important for a nation’s economy since it determines the capital accumulation in different sectors (Cetorelli and Strahan, 2006). The banks are

said of actively involved in this process through business lending, and other activities. It is therefore, not surprise that the banking market structure would affect the product market structure, but the relationship has yet to be extensively studied. This is the gap this paper aims to fill.

In general, two theories are widely quoted to explain the relationship between banking competition and the structure of non-financial industries, namely, the market power hypothesis (MPH) and the information-based hypothesis (IBH). The former one suggests that banks operating in a more competitive market have a stronger incentive to attract more borrowers by reducing the cost of credit and increasing the supply of liquidity (Cestone and White, 2003). This lowers the entry barrier of firms and therefore promotes the competition in the product market. In contrast, the information-based hypothesis argues that due to the information asymmetry between banks and borrowers, banks with stronger market power tend to have better ability to monitor and screen borrowers and hence reducing the adverse selection and moral hazard problems. As a result, these banks may be more willing to lend and even, at a lower rate. This would in turn attract more firms into industries (Cetorelli and Strahan, 2006). Moreover, in terms of the relationship between financially constrained firms and banking market competition, no consensus has been reached yet. Some papers argue that firms with financial difficulties tend to benefit more in a more competitive banking market as they have only limited access to nonbank financial sources (Francis et al., 2014). Other argue that financially constrained firms may get hurt in a competitive banking market as intensified banking competition may reduce the relation-based lending (Petersen and Rajan, 1995; Hombert and Matray, 2017).

Meanwhile, regarding another factor which may affect banks' lending behaviour significantly, distance, it has also been extensively studied (Petersen and Rajan, 2002). Previous studies point out that the out-of-state banking market can affect the credit condition of the local banking market as banking deregulation has removed many

restrictions on, both intrastate and interstate, branching activities (Rice and Strahan, 2010). Banks in one state could now be allowed access to a broader market free of regulatory intervention. However, only a handful of earlier studies considered this spatial effect of banks generated to its neighbouring states, for example, bank lending and firm innovation activities (Tian and Han, 2019). To overcome the monopoly power of local banks and potential transaction costs, neighbour-state banks are incentivised to decrease their lending rate to attract more customers, especially financial-unconstrained borrowers. The local banking market has information advantages and better screening ability than their out-of-state competitors (Dell'Ariccia and Marquez 2004). In return, local banks may offer better deals to local borrowers at a lower loan rate and this is particularly beneficial for firms facing financial constraints. Based on the discussion above, it seems that price discrimination does exist in bank financing and this study aims to explore this further.

This paper mainly focuses on the relationship between the banking market structure and the product market structure. The difference between this study and the study of Saidi and Streitz (2021) is they consider the role of common lender plays in product market and apply the data on syndicated loan. Besides the impact of the local banking market, the neighbouring banking market is also considered when evaluating their impact generated on the local product market. This allows us to testify whether increased banking competition would benefit firms from the non-financial sector in general, and whether such an impact is different among firms of different industries and with different financial conditions.

This paper contributes to the existing literature of the topic area in the following two aspects. First of all, it extents existing literature by providing more insights about how the neighbour-states banking market concentration may affect the structure of the local product market. Although distance is an important factor in bank lending, it was largely neglected by previous studies (Cetorelli and Strahan, 2006). Our cross industry-state

level dataset allows us to measure the banking structure at both local- and neighbour-state level and hence providing more insights on this. Secondly, our study employs a much larger industry-level data set for a more comprehensive analysis. This would make the results generated more reliable and robust. The rest of the paper is structured as follows. In section 2, we review literature on the relationship between bank concentration and product market structure. Section 3 explains the baseline model. We describe our data, variables in section 4 and section 5 reports the empirical results. In section 6, robustness test is performed to verify the tested results and the last section 7 concludes the paper.

3.2 Literature Review

3.2.1 The Theoretical Argument Related to the Role of Bank Competition

The economic role of financial market has triggered consistent debate among the scholars, economists, and policy makers. A positive relationship between financial development of economic growth was first proposed by Schumpeter (1912). Later, studies are conducted to testify the relationship between banking competition and output growth, profitability, income, innovation, and liquidity among firms from nonfinancial sectors (Smith, 1998; Black and Strahan, 2002; Saidi and Streitz, 2018; Tian et al., 2019; Bonaccorsi di Patti and Dell'Ariccia, 2004).

In general, two theories are widely quoted to explain the relationship between banking market structure and the real economy, the market power hypothesis (MPH) and the information-based hypothesis (IBH). The former is more conventional. It believes that there is a positive relationship between bank competition and economic growth as a highly competitive banking market can lower the cost of credit. This in turn can lead to more investment opportunities and higher profit enjoyed by firms (Hannan, 1991; Angelini et al., 1998; Berlin and Mester 1999; Beck et al. 2004). In addition, it has also been found that banks operating in a more competitive market tend to have stronger

incentives to collect information, screen potential customers and chase more aggressively for late payment (Villas-Boas and Schmidt-Mohr, 1999). This would therefore increase the chance for smaller firms or newly formed enterprises to get credit (Cetorelli, 2004; Bertrand et al., 2007; Berger and Black, 2011).

In contrast, banks in concentrated market may exploit their monopoly power by charging higher loan rates from customers. This may encourage firms to invest into projects with higher risks exposure and consequently lead to more corporate failure (Klein, 1971). Similar conclusion has also been reached by Ariss (2010) that banks in a concentrated market tend to have higher market power. This allows them to pass their efficiency losses to clients through the charge of a higher lending rate. On the other hand, to reduce the risks of adverse selection and moral hazard caused by asymmetric information, credit rationing is imposed by banks (Guzman, 2000; Stiglitiz and Weiss, 1981) as well. When the banking market is dominated by a small number of large ones, the smaller firms may face severer financial constraints, as large banks prefer "hard" information rather than "soft information" when making lending decisions (Stein, 2002). Moreover, to protect the profitability of firms with established relationships, large banks are even found of reluctant to extend credit to newly entered firms to the industry (Spagnolo, 2000; Cestone and White, 2003). Therefore, according to the market power hypothesis, reduced banking concentration would increase the cost of credit, making it harder for the newly entered firms to get the finance needed. This would increase the entry barrier, reduce the competition and consequently impede the economic growth and *vice versa*. We therefore make the hypothesis one as:

H1: Banks with high market power would weaken the industry market competition.

On the contrary, the IBH argues that increased market power in the banking sector can improve economic development as bigger banks with stronger market power tend to have stronger information acquisition, monitoring and screening capabilities. Initially

proposed by Mayer (1988), the bigger banks would utilise their market power to obtain information from different parties, e.g. suppliers, to evaluate the creditworthiness of potential borrowers comprehensively. As a result, compared with the less concentrated banking market, a concentrated one may ease credit constraints and lower the borrowing costs of the start-ups. The authors further explain though the loan cost would be higher in the later time, as bank lenders have information advantages compared with their competitors, the high future loan cost can be compensated by the high development of business and high profit of borrowers. Similar conclusions are also reached by later study of Caminal and Matutes (2002). This has effectively provided additional incentives to firms for the fulfilment of loan agreements. On the other hand, due to strong monitoring and screening ability and extensive lending experiences, big banks are found of more willing to engage into relationship lending (Dass and Massa, 2011; De Haas and Van Horen, 2013). This is particularly helpful for smaller firms and industries with relatively opaque accounting information (Alvarez and Bertin, 2016). Facing increased competition, banks, especially smaller banks, are reluctant to invest into direct information collection due to the costs incurred but this may lead to a higher default rate in the later stage (Marquez, 2002). To compensate, smaller banks are found of charging a higher lending rate, leading to further squeeze of credit supply (Hauswald and Marquez, 2006). As a result, a higher level of banking concentration could mitigate this issue to some extent (Zarutskie, 2006).

In addition to the expansion of credit supply, large banks are also found of being able to improve the performance of borrowing firms (Chan et al., 1986). A positive relationship is detected between bank concentration and the industry growth and capital accumulation among young firms (Cetorelli and Gambera, 2001). For countries with a higher banking market concentration, the value-added of the manufacturing industry is also found to be higher (Hoxha, 2013). Based on the discussion above, it can be concluded that the information-based hypothesis (IBH) suggests that bank concentration can lead to increased credit supply, a lower lending rate and improved

firm performance due to its stronger capacity in pre-lending information collection and screening and post-lending monitoring. Therefore, the second hypothesis could be made as the following:

H2: Banks with high market power could increase the industry market competition.

3.2.2 Empirical Studies on Banking Concentration and Industry Market Structure

Although many studies have been done to test the relationship between financial development and economic growth, only limited research are conducted to investigate how banking competition would affect and shape the structure of the product market. Based on the data of manufacturing sector of 17 OECD countries, the first study is conducted by Cetorelli (2001). It is concluded that bank concentration can lead to higher concentration in manufacturing industries, and for industries with a higher financial dependence, the average firm size is larger in a concentrated banking market. Later, he expended the research to incorporate a total of 29 OECD countries in 2004 and reached similar conclusion. Banks facing less competition are more likely to apply a credit ration, leading to a larger average firm size and a more concentrated product market. On the contrary, when facing tougher competition, it may promote the expansion of younger firms but restrict the development of matured ones as banking competition may lower the entry barrier into different industries Cetorelli (2003). Consequently, a large number of smaller firms could be given the opportunity to get the funding needed (Cetorelli and Strahan, 2006). However, some studies insist on different opinions. The study of Cetorelli and Gambera (2001) reveals a different picture. It is argued that a high level of bank concentration would promote the expansion of industries relying heavily on the external finance due to increased “connected” lending.

As for banking deregulation, it is considered to be an effective way to promote banking competition. In particular for industries depending heavily on banking finance, a large number of new firms are found of entering into the market following banking

deregulation (Bertrand et al., 2007). As banks are competing fiercely for high quality customers, this may lead to the unequally expansion of smaller firms but limited impact on large firms (Ye et al., 2019). Therefore, it seems that the structure of banking market may generate different impacts on industries with different reliance on external finance (Rajan and Zingales, 1998).

3.2.3 The Effect of Distance on Bank Lending

While most of the previous studies confirm that the structure of the product market could be affected by the concentration level of the local banking sector, a few recent studies including Berger and DeYoung (2006) also point out that the factor, distance, or the influence of neighbouring banks, should also be considered when understanding the local product market structure. According to Hotelling (1929), distance is an important determinant of loan pricing for bank lenders and credit availability for borrowers (Petersen and Rajan, 2002), despite of the improvement in information processing (Berger and DeYoung, 2006) and communication technologies (Pana et al., 2015). In general, distance has been found of affecting banks' lending through two channels, the information collection channel and the cost of transportation channel (Lederer and Hurter, 1986).

To decide whether to lend or not, a bank needs to collect large amount of corporate and market information and the distance between the bank and the potential borrowers may affect the accessibility of such key information (Brevoort and Hannan, 2006; McKee and Kagan, 2016). As a result, compared with distant lenders, it is much easier for local banks to collect the information needed at a lower cost (Almazan, 2002). Sometimes, some private information can also be collected by local banks as they might also provide services to the suppliers and/or customers of the borrowing company within the same market. As the lending rate partially reflects the risks faced by banks, it is not surprise that a higher loan rate is charged for distant borrowers due to the accessibility and

reliability of the information collected (Hauswald and Marquez, 2006). On the other hand, for the borrowers, they may also incur information costs when searching for suitable lenders from non-local banks and this is especially the case for financially constrained firms (Degryse and Ongena, 2005). As a result, the information advantage of local banks would allow them to evaluate the financial condition of local borrowers more precisely and be approached by the local firms more easily (Ostromogolsky, 2016). However, the close relationship between local banks and local firms may also lead to the loss of social welfare as a higher loan rate might be charged to borrowers if the local banks exploit their market power and/or distant banks failed to allocate their funds effectively due to lack of business information (DeYoung et al., 2008).

Another channel through which distance affects banks' lending conditions is the transportation costs for both of the borrowers and lenders. As for the borrowers, the transportation cost is determined by the number of transactions incurred and the travel distance in between. If the cost of transportation is too high, this would make the offers of distance banks unattractive. Consequently, firms are found of more willing to borrow from local banks, even at a higher rate (Lederer and Hurter, 1986). A similar conclusion has also been reached by Almazan (2002), Degryse and Ongena (2005) that the increased costs of transportation has made it more likely for firms to choose services from local banks. As for the lenders, a longer distance may also increase the costs incurred as additional expenses is needed in information collection, site visiting, monitoring and communication (Sussman and Zeira, 1995). This is particularly the case for smaller borrowers with limited publicly available information. This also explains why a higher rate is charged by banks for distant borrowers as they need to be compensated for the additional costs incurred (Petersen and Rajan, 2002). Interestingly, in order to attract distant borrowers, banks are also found of advertising lower rate for distant borrowers at the beginning. However, to recover the costs of advertisement and/or expenses in maintaining relationships with brokers or other agents that interact with potential customers, a higher loan rate might be charged later (Brevoort and

Wolken, 2009; Tian and Han, 2019). We therefore made the following hypothesis 3.

H3: The product market structure seems more sensitive to local bank market than to neighbour state market.

Based on the discussion above, it can be concluded that although bank deregulation and advancement in information technology have transformed the geographical distribution of banking services and reduced the connection between banks and local economies. Distance remains an important factor that is considered by both of the banks and the potential borrowers. However, to the best of our knowledge, no paper has conducted comprehensive analysis related to the spatial effect of banking market competition on the structure of the product market so far. This study aims to fill in this gap. In addition to the impact of bank concentration generated on the structure of the local product market, the influences of neighbouring banks are also considered in our research. In addition, the different financial situations of firms are also considered as it may affects banks' lending behaviours directly.

3.3 Methodology

This study aims to investigate the impact of bank structure on product market structure based on firm-level data of the US. The first baseline model can be specified as the following:

$$I_{ist} = a_0 + a_1 local\ bank\ concentration_{st} + a_2 industry - level\ Control_{ist} + a_3 state - level\ Control_{st} + \theta_i + \varepsilon_{ist} \quad \text{(Eq. 3-1)}$$

Where I_{ist} measures the structure of industry i, state s, year t. It is proxied by the average firm size which is calculated by the natural logarithm of the number of employees per firm in industry i, state s and year t. It is believed that the larger the

average size of the firms in an industry, the more concentrate the industry is and *vice versa* (Cetorelli, 2001). The level of bank concentration, $local\ bank\ concentration_{st}$, is measured by the one-year lagged value of local banking market concentration in states, year t, in order to rule out the possible reverse causal relationship (Wang et al., 2020; Tan et al., 2022). θ_i captures the industry fixed effects.

As for the control variables, we include industry market share (Marketshare). As suggested by the industry life cycle theory, the matured industry tends to attract less new entrants (Cetorelli and Gambera, 2001). Therefore, a larger industry should have more concentrated market, so the tested coefficient should be positive. In addition, Rajan et al. (1999) identify several industry-specific and state-specific factors as possible determinants of industry firm size. For instance, the industry R&D intensity, the amount of employed human capital in state level, and GDP per capita are all possible characteristics, among many others, that are likely to affect a product market structure. For R&D intensity, it is measured as the percentage of R&D expenditure to the firm's revenue (Rajan et al., 1999), and we take the median value of firms in industry i, state s per year to represent the level of industry R&D intensity. This variable has been used by a few studies to control for the size of the firm as it is believed that a larger number of R&D investments tends to lead to faster company growth. For firms in R&D intensive industries, their size is also larger in general (Rajan et al., 1999). Therefore, in our study, we also expect that a positive relationship could be identified between R&D intensity and firm size. For GDP per capita, it is included to control for the macroeconomic conditions. It is measured as the ratio of annual GDP value of a state to its population number. For state with a higher GDP per capita, more smaller firms might be created as better economic environment may lead to increased business confidence and hence, a larger number of new entrants (Carbonara et al., 2016; Dyck and Ovaska, 2011; Munemo, 2017). However, it is also argued that existing firms tend to grow faster under favourable economic conditions as they may expand further to achieve scale economies (Rajan and Zingales, 1998). As a result, it is hard to predict

how GDP per capita would impact on the size of firms. Lastly, in terms of human capital, we use the percentage of the population with a high school or college degree in a state as the proxy for human capital, following Bonaccorsi di Patti and Dell'Ariccia (2004). For an economy with more highly educated individuals, an increased number of small firms could be created due to entrepreneurship (Rosen, 1982), while on the other hand, these highly skilled labours may also contribute to the fast growth of established firms, and there would be a positive relationship between human capital and firm size (Kremer, 1993) and Bonaccorsi di Patti and Dell'Ariccia (2004) find the negative relationship between human capital and firm creation is because of the low opportunity cost of high level education in environment with less business opportunities. Consequently, the educational level of human capital may contribute both positively and negatively to the competition level of the product market.

In the second step, we take the heterogeneities of different industries into consideration. Due to various reasons, different industries may have different dependence on external finance (Rajan and Zingales, 1998). If the banking market concentration is found to have an impact on product market competition, this effect should be more significant on industries with a higher level of dependence on the external finance (Gong et al., 2018). As a result, we include the interaction term, $local\ bank\ concentration_{st} * external_i$ to capture the impact of financial dependence in the following Eq. 3-2 for further analysis.

$$I_{ist} = a_0 + a_1 local\ bank\ concentration_{st} * external_i + a_2 employment\ share_{ist} + \theta_i + S_{st} + \varepsilon_{ist} \ldots\ldots\ldots \text{(Eq. 3-2)}$$

For the dummy variable, $external_i$, it takes the value of 1 if the industry has an above-medium level of dependency on external finance, whereas it equals to 0 if the industry's dependence on external finance is below the medium level. For θ_i, it captures the industry fixed effects, the differential effect across industrial sectors, absorbing the

common effect to all industries. Moreover, following the study of Cetorelli (2004), we also include the fixed state-time effect, as represented by the variable, S_{st} , into consideration. We do not control the time effects individually but incorporate the interaction term with the state effects instead, in order to avoid the problem of reverse causality and omitted variable biases (Rajan and Zingales, 1998).

In the last part, to consider the impact generated by the neighbouring banking market on the local product market, we replace the variable of local banking market concentration in Eq. 3-2 with the variable, Neighbour_HHI (by Neighbour_CR in the robustness test), to capture the neighbour-state banking concentration. It can be represented by the following Eq. 3-3.

$$I_{ist} = a_0 + a_1 neighbour\_state\ bank\ concentration_{st} * external_i + a_2 employment\ share_{ist} + \theta_i + S_{st} + \varepsilon_{ist} \ldots\ldots \text{(Eq. 3-3)}$$

Where the interaction term, $neighbour\_state\ bank\ concentration_{st} * external_i$ is used to capture the impact of neighbouring banks on market structure of industries with high external financial dependence. With reference to the study of Tian and Han (2019), we measure the neighbour-state bank concentration by considering the spatially heterogeneous relationships between the states. it is calculated by the inverse distance weights. Later in the robustness test, we use the average weight to measure the level of neighbour-state bank concentration.

As for the impact generated by the local-state banking market concentration and neighbour-state banking market concentration, we test them in separate models as the inclusion of both variables into one model may lead to potential multicollinearity problem (Tian and Han, 2019).

3.4 Data and the Variables

3.4.1 Data Source

Data used in this study are collected from various sources. Data related to the number of firms are collected from County Business Patterns, an annual survey published by the Census Bureau. Product market structure data is related to the industry-state level. The industry is decided by 2-digit North American Industry Classification System (NAICS). The banking market concentration is calculated for each state in the U.S. based on bank deposit data from the Federal Deposit Insurance Corporation (FDIC) and. Data of Hawaii and Alaska are excluded when investigating the effect of neighbour-state banking market concentration, due to isolated geographical location. In the US, a series of banking reforms were introduced from the 1970s to mid-1990s, and this has generated profound impact on banking operations (Johnson and Rice, 2008). Due to the gradual reform process of different States and the data constraint, we therefore employ data between 1997 and 2020 or this research. This allows us to have a full set of information on industry as well as the banking market to consider the effects of banking market deregulation in US.

3.4.2 Measurement of Banking Market Structure

The bank market structure refers to the level of concentration or competition in the banking industry. Two types of measurements are commonly used to measure banking market structure, the structural and the non-structural approaches. The former explains the behaviour and performance of banks from their respective market structural characteristics, and it is represented by the concentration ratio of banks. The commonly used two measures are N-bank concentration ratio (CRn) and Herfindahl-Hirschman Index (HHI). A higher level of concentration indicates that those largest banks have more market power and less competition among themselves (Khan et al., 2016; Hirschman,1964). The key advantage of the structure approach lies on its simplicity to

calculate and to understand but it is also criticised for not considering the behaviour of the entire banking sector and the potentially biased estimations.

As for the non-structural approach, the Lerner-Index and H-statistic are widely adopted (Lerner, 1934; Panzar and Rosse, 1987). Instead of focusing on the banking market structure, they try to analyse the competitiveness of banks by investigating their behaviours. The Lerner Index is constructed based on the theory of firm market power. It can be calculated as the difference between the firm's marginal cost and product price and a higher value indicates a stronger market power (Lerner, 1934). For the H-Statistic, it is defined as the sum of elasticities of gross revenue with respect to the prices of inputs (Panzar and Rosse, 1987). It equals to one if the sample bank comes from a long-run competitive equilibrium. The value of H-statistic between zero to one indicates bank market is monopolistic competition. Compared with the structural approach, the non-structural method could capture the changes of the market over time, and it does not need to define the "relevant market". However, the overestimation issue related to the Lerner approach (banks with high risks are assigned with high value), and the misevaluation of the H-Statistic (the statistic can be positive in a monopoly market and negative in a competitive market) have been widely criticised (Ariss, 2010; Beck et al., 2013; Bikker et al., 2012; Leon, 2015).

In this paper, we investigate the role played by banking market concentration on product market structure, following the research of Bain (1951), we adopt the Herfindahl–Hirschman concentration index (HHI) to measure the banking market concentration in the first place. Then in the later robustness test, the concentration ratio of the top-three banks is used.

For the HHI indicator, it can be calculated as the following:

$$HHI_{st} = \sum_{I=1}^{N} M_{st}^2$$

where N stands for the total number of bank in state s, year t. M represents the market share of bank b in state s, year t, in terms of bank deposit. If there are N banks in a market, we use the sum of square of the share of each individual bank to calculate the HHI index.

As for the concentration ratios of top-three banks and of top-five banks, they can be estimated as the following:

$$\text{CRK3}=\sum m_{ist}$$

$$\text{CRK5}=\sum n_{ist}$$

Where CRK3 is the sum of concentration ratio of top three banks in a given state s, year t, in terms of bank deposit. CRK5 is the sum of concentration ratio of top five banks in a given state s, year t. m_{ist} is the market share of each of the top three banks. n_{ist} is the market share of each of the top five banks. The market share of banks is calculated as the ratio of the total deposit of certain bank to the total deposits of the banking industry in a given state s and year t (Bikker and Spierdijk, 2008).

3.4.3 Measurement of Product Market Structure

In terms of the product market structure, the average firm size is measured by the ratio of total number of employees to the total number of firms, for sector i, state s, and year t or the value added of the whole industry to the total number of firms for sector i, state s and year t. Both of total employment and value-added terms are common indicators of firm size and output production (Kumar and Zingale, 1999). They are important measurements of an industry's capital accumulation and the subsequent contribution to the overall economic growth. Therefore, in this study, we use of the logarithm of average firm size as the dependent variable. In addition, another product market structure proxy is the number of firms per capita for sector i, state s, and year t. We use average firm size and the number of firms per capita and to proxy for the industrial

structure. In particular, a higher number of firms per capita and smaller average firm size suggest a more competitive industrial structure (Gong et al., 2018).

In addition, to control the relative importance of each industry in a state, we construct an industry share of employment (Marketshare) by considering the percentage of employment of certain industry to the total employment of the state for industry i, state s and year. This is because according to the industry life cycle hypothesis, when an industry experiences rapid growth and moves to the matured stage, it would become less attractive to new entrants due to tougher competition, narrowed profit margin and high entry barrier (Klepper, 1996). Similar conclusions have also been reached in previous studies that large industries which have experienced substantial growth in the past tend to grow less in the future (Rajan and Zingales, 1998; Cetorelli and Gambera, 2001). As a result, one may argue that the variable of industry share represents the stage of development an industry is experiencing. For firms in a matured industry, they tend to be large in size when compared with the average size of the firm in small and immature industries.

3.4.4 Dependence on External Financing

When analysing the impact of banking concentration on the structure of the product market, we also take the different levels of dependence on external finance into consideration. It is expected that for industries relying more on external financing, they are more likely to be affected by the banking market structure (Gong et al., 2018). Following the research of Rajan and Zingales (1998), we calculate the external financial dependence of a firm as capital expenditures minus cash flow from operations, divided by the total capital expenditure at all-year level[1]. For firms with a larger share of capital

[1] External finance dependence = (Capital expenditures(capx)-funds from operations (fopt)) / capital expenditures (capx). When fopt is missing, funds from operations is defined as the sum of the following variables: Income before extraordinary items (ibc), depreciation and amortization (dpc), deferred taxes (txdc), equity in net loss/ earnings (esubc), sale of property, plant, and equipment and investments-gain/loss (sppiv), and funds from operations-other (fopo).

expenditure that is not financed by cash from operations, they tend to depend more on external finance. In our study, the dummy variable takes the value of one if an industry's external dependence index is higher than the median value of all industries of the whole sample. Due to its high dependence on external finance, this particular industry is also considered of more likely to experience financial constraints. Otherwise, the variable takes the value of 0.

As suggested by Rajan and Zingales (1998), external finance reflects in the incubation period before assets begin to generate sufficient cash to finance the firm. Thus, we can be confident that differences in response to bank concentration across these two groups of industries reflect differences in their financing needs, rather than differences in their real investment behaviour[2].

3.4.5 Summary of Main Statistics

Table 3-A1-3-A3 presents the summary statistics of all variables used in the empirical analysis. In terms of the local banking market concentration, HHI, it ranges from 0.007 to 0.913 with an average of 0.164. For the neighbour-state banking market, neighbour_HHI, it ranges from 0.031 to 0.792 with an average of 0.174. The summary statistics of bank concentration shows that the variation of bank competition is large in the US. A similar conclusion could also be reached if we look at the concentration index of the top three banks (CRK3). In GA, it has the lowest CRK3 ratio of just 13.6%, while the highest CRK3 ratio is identified for OK, at 96.1%. In average, the top three banks have controlled about 48.2% of the total market share. The dependent variable in the baseline model is measured by average firm size which are represented by three variables, the logarithm of the number of employees, the logarithm of value added of each firm, and the number of firms per capita.

[2] Implicit in our identification strategy is the assumption that external financial dependence is constant over time, or at least that the industry ordering is not altered substantially. Since we compute external financial dependence using Compustat firms, presumably closer to industry steady state conditions, this assumption seems reasonable.

As for the dependence of external finance, the average of the whole sample suggests that in average, only about 17.9% of the capital needed by firms is required to borrow from external sources. Most industries seem to have good internal funding source, such as utilities and retail trade industries. On the other hand, the manufacturing industry is found of having the highest need for external funds, reaching a high level of almost 50%. Consequently, behaviour of banks could generate heterogeneous effects across industries due to their different level of financial dependence.

Table 3-A 1 Summary statistic of test variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Firmsize (Emp)	11351	3.360	1.551	0	12.310
Firmsize (Value)	11375	7.805	1.654	3.964	11.259
Firm capita	11375	0.001	0.001	0	0.005
HHI	11375	0.164	0.186	0.007	0.913
Neighbour HHI	11375	0.174	0.127	0.031	0.792
Marketshare	11375	0.017	0.060	0	0.996
RD	11375	0.010	0.030	0	0.140
High_Capital	11375	0.280	0.055	0.151	0.450
GDP growth	11375	0.045	0.012	0.021	0.086

Table 3-A 2 Industry-level external financial dependence

Naics code	External finance (%)	Mean (%)
Mining	18.1302	17.9117
Utilities	0.1500	17.9117
Construction	7.7987	17.9117
Manufacturing	49.0074	17.9117
Wholesale Trade	-8.1431	17.9117
Retail Trade	0.5266	17.9117
Transportation and Warehousing	-0.1061	17.9117
Information	12.0287	17.9117
Real Estate Rental and Leasing	-26.280	17.9117
Professional, Scientific, and Technical Services	-84.4090	17.9117
Management of Companies and Enterprises	16.7518	17.9117
Administrative and Support and Waste Management and Remediation Services	7.5712	17.9117
Educational Services	6.0165	17.9117
Health Care and Social Assistance	7.8481	17.9117
Arts, Entertainment, and Recreation	20.3500	17.9117
Accommodation and Food Services	1.1240	17.9117
Other Services (except Public Administration)	9.1901	17.9117

Table 3-A 3 State-level bank concentration

State	Mean (HHI)	Mean (CRK3)
AK	0.332	0.776
AL	0.285	0.309
AR	0.058	0.697
AZ	0.327	0.410
CA	0.080	0.323
CO	0.078	0.585
CT	0.157	0.707
DE	0.209	0.237
FL	0.034	0.646
GA	0.339	0.136
HI	0.272	0.403
IA	0.015	0.456
ID	0.098	0.300
IL	0.101	0.213
IN	0.047	0.202
KS	0.024	0.470
KY	0.025	0.611
LA	0.114	0.338
MA	0.287	0.526
MD	0.063	0.493
ME	0.199	0.313
MI	0.108	0.328
MN	0.082	0.496
MO	0.046	0.499
MS	0.106	0.949
MT	0.124	0.305
NC	0.566	0.391
ND	0.059	0.488
NE	0.073	0.372
NH	0.141	0.371
NJ	0.067	0.868
NM	0.068	0.750
NV	0.598	0.348
NY	0.168	0.574
OH	0.369	0.411
OK	0.060	0.961
OR	0.226	0.432
PA	0.077	0.807
RI	0.775	0.462
SC	0.089	0.310
SD	0.482	0.606
TN	0.108	0.619
TX	0.045	0.533
UT	0.194	0.429
VA	0.181	0.356
VT	0.157	0.449
WA	0.100	0.322
WI	0.077	0.482
WV	0.086	0.776
WY	0.070	0.309
Total	0.164	0.697

3.5 Empirical Results

Before analysing the regression results, we first test the correlation between the main

variable and summarise the results in Table 3-2. The independent variables are not highly correlated. When the product market competition is measured by the average firm size, there is a positive relationship between the average firm size (Firmsize_Emp, Firmsize_Value) and bank market concentration, irrespective of the measurement chosen (local (HHI) or neighbour-state bank market (Neighbour_HHI). The bank market concentration (HHI_External, and NHHI_External) seems to have a negative correlation with the average firm size in industries which depend more heavily on external finance.

We then apply Eq. 3-1, the baseline model, and summarise the results in Table 3-3 below. Column 1 to column 3 are the results when the logarithm of the number of employees of each firm, the logarithm of value added per firm in industry i, state s and year t and the number of firms per capita is used as the dependent variable respectively. As for the proxy for local bank concentration, the HHI is used. As a higher number of firms per capita and smaller average firm size suggest a more competitive industrial structure (Gong et al., 2018), the statistical results indicate that in general, a higher level of bank concentration would lead to a higher level of concentration of the product market, except when the product market competition is measured by the number of employments. This is consistent with the market power hypothesis (MPH) that a highly concentrated banking market may lead to reduced competition of the product market as the banks may exploit their monopoly power by charging higher loan rates from customers (Klein, 1971). The more concentrated the product market structure, involving a smaller number of firms, and greater probability that firms will achieve a joint price-output configuration that approaches a monopolistic solution (Berger, 1995; Berger et al., 2004). In addition, highly concentrated banking market has effectively made it hard for the new entries to get the financial support needed (Cetorelli and Gambera, 2001). The insignificant relationship between HHI and Emp might because the employee number is no longer a suitable proxy for firm size due to the rapid development of information technology.

Regarding the control variables, the GDP per capita and human capital are found of

being able to affect the firm size significantly. As for GDP per capita, it is found of contributing negatively to product market competition. It therefore suggests that a better economic environment may stimulate the growth of large firms more rapidly, making the product market more concentrated (Rajan and Zingales, 1998). This is further confirmed by the significant negative relationship between GDP per capita and Firm per capita. A favourable economic condition would reduce the average number of firms owned by each individual. This is as expected that an economic boom may increase market confidence and lead to increased mergers and acquisitions (Ali-Yrkkö, 2002). A similar story has also been identified for human capital (Human_capital) and product market concentration. For states with high quality human capital, their product markets tend to be more concentrated, consistent with the conclusion reached by Rosen (1982) and Kremer (1993). As the talented individuals are more likely to be attracted by large firms, a higher entry barrier would be built up. Consequently, the competitive advantages of those market leaders would be further strengthened, making the product market more concentrated.

For the other control variables, the coefficients have the expected signs, but they are statistically insignificant. For Marketshare, it has only got a statistically significant positive relationship with the employee-based firm size, suggesting that industries with a larger market share are also more likely to have a larger number of employees. This is as expected and consistent with previous studies (Gong et al., 2018). However, when the firm size is measured by the value added, it is not always the case as firms with a larger number of employees are not necessarily to have a higher value-added. This is especially the case for firms operating in conventional industries. As for R&D investment, it has insignificant relationship with all three firm size measurements. In other word, for firms with larger R&D investment, it does not necessarily mean that their size is bigger. This is not surprised as the technological development has made many start-ups in emerging industries invest heavily in R&D in order to survive and to compete with existing firms.

In the next step, considering the different external financial dependence of industries, we test the industry-specific effect based on the specification in Eq. 3-2 and report the results in Table 3-4 below. We use the same set of variables to represent the product market competition level, but employ the interaction term, HHI_External, to represent the joint impact of local bank concentration and industries' relative dependence on external finance. In addition, we control for state-year and industry fixed effects. As we are not trying to identify the first-order effects, we can therefore drop the vector of state controls but include the state dummy instead.

Table 3-2 Correlation between main variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firmsize (Emp)	1.000										
(2) Firmsize (Value)	0.639***	1.000									
(3) Firm_capita	-0.776***	-0.710***	1.000								
(4) HHI	0.009	0.034***	-0.025***	1.000							
(5) Neighbour_HHI	-0.006	0.046***	0.001	0.082***	1.000						
(6) HHI_External	-0.006	-0.017*	0.009	0.011	-0.011	1.000					
(7) NHHI_External	-0.029***	0.002	0.004	-0.011	-0.008	0.064***	1.000				
(8) Marketshare	0.035***	-0.03***	-0.016*	-0.004	0.001	0.020**	-0.001	1.000			
(9) R&D	0.038***	0.058***	-0.074***	0.011	0.060***	0.012	0.046***	0.017*	1.000		
(10) Human_capital	0.028***	0.110***	0.040***	0.025***	0.328***	0.003	-0.011	-0.077***	0.069***	1.000	
(11) GDP_percapita	0.075***	0.222***	-0.057***	0.108***	0.357***	0.001	-0.015	-0.036***	0.041***	0.072**	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Table 3-3 Baseline regression

Variables	Dependent variable=Average firm size Emp	Value	Firm_capita
	(1)	(2)	(3)
HHI	0.0108	0.2380***	-0.0001***
	(0.0752)	(0.0612)	(2.65e-05)
Marketshare	0.5630**	0.2530	2.51e-05
	(0.2440)	(0.1980)	(8.59e-05)
R&D	0.0233	0.2340	3.65e-05
	(0.4180)	(0.3400)	(0.0001)
GDP_percapita	8.0920***	32.2800***	-0.0052***
	(1.4760)	(1.2000)	(0.00052)
Human_capital	3.6370***	5.6110***	-0.0026***
	(0.5320)	(0.4330)	(0.0002)
Constant	3.3500***	7.8040***	0.0010***
	(0.0089)	(0.0072)	(3.14e-06)
Observations	11,737	11,737	11,737
R-squared	0.4500	0.3310	0.1530
Number of ns	652	652	652
F	103.4000	1097	401.4000

Note: This table reports regression results relating banking concentration to the structure of product market. The dependent variables are the natural logarithm of the number of employments per firm, natural logarithm of value added per firm and the number of number of firms per capita in industry i, state s and year t. HHI measures the concentration levelof local banking market. Standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

It can be found that when the state-year and industry fixed effects are controlled, a higher level of banking concentration would reduce the average size of firms that operate in financially constrained industries, as indicated by the decreased value-added and the increased number of firms per capita. In other word, a concentrated banking market would stimulate the competition of the product market with highly external financial dependence. This is consistent with Petersen and Rajan (1995), who find that younger firms can obtain more credit in a concentrated market for a sample of SMEs in the US. As suggested by the information-based hypothesis (IBH), the increased market power of leading banks would make it possible for them to collect more information of firms. This allows them to exert a stronger monitoring and screening power and hence assisting the development of relatively opaque smaller firms and start-ups. However, when the product market concentration is measured by the employment number, the tested relationship is negative but insignificant. This is not surprised as the employee number is no longer a good measurement of firm size due to the development of

information technology. In particular, for the newly start-ups, many of them are operating in emerging industries, this has made the employee number become even less relevant to firm size.

In terms of Marketshare, in our regression. It is found of having a positive relationship with all product market concentration measurements. It means for industries with highly external financial dependence, they tend to have a large firm size with large market share, no matter measured by the employee number, the value added or the number of firms per capita. The reason might be matured industries with highly external financial need, the existing firms in such industries have establish a stable relationship with financial institutions, which makes it hard for new entrants to obtain external financial support. The result is consistent with the study of Cetorelli and Strahan (2006).

Based on the above analysis, one may conclude that in general, bank concentration could generate a negative effect on product market competition as bank lending is mainly directed to larger firms. However, when the concentration level of banks and the financial dependence of industries are considered jointly, it can be found that actually, a higher level of bank concentration could effectively stimulate the development of firms in financially constrained industries. This is particular important as most of the new establishments are operating in emerging industries which are critical for a countries economic advancement. Therefore, the tested results indicates that bank concentration could affect firms from different industries differently depending on their dependence on external finance.

Table 3-4 The interactive effect between local bank concentration and industry external financial dependence on the product market structure

Variables	Dependent variable=Average firm size; measured in Emp	Value	Firm_capita
	(1)	(2)	(3)
HHI_External	-0.1530	-0.2680***	5.79e-05**
	(0.1190)	(0.0718)	(2.88e-05)
Marketshare	0.6260***	0.7220***	-0.0001**
	(0.1640)	(0.1810)	(6.07e-05)
Observations	11,736	11,736	11,736
R-squared	0.7880	0.8810	0.8870
Industry FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	8.0530	14.2300	4.1220

Note: This table reports regression results relating banking concentration to the structure of product market. The dependent variable is measured by the average firm size, which is measured by the natural logarithm of the number of employees per firms (Emp) in industry i, state s and year t and the natural logarithm of the value added per firm (Value) in industry i, state s and year t, and the number of firms per capita (Firm_capita) in industry i, state s and year t. HHI_External represents the interaction term between bank concentration (HHI) and industry external financial dependence dummy variable the dummy variable equals to one when industries have above-median needs for external sources of fundings. Regressions are estimated using panel data with industry-year and state-year fixed effects in the first columns and estimated using panel data with industry and state-year fixed effects in the last columns. Standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

In the next part, we will test the effect of neighbouring banking industry in Eq. 3-3. The results are reported in Table 3-5. The variable NHHI_External represents the interaction between the concentration level of neighbouring banking market and the financial dependence of industries. Model (1)-(3) measure the product market competition is measured by employment-based average firm size, value added-based average firm size and number of firms per capita, respectively. In general, consistent with the finding obtained in Eq. 3-2, a significant negative relationship has been detected between the concentration level of neighbouring banking industry and the competition level of local product market. For example, a 1 increase in NHHI_External would decrease the number of employments per firms in an external-financial dependent industry by 42%. When the neighbouring banking sector is highly concentrated, the local industries would become more competitive, in particular if they rely heavily on bank lending. This is consitent with expectations and previous studies

that development of information technology, such as social connection has effectively blurred the geographical boundary of different regions (Rehbein and Rother, 2020). In particular, for those big banks, their strong market position allows them to access the information needed of neighbouring firms when making lending decisions. What is more, loan rates decrease with the distance between the firm and the lending bank (Degryse and Ongena, 2003). That explains why the development of the local product market could be affected by the structure of neighbouring banking industry as well.

As for the control variable, Marketshare, it is found of having a statistically significant relationship with all three firm size measurements. It again confirms that firms in matured industries tend to have larger size, and this has effectively set up higher entry barrier for new entrants and reduced the competition of the product market.

Table 3-5 The interactive effect between neighbour-state bank concentration and firm external financial dependence on the product market structure

	Dependent variable=Average firm size; measured in		
Variables	Emp	Value	Firm_capita
	(1)	(2)	(3)
NHHI_External	-0.8630***	0.0327	0.0001***
	(0.1910)	(0.1170)	(4.39e-05)
Marketshare	0.5750***	0.7090***	-0.0001**
	(0.1630)	(0.1800)	(6.04e-05)
Observations	11,374	11,374	11,374
R-squared	0.7920	0.8810	0.8870
Industry FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	16.4100	7.8180	7.3640

Note: The dependent variable is measured by the average firm size, which is measured by the natural logarithm of the number of employees per firms (Emp) in industry i, state s and year t and the natural logarithm of the value added per firm (Value) in industry i, state s and year t, and the number of firms per capita (Firm_capita) in industry i, state s and year t. NHHI_External represents the interaction term between bank concentration (HHI) and industry external financial dependence dummy variable the dummy variable equals to one when industries have above-median needs for external sources of fundings. Regressions are estimated using panel data with industry and state-year fixed effects. Standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

In the last part, we restrict the observation period in order to control for the potential impact of financial crisis. The global financial crisis of 2008–2010 has violated the stability of global financial system and led prolonged economic recession across the

world (Košak et al., 2015). Following the collapse of Lehman Brothers in September 2008, bank creditors panicked and started withdrawing their funds, causing banks to struggle with debt rollovers. This led to a significant drop in new lending across all loan types during the financial crisis (Ivashina and Scharfstein, 2010). We therefore divide the sample period into two sub-parts, the financial crisis periods (FC) and non-financial crisis period (NFC) and re-run above models. The results are summarised in Table 3-6. In Panel A, we test the impact of local banking market concentration on the product market competition based on two different time period, FC and NFC and the Panel B focuses on the impact generated by the neighbouring banking market. Model (1)-(2) are the regression when the product market competition is represented by the average firm size based on the number of employments per firm. Model (3)-(4) are the regression when the product market competition is represented by the average firm size based on the value added per firm, and Model (5)-(6) product market competition is represented by the average firm size based on the number of firm per capita.

It can be found that for both of the local and neighbouring banks, only limited impact is generated during the financial crisis period when compared with non-crisis period. This is consistent with expectation as the crisis has generated substantial turmoil in the global financial market, depleted the banking credit and hence reduced their impact on the product market (Gorton, 2010). Due to the increased volatilities, problems of asymmetric information and limited contractibility were exaggerated, prompting banks, even healthy ones, to curtail lending to riskier borrowers ("flight to quality") or raise lending spreads (Dell'Ariccia et al., 2004). Meanwhile, on the demand side, the lack of market confidence has led firms to curtail their spending and investments, leading to significant fall in demand for funding (Kahle and Stulz, 2013). Last but not least, it also points out that that the number of new business registration has also reduced significantly during the financial crisis due to increased market uncertainties and financing difficulties, which is consistent with Claessens et al. (2012). That explains why the tested relationship between bank concentration and product market

competition is more significantly during the non-crisis period.

In terms of market share variable (Marketshare), which represents the importance of industries in a market and the development stage of the industries, the significant coefficient suggests that matured industries are less competitive during the non-financial crisis periods. This is consistent with the argument that mature industries would become less attractive to new entrants due to the high entry barrier and limited future growth potential (Rajan and Zingales, 1998).

Table 3-6 The impact of financial crisis

	Dependent variable=Average firm size measured in					
Variables	Emp	Emp	Value	Value	Firm_capita	Firm_capita
	(FC)	(NFC)	(FC)	(NFC)	(FC)	(NFC)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
HHI_External	-0.1630	-0.1660	-0.1670	-0.2850***	4.90e-05	5.85e-05*
	(0.2040)	(0.1360)	(0.1880)	(0.0779)	(4.83e-05)	(3.29e-05)
Marketshare	0.2410	0.7690***	0.5690	0.7420***	-4.51e-05	-0.0001**
	(0.2890)	(0.1930)	(0.5710)	(0.1890)	(0.0001)	(6.68e-05)
Observation	1,579	10,133	1,579	10,157	1,579	10,157
R-squared	0.9420	0.7930	0.8870	0.8810	0.9290	0.8810
Industry FE	YES	YES	YES	YES	YES	YES
State-Year FE	YES	YES	YES	YES	YES	YES
F	6.1990	8.6420	8.7230	13.740	2.5360	3.6160
Panel B						
NHHI_External	-1.0400***	-0.8420***	0.0300	0.0352	0.0001	0.0001***
	(0.2860)	(0.2240)	(0.3170)	(0.1250)	(8.92e-05)	(4.85e-05)
Marketshare	0.2240	0.7120***	0.5480	0.7300***	-5.06e-05	-0.00015**
	(0.2880)	(0.1920)	(0.5660)	(0.1890)	(0.0001)	(6.65e-05)
Observations	1,531	9,820	1,531	9,843	1,531	9,843
R-squared	0.9440	0.7950	0.8870	0.8810	0.9290	0.8810
Industry FE	YES	YES	YES	YES	YES	YES
State-Year FE	YES	YES	YES	YES	YES	YES
F	6.8930	14.2200	4.7110	7.5460	3.0090	6.4130

Note: The dependent variable is measured by the average firm size, which is measured by the natural logarithm of the number of employees per firms (Emp) in industry i, state s and year t and the natural logarithm of the value added per firm (Value) in industry i, state s and year t, and the number of firms per capita (Firm_capita) in industry i, state s and year t. HHI_External measures the interaction between local HHI and external financial dependence dummy variable, NHHI_External measures the interaction between neighbour-state HHI and external financial dependence dummy variable. In addition, financial crisis time is proxied by FC, and non-financial crisis time is proxied by NFC. The models are estimated using panel data with industry and state-year fixed effects. Standard errors in parentheses.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

3.6 Robustness Test

In this section, we undertake three robustness tests to further verify the validity of the conclusions reached. First of all, following the research of Gong et al. (2018), we use an alternative model which controls both $market\ trend\ _{st}$ and $industry\ trend_{it}$.

$$I_{ist} = a_0 + a_1 local\ bank\ concentration_{st} * external_i + a_2 employment\ share_{ist} + industry\ trend_{it} + market\ trend\ _{st} + \varepsilon_{ist} \ldots\ldots\ldots\ldots\ldots \text{(Eq. 3-4)}$$

Where $industry\ trend_{it}$ is industry-year fixed effects, capturing time-varying and industry-specific shocks, such as technological innovation. The variable, $market\ trend\ _{st}$is state-year fixed effects, capturing time-varying demand shocks in the local market. By capturing states and industry specific unobserved factors, it is expected that the inclusion of these two variables could effectively mitigate problems related to over omitted variables and reverse causality (Gong et al., 2018).

The results in Table 3-7 (Panel A) are in line with earlier findings about local banking market concentration based on Eq. 3-2, and the results in Table 3-7 (Panel B) are consistent with earlier findings about neighbouring-state banking market concentration based on Eq. 3-3. They both in support of the information-based hypothesis that the bank market concentration can promote the product market competition (Petersen and Rajan, 1995). In particular, when the product market relies heavily on external finance, a higher level of bank concentration would lead to reduced firm size and hence, increased competition.

Secondly, we re-estimate our specifications by using two alternative proxies for bank market concentration, the top-three banks concentration ratio, and the top-five bank concentration ratio (Cetorelli and Gambera, 2001; Cetorelli, 2004). The results are

summarised in Table 3-8. Model (1)-(3) represents the regression when the bank market concentration is measured by the top-three banks concentration ratio and Model (4)-(6) represent the regression when the bank market concentration is measured by the top-five banks concentration ratio. For Panel A and Panel B, again, it separates the impact generated local banks and neighbouring banks.

Table 3-7 Robustness test

	Dependent variable=Average firm size		
Variables	Emp	Value	Firm_capita
Panel A			
	(1)	(2)	(3)
HHI_External	-0.2000**	-0.2600***	2.81e-05
	(0.1010)	(0.0665)	(2.03e-05)
Marketshare	0.6840***	0.7410***	-0.0002***
	(0.1940)	(0.1780)	(4.67e-05)
Observations	11,736	11,736	11,736
R-squared	0.8670	0.9040	0.9310
Industry-Year FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	7.5900	15.4300	6.3450
Panel B			
	(4)	(5)	(6)
NHHI_External	-1.1030***	0.0515	7.16e-05**
	(0.1520)	(0.1130)	(3.20e-05)
Marketshare	0.6350***	0.7310***	-0.0002***
	(0.1930)	(0.1770)	(4.66e-05)
Observations	11,374	11,374	11,374
R-squared	0.8700	0.9040	0.9310
Industry-Year FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	30.9900	8.6100	9.2630

Note: The dependent variable is measured by the average firm size, which is measured by the natural logarithm of the number of employees per firms (Emp) in industry i, state s and year t and the natural logarithm of the value added per firm (Value) in industry i, state s and year t, and the number of firms per capita (Firm_capita) in industry i, state s and year t. HHI_External measures the interaction between local HHI and external financial dependence dummy variable, NHHI_External measures the interaction between neighbour-state HHI and external financial dependence dummy variable. In addition, financial crisis time is proxied by FC, and non-financial crisis time is proxied by NFC. The models are estimated using panel data with industry-year and state-year fixed effects. Standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

In general, the results are consistent with above findings. A higher level of bank

concentration in both of local and neighbouring banking market could increase the competition level of the local product markets with high external financial dependence. No matter how the concentration level of the banking market is measured, the results remain robust.

Table 3-8 Robustness tests – the alternative measurement of banking concentration

	Dependent variable=Average firm size			Dependent Variable=Average firm size		
Variables	Emp	Value	Firm_capita	Emp	Value	Firm_capita
Panel A						
	(1)	(2)	(3)	(4)	(5)	(6)
CRK3_External	-0.1730**	-0.2390***	4.25e-05*			
	(0.0872)	(0.0567)	(2.35e-05)			
CRK5_External				-0.1700*	-0.2290***	2.17e-05
				(0.0880)	(0.0583)	(2.40e-05)
Marketshare	0.6310***	0.7260***	-0.0001**	0.6320***	0.7270***	-0.0001**
	(0.1640)	(0.1810)	(6.07e-05)	(0.1640)	(0.1810)	(6.06e-05)
Observations	11,736	11,736	11,736	11,736	11,736	11,736
R-squared	0.7880	0.8810	0.8870	0.7880	0.8810	0.8870
Industry FE	YES	YES	YES	YES	YES	YES
State-Year FE	YES	YES	YES	YES	YES	YES
F	9.3250	15.9000	3.7470	9.1840	14.5100	2.6180
Panel B						
	(7)	(8)	(9)	(10)	(11)	(12)
NCRK3_External	-0.7460***	-0.0580	0.0001***			
	(0.1530)	(0.0945)	(3.76e-05)			
NCRK5_External				-0.6890***	-0.1520	0.0001***
				(0.1590)	(0.0977)	(3.85e-05)
Marketshare	0.573***	0.709***	-0.000136**	0.573***	0.709***	-0.000136**
	(0.1620)	(0.1800)	(6.04e-05)	(0.1630)	(0.1800)	(6.04e-05)
Observations	11,374	11,374	11,374	11,374	11,374	11,374
R-squared	0.7920	0.8810	0.8870	0.7920	0.8820	0.8870
Industry FE	YES	YES	YES	YES	YES	YES
State-Year FE	YES	YES	YES	YES	YES	YES
F	18.6200	7.9090	9.9940	15.970	8.8010	9.7230

Note: This table reports regression results relating banking concentration to the structure of product market. The dependent variable is measured by the average firm size, which is measured by the natural logarithm of the number of employees per firms (Emp) in industry i, state s and year t and the natural logarithm of the value added per firm (Value) in industry i, state s and year t, and the number of firms per capita (Firm_capita) in industry i, state s and year t. NCRK3_External measures the interaction between neighbour-state three-bank concentration ratio and external financial dependence dummy variable and NCRK5_External measures the interaction between neighbour-state five-bank concentration and external financial dependence dummy variable. Regressions are estimated using panel data with industry and state-year fixed effects. Standard errors in parentheses. *, **, and *** denote

significance at the 10%, 5%, and 1% levels, respectively.

Table 3-9 Robustness tests –The alternative measure of neighbour_state banking competition

	Dependent variable=Average firm size		
Variables	Emp	Value	Firm_capita
Panel A	(1)	(2)	(3)
NHHI_External	-0.9140***	0.1870	0.0001**
	(0.2200)	(0.1320)	(5.16e-05)
Marketshare	0.5890***	0.7110***	-0.0001**
	(0.1630)	(0.1810)	(6.06e-05)
Observations	11,727	11,727	11,727
R-squared	0.7910	0.8810	0.8870
Industry FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	15.0700	8.8530	4.3530
Panel B			
	(4)	(5)	(6)
NCRK3_External	-0.8540***	0.0672	0.0001***
	(0.1650)	(0.1020)	(4.09e-05)
Marketshare	0.5860***	0.7120***	-0.0001**
	(0.1630)	(0.1810)	(6.06e-05)
Observations	11,727	11,727	11,727
R-squared	0.7910	0.8810	0.8870
Industry FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	20.4000	8.0450	6.1560
Panel C			
	(7)	(8)	(9)
NCRK5_External	-0.8250***	-0.0338	0.0001***
	(0.1700)	(0.1040)	(4.15e-05)
Marketshare	0.5860***	0.7130***	-0.0001**
	(0.1630)	(0.1810)	(6.05e-05)
Observations	11,727	11,727	11,727
R-squared	0.7910	0.8810	0.8870
Industry FE	YES	YES	YES
State-Year FE	YES	YES	YES
F	18.6900	7.7990	6.4590

Note: This table reports regression results relating banking concentration to the structure of the product market. The dependent variable is measured by the average firm size, which is measured by the natural logarithm of the number of employees per firms (Emp) in industry i, state s and year t and the natural logarithm of the value added per firm (Value) in industry i, state s and year t, and the number of firms per capita (Firm_capita) in industry i, state s and year t. NHHI_External measures the interaction between neighbour-state HHI and external financial dependence dummy variable, NCRK3_External measures the interaction between neighbour-state three-bank concentration ratio and external financial dependence dummy variable and NCRK5_External measures the interaction between neighbour-state five-bank concentration and external financial dependence dummy variable. Regressions are estimated using panel data with industry and state-year fixed effects. Standard errors in parentheses. *, **, and ***

denote significance at the 10%, 5%, and 1% levels, respectively.

Lastly, we also change the measurement of neighbour-state banking market concentration. The results are presented in Table 3-9. In Panel A, the variable NHHI_External represents the interaction between the concentration level of neighbouring banking market (based on HHI) and the financial dependence of industries, while in Panel B and C, the variable is replaced by NCRK3_External (the concentration level based on the top-three bank market ratio * external finance dependence) and NCRK5_External (the concentration level based on the top-five bank market ratio * external finance dependence) respectively. It can be found that all results are in support of our conclusion that the concentration level of neighbouring banking industry could affect the structure of local product market. When the concentration level is higher, more competitional could be instilled into the local product market, leading to a reduced average firm size of the industry. Therefore, it again confirms that the tested results are robust and are not subject to changes of the measurement used for neighbouring banking market structure.

3.7 Conclusion

This paper presents new evidence on the causal relationship between banking concentration and the structure of the product market based on comprehensive dataset of the US firms and banks. Three market structure indicators-HHI, Top-three (CRK3) and Top-five banks concentration ratio (CRK5) are used to measure banking market concentration while the product market concentration is measured by the employments-based average firm size, the valueadded-based average firm size and by the number of firms per capita. In addition to the impact generated by local banks, the spatial effect of neighbouring banks generated to the product market have also been considered in this study.

Using data of US banks and firms collected from various databases over the period of

1997-2020, the fixed effects models are conducted. It is concluded that bank market concentration, measured by HHI of both of the local and neighbouring banking market would have first-order negative effect on level of competition of the local product market. This finding is consistent with the market power hypothesis (MPH)that higher bank concentration results in a lower amount of credit available in the economy as a whole. Regardless of their external financial dependence, this effect is common to all industrial sectors. However, we also find the evidence that the effect of bank concentration turns to be opposite when the industry is highly external financial dependent. This finding supports models predicting that concentration of market power in banking facilitates the development of lending relationships, which have in turn an enhancing effect on product market competition.

Moreover, this study further investigates the impact of financial crisis on the identified relationship between bank concentration and product market competition. It is concluded that due to lack of liquidity and increased uncertainties during the crisis period, banks are reluctant to lend, especially to firms in financial-constrained industries. Consequently, a relative weak relationship is identified between bank competition and product market concentration during the period of financial crisis.

Therefore, the evidence of this paper thus indicates that banking market structure has a significant impact on important structural characteristics of sectors of production. It seems that the concentration of the banking market affects the competition level of product market structure, but the impact can be different in different time period and/or among firms with different external financial conditions. It mainly contributes to the literature on the real effects of banking market concentration, as well as the more general literature on the effects of bank financing.

The policy implications associated with this issue are especially relevant. Consistent to existing empirical evidence, firstly, the results show clear evidence on the favourable

real effects of bank market concentration for industries with highly external financial dependence, not only locally at home state, but overall, in a much wider region on industries with highly external financial dependence. Therefore, Thus, we cannot rule out that regulatory changes aimed at fostering competition in the banking industry could have significant repercussions not only on credit supply but also on its allocation across different types of borrowers and segments of the economy. In such a case, the effectiveness of banking sector reforms in promoting growth and innovation would vary depending on the sectoral composition of the economy. Second, financial crisis is detrimental to both financial market and real economy, therefore policy makers should undertake unprecedented actions to stabilize financial markets.

Chapter 4 Bank Competition, Capital Adequacy and Liquidity Creation

4.1 Introduction

Banks play a critical role in an economy, bridging the fund from short-term liquid liabilities to long-term illiquid assets. By doing so, banks provide households with insurance against idiosyncratic consumption and depositors' on-demand liquidity (Bryant 1980; Diamond and Dybvig, 1983). In addition, banks create liquidity off the balance sheet through loan commitments and similar claims to liquid funds (Holmström and Tirole, 1998; Kashyap et al., 2002). Compared with bank loans, liquidity creation covers a broader range of banking activities such as off-balance sheet financing. It is therefore considered a better measurement of banks' total output (Berger et al., 2019; Berger and Bouwman, 2009; Berger and Sedunov, 2017; Davydov et al., 2018). Many existing studies have also proved that bank liquidity creation is critical to a country's economic growth and financial stability (Berger and Sedunov, 2017; Fidrmuc et al., 2015). However, the creation of additional liquidity also increases the risk exposure of banks (Fungáčová et al., 2015; Berger and Bouwman, 2017). The 2008 financial crisis is a good example of this. When banks hold only limited number of financial resources and fail to prepare adequately for future uncertainties, the crisis may occur (Chatterjee, 2018). Meanwhile, as an essential component of a country's monetary policy transmission channel, healthy and well-functioning banking industry is also of regulatory concern as it would directly impact liquidity provision and economic growth. This has therefore made the comprehensive study of banks' liquidity creation of great interest.

Over the past decades, to improve the allocative efficiency of the banking industry, a series of reforms, such as the Riegle-Neal Act of 1994 and the Interstate Banking and

Branching Efficiency Act (IBBEA), were implemented to deregulate the sector. This has also increased the industry's competitiveness (Berger and Mester, 2003). As the market power of banks may directly affect their loan pricing, a thorough understanding of the banking market structure would be useful as it can be used to predict their lending behaviours (Vanhoose, 1985). In general, two schools of thoughts are widely quoted when investigating the relationship between bank competition and liquidity creation, the "competition-fragility" and the "competition-stability" theories. The former argues that increased competition may squeeze the profit margin of banks, lowering their risk absorption capacity and hence leading to reduced liquidity creation (Boyd and De Nicolo, 2005; Peydro et al., 2016). While the latter suggests that as bank competition may stimulate financial innovations, and bank liquidity creation can be regarded as one of them, intensified competition may lead to increased liquidity creation (Laeven et al., 2015). Meanwhile, if this also facilitates information dissemination, the overall market confidence could then be enhanced, resulting in increased demand (Jiang et al., 2016). Consequently, a healthy borrowing-lending cycle could be formed. Although a few studies are conducted to test the above two hypotheses, the conclusions are inconsistent.

In addition, another incident that triggered increasing attention on bank liquidity creation is the 2008 financial crisis. After that, a stricter requirement on bank capital adequacy was imposed, as manifested by Basel III. To maintain a higher level of capital adequacy, banks need to cut lending, leading to reduced liquidity supply but, potentially, a higher level of asset quality. A few studies have been done to evaluate the impact of bank capital adequacy on liquidity creation in different countries. Berger and Bouwman (2009) find that the relationship between bank capital and liquidity creation is favourable for large banks while negative for small banks in the US. It is explained that for larger banks, the "risk absorption" hypothesis is more suitable but for the smaller banks, their lending behaviours are more dominated by the "financial fragility-crowding out" hypothesis. Some others argue that there is actually dual causality relationship between bank capital adequacy and liquidity creation, but such relationship

can be both negative (Horváth et al., 2014; Distinguin et al., 2013) or positive (Tran et al., 2016). This is mainly because banks from different countries and periods, crisis vs. non-crisis periods, are employed for the study. Based on the discussion above, it seems that, again, no consensus has been reached about the role played by bank capital adequacy requirements and liquidity creation. Therefore, additional research is needed.

Despite of the importance of liquidity creation, the empirical research conducted remains limited. This might be due to the absence of a comprehensive bank liquidity creation measurement. In 2004, Deep and Schaefer (2004) propose the liquidity transformation gap index as a proxy for liquidity creation. It uses the terms to maturity of loans to measure the liquidity condition but fail to take the off-balance sheet activities into consideration. In practice, off-balance sheet finance can be an important source for banks' liquidity creation (Holmstrom and Tirole, 1998). Later in 2009, Berger and Bowman develop a more comprehensive measurement to capture bank liquidity creation. It not only incorporates the off-balance sheet activities but also adopts different classification criteria for bank liquidity creation. Nevertheless, the method is also criticised for its high dependence on the quality of input data (D'Avino et al., 2021), which has limited its application to single and developed countries. Therefore, D'Avino et al. (2021) propose another method, Aggregate Bank Liquidity Creation (A-BLC), incorporating the macroeconomic, country-wide, banking systems' balance sheet data into consideration. In this paper, as our focus is on the US market, we will adopt the measurement proposed by Berger and Bowman (2009).

Employing a sample of US banks over the period of 1997 to 2020, we are going to advance the understanding of determinants of bank liquidity creation by exploring the interrelationship of bank competition, bank capital adequacy requirement and bank liquidity creation. In particular, we will investigate whether increased bank competition and capital requirement would lead to reduced liquidity creation. This paper contributes to the existing study on the topic area in the following aspects.

First of all, we contribute to the literature on bank liquidity creation. Due to lack of comprehensive bank liquidity creation measures, only few studies were done empirically to investigate its determinants, e.g. equity ratio (Berger and Bouwman, 2009), corporate governance (Diaz and Huang, 2017), and real economic output (Berger and Sedunov, 2017). This study incorporates two major factors, bank competition and capital adequacy control, into consideration. Not only their individual impacts, but also their joint impact on liquidity creation would all be investigated employing the latest data of the US banking sector. As liquidity creation could be affected by a series of factors, influences from both of the market (competition) and regulatory control (capital adequacy) should be considered simultaneously when understanding the lending behaviours of banks. Such information can be useful for government in setting up policies, in particular during market downturn and firms facing liquidity constrains.

Secondly, this study also takes the bank size, three liquidity components into consideration when investigating the lending behaviour of banks. With much bigger capital base and stronger market position, large banks are believed of playing a more significant role in market liquidity creation. Whether the effect is different for asset-side liquidity creation, liability-side liquidity creation and off-balance-sheet liquidity creation? The answer to this question is particular useful for the government when formulating legislations related to bank merger and acquisitions and capital control.

The rest of the research is organised as the following. Section 2 summarises the related literature and Section 3 discusses the empirical research design and variables. Section 4 reports and discusses the estimation results, and the final Section 5 concludes the research with some policy implications.

4.2 Literature Review

Over the past decades, the US banking industry has changed dramatically in response to nationwide deregulation in the banking sector. Concerns were raised about the impacts of such change on the performance of banks (Tian and Han, 2019). As deregulation allows banks with increased flexibility in the use of soft information, which is largely local, and socially embedded, this is expected to provide small- and medium-sized banks with increased opportunities to penetrate into areas that were largely dominated by large banks, such as relationship lending (Berger et al., 2002). As a result, the market power of large banks is reduced to some extent. However, as the bank market power may directly affect their capacity of passing the marginal cost shocks to the volume and price of funds/loans and the liquidity created, a good understanding of banking market structure has therefore become necessary (Vanhoose, 1985).

In general, two different schools of thought, the "competition-fragility" theory and the "competition-stability" theory, are widely quoted when explaining the relationship between bank market power, or banking competition, and liquidity creation (Bouwman, 2015). The former argues that increased competition would reduce banks' liquidity creation as it lowers the risk absorption capacity of banks. Liquidity creation can be risky and expensive as banks may have to suffer losses if they need to dispose of liquidity assets in response to sudden withdraws (Allen and Gale 2004). Therefore, facing increased competition and squeezed profit margin, banks may also reduce loan offerings due to reduced buffers against losses (Jayaratne and Strahan, 1998; Boyd and De Nicolo, 2005; Peydro et al., 2016). On the other hand, with reference to "relationship lending", it is argued that increased competition may lower banks' liquidity creation further due to reduced relationship-building opportunities (Petersen and Rajan, 1995). In a highly competitive banking market, the switching costs of customers are lower. This makes it hard for banks to recoup the costs of long-run relationships building with firms (Black and Strahan, 2002 and Cetorelli and Strahan, 2006). Moreover, a long-run bank-firm relationship may facilitate banks' acquisition of "soft" information about

firms, a less close relationship between the two would inevitably lead to reduced relationship lending opportunities (Berger et al., 2005; Berger and Udell, 1995 and Diamond and Rajan, 2001). As a result, competition has led to reduced profitability and relationship lending, resulting in less liquidity creation.

H1: Banks with high market power would promote bank liquidity creation.

On the contrary, other studies also find channels through which liquidity could be boosted via competition. To compete for customers, banks are more actively engaged in financial innovation, and this could lead to increased efficiency and liquidity creation (Boot and Thakor, 2000; Black and Strahan, 2002; Laeven et al., 2015). Meanwhile, competition also reduces the pricing power of banks, forcing them to lower the lending rate (Hannan, 1991). This in turn boosts the market demand for loans, leading to increased bank lending. Therefore, based on the "competition-stability" perspective, competition triggers the reduction in bank lending rates and the increased financial innovation of banks. Such demand-pull and supply-push factors work together, resulting in increased liquidity creation and improved stability of the financial sector. Secondly, competition could also increase the transparency of banks, urging them to devote more efforts to monitor the performance of firms that got the loans (Jiang et al., 2019). This would reduce the default risks, leading to increased efficiency in credit allocation. In turn, a lower default risk may increase the market confidence, encouraging more bank lending and liquidity creation.

H2: Banks with high market power would weaken bank liquidity creation.

The study of Joh and Kim (2008) is among the first few which try to investigate the relationship between bank competition and liquidity creation empirically. Based on a sample of 25 OECD countries over the period of 2000-2010, it is concluded that bank competition reduces the market liquidity as intensified competition increases the

funding costs of banks. In addition, they further point out that large banks are more willing to lend in a relatively concentrated banking market. This might be because it is easier for large banks to enjoy the monopolist profits when the market competition is limited. Similar conclusion has also been reached by the study of Horvath et al. (2016) based on a sample of Czech Republic banks over the period of 2002 to 2010. In support for the competition fragility hypothesis, they argue that a competitive banking framework may limit banks' liquidity creation capacity as competition incentives banks to reduce their lending and deposit activities to diminish the threat of bank runs. More recently, the study of Ali et al. (2022) based on the Chinese banking sector also confirms the above findings. As competition reduces the deposits collected by banks, this in turn decreases the loan generated. However, it is also argued that even when the banking market is relatively concentrated, the creation of sufficient liquidity remains uncertain, in particular if large banks are found of exploiting their monopolist power by charging a higher interest margin (Berger and Hannan, 1989). The later study of Corvoisier and Gropp (2002) confirms this finding based on all euro-area countries except Luxembourg. The lower interest rate set for demand deposits and higher loan rate charged for lending have depressed both of the savers and borrowers, leading to reduced market liquidity.

Over the past decade, the depletion of liquidity caused by the financial crisis has led policy makers and economists to rethink the role played by financial regulation on liquidity creation. Theoretically speaking, tougher regulation should lead to reduced liquidity but improved financial stability as banks need to reserve more capital to meet the regulatory requirements (Gorton and Winton, 2000). Therefore, according to the financial fragility-crowding out theory, higher capital adequacy requirements would crowd out deposits, reducing the liquidity creation (Diamond and Rajan, 2000, 2001), while lower capital adequacy would free up more funding, making it possible for banks to lend more (Fungáčová et al., 2017). While on the other hand, the risk absorption hypothesis argues that bank capital actually impacts the liquidity creation positively

(Berger and Bouwman, 2009). For banks, if a higher liquidity is created, a greater default risks they likely face because of the mismatched maturity of illiquid assets and liquid deposits (Allen and Gale, 2004). As a financial intermediary and risk transformer, stronger capital requirements allow banks to absorb more risks. Hence, banks may be required to hold more capital to strengthen their solvency, and this may benefit the market over the long term in terms of sustained liquidity creation (Matz and Neu, 2007).

H3: High capital adequacy of banks would weaken bank liquidity creation.

H4: High capital adequacy of banks would promote bank liquidity creation.

In practice, mixed findings were obtained. Employing data of Chinese banks, the study of Lei and Song (2013) conclude that bank capital requirements is negatively related to liquidity creation, and this is in support of the fragility-crowding out hypothesis. Similar conclusions are also reached by Horváth et al. (2016) and Fu et al. (2015) in their studies based on Czech Republic and Asia-Pacific countries respectively. After the implementation of Basel III, banks are required to reserve a higher level of capital, and this has directly reduced the liquidity creation capacity of banks (Casu et al., 2019). While on the other hand, a positive relationship between bank capital requirement and liquidity creation is also detected and it is explained according to the risk absorption hypothesis (Berger and Bouwman, 2009). When more liquidities are created, banks may face increased default risks (Allen and Gale, 2004). A higher capital requirement is therefore acting as a safeguard, can increase the risk tolerance of banks. Such a positive impact is more prominent among large banks as the market for capital of small banks is small, constraining their ability to raise capital and absorb risk for liquidity creation (Berger and Bouwman, 2009). Similar conclusions are reached by later studies of Al-Khouri (2012) for banks in Gulf Cooperation Council countries and Tran et al. (2016) for the US. Moreover, in the recent study of Fungáčová et al. (2017) on the Russian market, a statistically negative relationship is detected between bank capital and

liquidity creation, the deposit insurance scheme has a limit impact on it. This might because the deposit insurance encourages undercapitalized banks to absorb greater risks, and thus reducing the positive impact of capital on liquidity creation.

Based on the discussion above, it seems that a consensus view towards the relationship between bank competition and market liquidity creation has yet been reached, not to say when the influence of bank capital adequacy requirement is also considered jointly. Therefore, employing a sample of US banks over the period of 1997 to 2020, we are going to advance the understanding of determinants of bank liquidity creation by exploring the interrelationship of bank competition, bank capital adequacy requirement and bank liquidity creation in this study. In particular, we will investigate whether increased bank competition and capital adequacy would lead to reduced liquidity creation or not.

4.3 Data and Methodology

4.3.1 Data

In this study, a sample of US banks over the period of 1997 to 2020 would be employed. This enables us to investigate the banks' behaviour on liquidity creation under different financial and economic conditions. The measurement of bank liquidity creation in this paper follows the study of Berger and Bouwman (2009), which includes four types of liquidity creation measurements. Financial statement items are obtained from the Call Report of the Federal Reserve Bank of Chicago. Market and macroeconomic information are collected from the Federal Deposit Insurance Corporation (FDIC), and the US Department of Commerce.

4.3.2 Model

Following the research of Choi (2018), the fixed effect model is employed for this study. The year fixed effect, and state-year fixed effect in this paper are to control for time-specific effects in different models, and the firm fixed effect is to control various bank-level specifications. The following equation is employed for the regression analysis:

$$LC_{i,t}=\beta_0 + +\beta_1 Lerner_{i,t-1} + \beta_2 interaction_{i,t-1} + \beta_3 capital\ ratio_{i,t-1} + B_4'\ Control\ variables_{i,t-1} + B_5'\ Macro\ Control\ variables_{s,j-1} + \varepsilon_{itj} \ldots\ldots \text{(Eq. 4-1)}$$

$LC_{i,t}$ represents total liquidity creation or liquidity creation measured in different components including asset-side, liability-side or off-balance sheet liquidities scaled by gross total assets at bank i from year t-1 to year t in %. The coefficient β_1 captures the effect of bank competition measured by the Lerner index. β_2 captures the effect of the interaction term between the applied competition measure and the bank capital adequacy. Parameter β_3 represents the effect of different types of capital adequacy measurements contrasted. The vector B_4' represents the bank-level control variables' influence on a bank's liquidity creation. And the B_5' represents the effect of state-level control variables on the bank liquidity creation. The regression approach controls for bank-specific variables taking into account business model-related characteristics such as credit risk, market share, and profitability. Furthermore, the logarithm of real state GDP and personal income are included as macroeconomic control variables. In addition, to mitigate potential endogeneity issue, as there would be contemporaneous realizations of both the dependent variable and the explanatory variables in question affect each other, we follow the approach of Berger and Bouwman (2009) and Distinguin et al. (2013) by replacing all bank-level explanatory variables with one-year lagged value in all regressions.

4.3.3 Measurement of Liquidity Creation

For bank loans, they could be classified according to loan categories or by terms to

maturity. Based on different classification criteria, Berger and Bouwman (2009) designed proxies for liquidity creation accordingly. Under both measurements, first of all, all bank-balance-sheet and off-balance-sheet activities are classified by their liquidity condition. For example, when loans are grouped by categories, liquid assets mainly include cash and due from other institutions, all securities, trading assets, while for illiquid assets, they mainly include commercial real estate loans, commercial and industrial loans, lease financing receivables, etc. As for liabilities, the liquid liabilities mainly include transactions deposits, savings deposits, overnight federal funds purchased, and trading liabilities, while the illiquid liabilities plus equity include bank's liability on bankers' acceptances, subordinated debt and equity. On the other hand, when loans are classified by the maturity, loans with a term to maturity of less than one year is classified as semi-liquid and all long-term loans of over one year are illiquid.
Then in the second step, different weights are assigned to different types of assets. Specifically, for illiquid assets, liquid liabilities, and illiquid off-balance-sheet items, a weight of 0.5 is assigned. For semiliquid assets and liabilities and semiliquid off-balance-sheet items, a weight of 0 is assigned. Lastly, for the liquid asset, illiquid liabilities or equity, and liquid off-balance-sheet items, a weight of -0.5 are assigned. The weights are consistent with the liquidity creation theory, which argues that the maximised liquidity can be created when illiquid assets are transformed into liquid liabilities and the maximised liquidity can be destroyed when liquid assets are transformed into illiquid liabilities or equity. As for the magnitudes of the weights, they are based on simple dollar-for-dollar adding up constraints, so that $1 of liquidity is created when banks transform $1 of illiquid assets into $1 of liquid liabilities. (Berger and Bouwman, 2009).

After that, we construct four liquidity creation measures by combining the bank balance-sheet and off-balance-sheet activities classified in the first step and weights assigned in the second step differently. These measures classify all activities other than loans by both product category (cat) and maturity (mat), but for loan items, they are

only classified by either category (cat) or maturity (mat) but not both. Then for each measure, we further divide them into two categories by incorporating the off-balance-sheet activities (cat/mat fat), or not (cat/mat nonfat). Nevertheless, among the four measurements based on liquidity condition, the category-based liquidity creation including the off-balance-sheet items is preferred. This is because how costly, timely, and easy it is to dispose of obligations on the asset side is more important than the time until self-liquidation (maturity).

We could illustrate the above discussions in Panel A, Table 1 below. Then in Panel B, Table 4-1, we present the equations used for liquidity creation estimation. Inspired by the work of Jiang et al. (2019), we also divide banks' liquidity creation into three categories, the asset-side liquidity creation, liability-side liquidity creation and off-balance sheet liquidity creation. It is argued that changes in banking market condition may affect different components of liquidity creation differently. For example, the recent banking deregulation in the US is found of generating the most significant impact on the asset-side liquidity creation but the least influence on the liability-side liquidity creation (Jiang et al., 2019). Therefore, in this research, we also consider the diverged impact generated on different components of liquidity creation.

Lastly, to make the liquidity creation measures comparable across banks, we normalize bank liquidity creation by the bank's gross total assets, which equals the sum of total assets, allowances for loan and lease losses, and allocated transfer risk reserve (a reserve for certain foreign loans). We winsorize the four liquidity creation ratios at the 2.5% and 97.5% levels.

Table 4-1 Liquidity creation measurement

Step 1: Bank activities are classified as liquid, semiliquid, and illiquid, based on the activities category in Panel A.

Step 2: We assign weights to all bank activities classified in Step 1.

Step 3: We combine the bank activities classification in Step 1 with weights in Step 2 in two ways to construct liquidity-creation measures by using the "cat" ("mat") based on the activities category (maturity), and by

alternatively including off-balance-sheet activities (fat) or excluding these activities (nonfat). In addition, we establish the three components of liquidity creation, detailed in Panel B. In addition, we consider the three components of liquidity creation, which are asset-side liquidity creation, liability-side liquidity creation and off-balance-sheet liquidity creation.

Panel A: Liquidity classification of bank activities		
Asset		
Illiquid asset (weight=1/2)	Semiliquid asset (weight=0)	Liquid assets (weight=-1/2)
(Cat) (Mat)	(Cat) (Mat)	(Cat)
Corporate& commercial loans All loans and leases with a remaining maturity > 1 year	Residential mortgage loans All loans and leases with a remaining maturity <= 1 year	Cash and due from banks
Investments in property	Other mortgage loans	Trading securities and at fv through income
Foreclosed real estate	Other consumer/retail loans	Tradable derivatives
Fixed assets	Loans and advances to banks	Available-for-sale securities
Goodwill	Reverse repos and cash collateral	Held to maturity securities
Other intangibles		At-equity investments in associates
Other assets		Other securities
Liabilities plus Equity		
Liquid liabilities (weight=1/2)	Semiliquid liabilities (weight=0)	Illiquid liabilities plus equity (weight=-1/2)
Customer deposits — current	Customer deposits — term	Senior debt maturing after 1 year
Customer deposits — savings	Deposits from banks	Subordinated borrowing
Tradable derivatives	Repos and cash collateral	Other funding
Trading liabilities	Other deposits and short-term borrowings	Credit impairment reserves
	Fair value portion of debt	Reserves for pensions and other
		Current tax liabilities
		Deferred tax liabilities
		Other deferred liabilities
		Other liabilities
		Total equity
Off-balance-sheet activities		
Illiquid activities (weight=1/2)	Semiliquid activities (weight=0)	Liquid activities (weight=-1/2)
Net standby letters of credit	Net credit derivatives	Net participations acquired
Commercial and similar letters of credit	Net securities lent	Interest rate derivatives
Other contingent liabilities		Foreign exchange derivatives
Unused commitments		Equity and commodity derivatives
Panel B: Liquidity creation formulas		
Cat(Mat)fat=	1/2*illiquid assets+1/2*liquid liabilities+1/2*illiquid activities+0*semiliquid assets+0*semiliquid liabilities+0*semiliquid activities -1/2*liquid assets-1/2*illiquid liabities or equity-1/2*liquid activities	
Cat(Mat) nonfat=	+1/2*illiquid assets+1/2*liquid liabilities+0*semiliquid asset+0*semiliquid liabilities-1/2*liquid assets-1/2*illiquid liabilities-1/2*equity	
Assetside_LC=	1/2*illiquid assets - 1/2*liquid assets	
Liailityside_LC=	1/2*liquid liabilities - 1/2*illiquid liabilities	
Offcat(mat)fat_LC=	Cat(Mat)fat-Cat(Mat)nonfat	

4.3.4 Measurement of Bank Competition

According to the traditional industrial organization (IO) approach derived from the structure conduct performance (SCP) paradigm, increased concentration results in lower level of bank competition and this in turn boosts banks' financial performance. To measure the intensity of bank competition, the Herfindahl-Hirschman Index, HHI, is widely employed by earlier studies (Caves, 1980). However, in essence, the two concepts are not the same. The market concentration is a market-based measurement and when it is used to proxy bank competition, it may not be that accurate (Beck et al., 2013). Therefore, another approach related to the so-called "new empirical industrial organization" is provided, which is linked to the idea that competition measures should be issued from economic explanations of bank behaviour. The most applied measure is Lerner index. Compared with HHI, the Lerner index is considered a better proxy for bank competition as it is not constructed based on the assumption of competition-concentration trade-off, nor it considers the interrelationship between the two (Weill, 2013). In addition, the HHI, which emphasises market shares, doesn't consider how those shares were obtained, whether through lower costs or unfair practices, known as the "efficient structure controversy" as described by Berger (1995). If lower costs were a significant factor in some banks having a higher HHI, then the perception of competition would be overestimated. However, the Lerner index attempts to address this by looking at the difference between average price and estimated marginal cost, divided by the average price. It can interpret the influence of economies of scale, productivity, and differences in risk among banks. As the two measures could not be used interchangeably, we therefore adopt the Lerner Index in our study.

The index takes the value of 0 to 1, and a higher value represents higher pricing power of banks or less competitive conditions in the banking market. The Lerner Index is calculated as the mark-up of price over marginal cost. The price is the average price of bank output, measured by total revenue to total assets (Horvath et al., 2016), and the

marginal cost is estimated by the translog cost function of total assets and their input (price of labour, price of physical capital and price of borrowed funds). For the input, following the research of Turk-Ariss (2010), the following equation is specified:

$$lnTC_{it} = \partial_0 + \partial_1 lnQ_{it} + \frac{1}{2}\partial_2 (lnQ_{it})^2 + \sum_{k=1}^{3} \beta_{it}\, lnW_{k,it} +$$

$$\sum_{k=1}^{3}\sum_{j=1}^{3} lnW_{k,it}\, lnW_{j,it} + \sum_{k=1}^{3} \gamma_k lnQ_{it} lnW_{k,it} + v_t + \varepsilon_{it} \quad \text{.....(Eq. 4-2)}$$

Where the TC_{it} represents total costs. Q_{it} is total assets. W_1 is the price of labour estimated by the ratio of staff expenses to total number of employees. W_2 is the price of physical capital calculated by the ratio of total general and administrative expenses, other operating expenses, and depreciation divided by fixed assets, and W_3 is the price of borrowed funds estimated by the ratio of the cost of borrowed funds to borrowed funds. Q_{it} represents the total asset of the respective banks. Therefore, the total cost is equal to the sum of general and administrative expenses, staff expenses, depreciation, operating expenses, and costs of borrowed funds.

Then, the estimated coefficients of the cost function are used to calculate the marginal cost:

$$MC_{it} = \frac{Cost_{it}}{Q_{it}}\left[\partial_1 + \partial_2 lnQ_{it} + \sum_{k=1}^{3} \beta_k\, lnW_{k,it}\right] \text{.....(Eq. 4-3)}$$

In the end, the following equation is used to calculate the Lerner index for bank i at time t.

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \text{.....(Eq. 4-4)}$$

4.3.5 Bank Capital Adequacy

As for the capital adequacy ratio, in general, three measures are used. The first one is the ratio of Tier-1 capital. The Tier 1 ratio refers to shareholder funds plus perpetual

non-cumulative preference shares as a percentage of the risk-weighted assets and off-balance sheet risks (capitalratio1). The second one is the total regulatory capital ratio. Under Basel rules, it is calculated by total Tier 1 and Tier 2 capitals divided by the risk-weighted assets and off-balance-sheet risks (totalcapitalratio). In addition, since large banks might increase their risk exposure through managing the off-balance-sheet activities, we therefore employ a third measure for capital adequacy. It equals to the ratio of equity to total assets and off-balance sheet exposures (equityratio), consistent with Basel III's provisions.

4.3.6 Other Control Variables

Based on the studies of Berger and Bouwman (2009) and Horváth et al. (2014), we also included bank-level and state-level controls variables for our regression analysis.

For bank-level control variables, we include three variables to captures banks credit risks exposure, profitability and size. As for credit risk (creditrisk), it is calculated by the bank's risk-weighted assets and off-balance-sheet activities divided by total asset. As suggested by Berger and Bouwman (2009), the credit risks exposure of banks is a crucial indicator to look into as it may directly affect their liquidity generation capacity. According to Bernanke and Gertler (1989), prudential banks may reduce lending when they faced up with increasing NPLs, therefore, a negative relationship between credit risk and liquidity creation is expected.

For profitability (roe), it is measured by the ratio of net income over the average total stockholders' equity. It is considered as a comprehensive measure for banks operational efficiency and income generation capacity. A higher profit may lead to higher equity, which might in turn enhance banks' liquidity creation capacity (Berger et al., 2016; Hacketha et al., 2010). Therefore, a positive relationship is expected between profitability of banks and liquidity creation.

Lastly, for bank size (lnasset), it is measured by the natural logarithm of gross total assets. In general, it is expected that large banks could create more liquidity than small banks as they tend to have easier access to the lender of last resort and are more likely to benefit from the safety net provision (Distinguin et al., 2013). As a result, a positive relationship is expected between bank size and the liquidity creation.

In term of macroeconomic variables, we use the natural logarithm of state GDP and personal income to capture the development of the state economy, the business cycle and the general macroeconomic conditions. It is expected that during economic booms, demand for differentiated financial products tend to be high, and this may allow banks to expand their loan book with a higher rate charged. Whereas during economic downturn, credit supply of banks tends to be squeezed and this would further deepen the economic recession. Therefore, the liquidity creation of banks can be said of procyclical (Davydov et al., 2018). In terms of personal income, a higher level of household income is expected to increase the banks' confidence in lending as the borrowers tend to have stronger debt paying capacities (Louzis et al., 2012; Niu, 2022). Meanwhile, people with higher income level are also expected to have more savings. This allows them to pay a higher percentage of deposit, making banks more willing to lend. As a result, a positive relationship between personal income and bank liquidity creation is expected.

4.4 Empirical Results Analysis

4.4.1 Data Description

Table 4-2 presents summary the statistics for all key variables used of the statistical analysis. In terms of the banking market competition, Lerner index, it has an average of 0.3100, indicating that in general, banks in the US are facing moderate to high level of competition as the pricing power of individual bank is relatively weak. Although the

maximum and minimum value of learner index ranges from 0.099 to 0.515, the standard deviation of the variable is relatively low, suggesting that the competitive environment of the US banking market remains relatively stable over the same period of 1997 to 2020. As for the dependent variable, it is measured by the category-based liquidity creation indicator. The mean of total bank liquidity creation (Catfat) is 0.218, but when the off-balance-sheet items are not considered (Catnonfat), the mean would drop to zero. In addition, it can be found that the majority of banks' liquidity creation are through liability-side items (Liabilityside_LC), averaged at 0.174, much higher than the asset side (Assetside_LC) and off-balance sheet side (Offcatfat) liquidity creations which are 0.003 and 0.047, respectively.

Table 4-2 Descriptive statistics

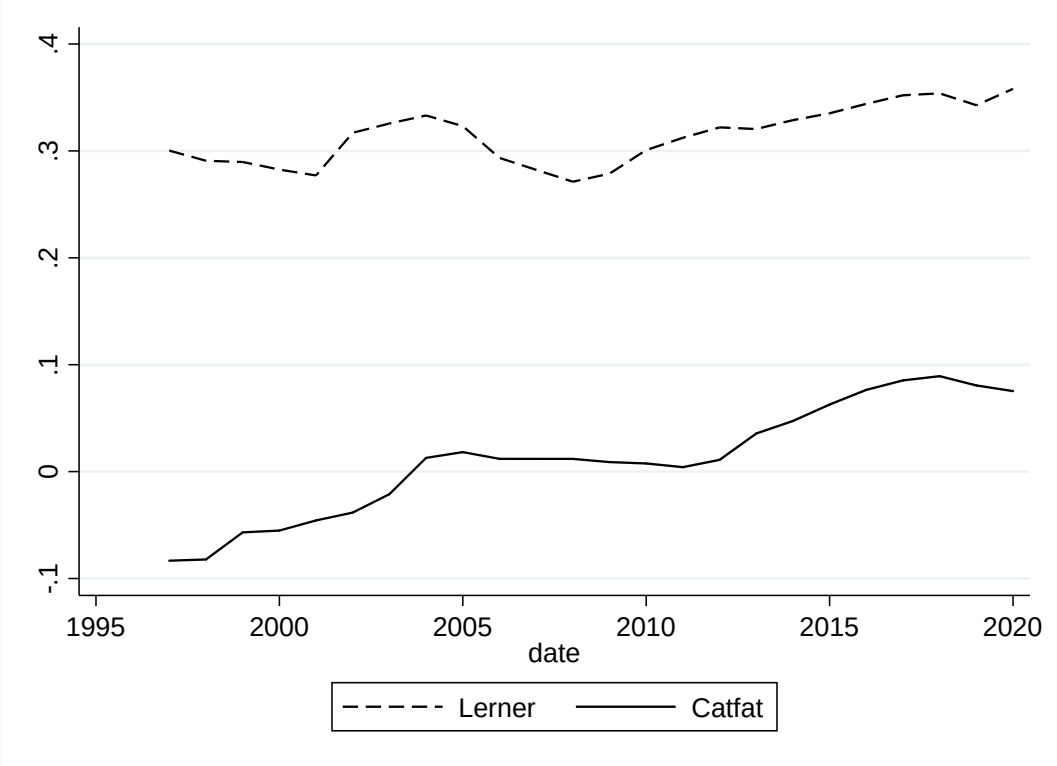
Variable	Obs	Mean	Std. Dev.	Min	Max
Catfat	172377	0.218	0.181	-0.235	0.557
Catnonfat	172377	0	0.159	-0.415	0.277
Offcat	172377	0.047	0.06	-0.683	0.801
Assetside LC	172377	-0.003	0.129	-0.313	0.229
Liabilityside LC	172377	0.174	0.09	-0.07	0.337
Lerner	172377	0.310	0.094	0.099	0.515
capitalratio1	71063	17.076	7.103	9.476	41.991
totalcapitalratio	170525	17.705	69.694	7.366	10.180
equityratio	172377	10.773	3.191	6.402	20.728
lnasset	172377	0	1.261	-2.213	3.35
lnroe	161884	0	.764	-8.327	1.099
nclnlsr	171902	0	2.087	-1.295	98.705
lnGDP	172377	0	.943	-2.016	1.847
lnpersonalincome	172377	0	1.062	-1.95	2.163

Note: This table presents summary statistics for the total liquidity creation measures and its components, competition measures, and capital adequacy indicators, as well as control variables in the sample.

We then depict the trend of bank market competition and liquidity creation over the sample period in Figure 4-1 below. It can be found that both two variables show an upward trend. For Leaner Index, the change was not that significant, suggesting that the competitive environment of the US banking sector remains relatively stable. However, for liquidity creation, it has increased significantly from 0.135 in 1997 to 0.294 in 2020. The only significant dips were in 2008-10 when banks were hit badly by the global financial crisis and in 2020 when the Covid-19 pandemic put a pause button on the

global economy.

Figure 4-1 Bank competition and bank liquidity creation in the US



Note: Catfat is proxy for category-based total liquidity creation and Lerner represents the bank competition level a good measure for bank pricing power.

4.4.2 Variables Correlation

Before the regression analysis, we firstly test the correlation relationship between all key variables and summarise the results in Table 4-3. For this part, bank liquidity creation is proxied by our "preferred" category-based liquidity creation measurement (Catfat). The low correlation coefficients suggest that the explanatory variables are not highly correlated and hence there is no multicollinearity problem. In addition, a positive relationship between bank liquidity creation (Catfat) and bank market power (low bank competition) and a negative relationship between capital adequacy ratio and bank liquidity creation have also been detected, consistent with our expectations. Then in the next section, we will apply the regression models.

Table 4-3 Correlation between main variables

Variables	(Catfat)	(Lerner)	(capitalratio1)	(totalcapitalratio)	(equityratio)	(lnasset)	(lnroe)	(nclnlsr)	(lnGDP)	(lnpersonalincome)
Catfat	1.000									
Lerner	0.159***	1.000								
capitalratio1	-0.085***	0.004	1.000							
totalcapitalratio	-0.099***	0.016***	1.000***	1.000						
equityratio	-0.253***	0.140***	0.195***	0.230***	1.000					
lnasset	0.308***	0.228***	-0.024***	-0.034***	-0.108***	1.000				
lnroe_1	0.184***	0.551***	-0.032***	-0.042***	-0.208***	0.121***	1.000			
nclnlsr	-0.033***	-0.142***	0.029***	0.048***	0.031***	0.027***	-0.168***	1.000		
lnGDP	0.039***	-0.029***	-0.008**	-0.003	0.003	0.225***	-0.094***	0.028***	1.000	
lnpersonalincome	0.098***	0.078***	-0.008**	-0.003	0.032***	0.079***	-0.007***	0.025***	0.179***	1.000

Note:*** p<0.01, ** p<0.05, * p<0.1

4.4.3 Main Results

Table 4-4 shows the results of the baseline regression model. In column 1 and 2, 3 and 4, and 5 and6, the capital ratio is measured by the Tier 1 capital ratio, the total capital ratio and the equity ratio, respectively. In columns 1, 3 and 5, the bank and year fixed effects are considered while in columns 2, 4 and 6, the bank and state-year fixed effects are specified. For the Lerner Index, it is found of having statistically significant positive relationship with liquidity creation under all estimations. As the Lerner Index measures the individual pricing power of each bank, it therefore suggests that when banks are given a higher level of pricing power, they are more willing to lend. In other word, increased competition in the banking market would lead to reduced liquidity creation and this is in line with the competition-fragility theory and the conclusions reached in earlier studies (Horváth et al., 2016; Choi, 2018). In addition, this result supports the hypothesis that market power can affect the availability of funds, which supports H1. Banks with stronger market power may also attract larger number of deposits and this would in turn increases their lending power. However, our result is different from the one reached by Berger and Bouwman (2009) who claim no significant relationship between competition and liquidity creation for the US banking sector. This might because in their study, the Herfindahl–Hirschman index, a concertation measurement, is used to proxy bank competition and it is not that appropriate.

We then look at the impact of capital adequacy on banks' liquidity creation. As for the three measures for capital adequacy, they are found of having a significant negative relationship with liquidity creation. The significantly negative coefficient can be explained through two aspects, firstly, a higher capital ratio has effectively "crowds out" deposits, leaving a smaller percentage of funding available for lending (Gorton and Winton, 2000). Secondly, according to the "financial fragility" theory, in response to a higher level of bank capital requirement, bank could reduce lending to make its structure less fragile (Diamond and Rajan. (2000). In theory, the capital structure of

banks is fragile as they need to finance relatively illiquid assets with relatively liquid liabilities. However, additional capital requirements may discourage banks' commitments in monitoring, which in turn reduces their ability for liquidity creation (Berger and Bouwman, 2007). The findings verify H3.

Regarding the control variables, the tested relationships and significance levels are all in line with expectations. For credit risk, it generates a significant negative impact on bank liquidity creation. This is because when banks are facing a higher level of credit risk, they could become reluctant to lend, leading to reduced liquidity creation (Le and Pham, 2021). Regarding bank size, big banks are found of capable of providing more liquidity than the small banks, consistent with the findings of Distinguin et al. (2013). Compared with smaller banks, the reputational advantage of bigger banks allows them to access border funding sources. This has effectively reduced their risk exposure, making the big banks more willing to lend. In terms of profitability, a significant positive relationship with liquidity creation has also been tested. This is consistent with earlier studies that a higher level of profit could increase bank equity, making it possible for them to create more liquidity (Berger et al., 2016 and Hacketha et al., 2010). As for the macroeconomic control variables, natural logarithm state GDP and state personal income, both of them are found of having a positive relationship with liquidity creation but it is only significant in a few regressions (Davydov et al., 2018). This might indicate the lending decision of banks are more related to banks' own operations and characteristics. Although the external environment may impact on the lending decision of banks, the influence remains limited and is subject to the measurements chosen.

To further explore the joint effect between bank competition and capital on liquidity creation, we incorporate the interaction terms into the regressions and summaries the results in Table 4-5 below. It can be found that the coefficients of all interaction terms are significantly positive, indicating that capital adequacy requirement enhances the liquidity creation power of banks with strong market power. This is consistent with the

findings in the study of Choi (2018). For a bank with high pricing power, a higher capital ratio is expected to offer more protection to the depositors, leading to improved market confidence. This is especially important when the market is relatively concentrated. Consequently, more savings can be absorbed by banks, providing them with increased capital for lending.

Table 4-4 Main results

Variables	(1) Catfat	(2) Catfat	(3) Catfat	(4) Catfat	(5) Catfat	(6) Catfat
L.Lerner	0.0403***	0.0408***	0.0242	0.0318**	0.0446***	0.0503***
	(0.0108)	(0.00749)	(0.0202)	(0.0155)	(0.0117)	(0.00610)
L.capitalratio1	-0.0005***	-0.0005***				
	(0.0003)	(0.0003)				
L.totalcapitalratio			-0.0016*	-0.0016**		
			(0.0008)	(0.0008)		
L.equityratio					-0.0046***	-0.0044***
					(0.0004)	(0.0002)
L.lnasset	0.0083**	0.0090***	0.0046	0.0054**	0.0044*	0.0054***
	(0.0038)	(0.0025)	(0.0039)	(0.0027)	(0.0025)	(0.0011)
L.lnroe	0.0001	0.0003	0.0054***	0.0051***	0.0031***	0.0031***
	(0.0008)	(0.0007)	(0.0018)	(0.0014)	(0.0009)	(0.0006)
L.nclnlsr	-0.0034***	-0.0035***	-0.0029***	-0.0029***	-0.0033***	-0.0032***
	(0.0003)	(0.0002)	(0.0006)	(0.0003)	(0.0005)	(0.0002)
L.lnGDP	0.00122	0.0140	0.0128**	0.0011	0.0141**	0.0018
	(0.0099)	(0.0112)	(0.0063)	(0.0087)	(0.0065)	(0.0089)
L.lnpersonalincome	0.0134*	0.0076	0.0173**	0.0003	0.0176**	0.0012
	(0.0072)	(0.0067)	(0.0072)	(0.0067)	(0.0077)	(0.0067)
Constant	0.2230***		0.1470***		0.1460***	
	(0.0015)		(0.0043)		(0.0045)	
Observations	59,863	59,538	142,576	141,909	142,576	141,909
R-squared	0.2830	0.9170	0.3290	0.8480	0.3150	0.8450
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES					
State-Year FE		YES	YES	YES	YES	YES
F	323.4	48.25	472.6	106.9	459.1	179.1

Note: This table shows t results when the liquidity creation is calculated based on category and scaled by gross total assets (Catfat). All regressions include interaction terms of pricing power in the market (Lerner index), three capital adequacy indicators, which are interaction1, interactionT and interactionE, respectively. Columns (1), (3), and (5) include bank and year fixed effects. Columns (2), (4), and (6) include bank and state-year fixed effects. All the variables are one-year lag in the regression and t-statistics are depicted in brackets. */**/*** denote the significance at the 10%, 5% and 1% levels, respectively.

Table 4-5 Interactive effect analysis

Variables	(1) Catfat	(2) Catfat	(3) Catfat	(4) Catfat	(5) Catfat	(6) Catfat
L.Lerner	0.0414***	0.0418***	0.0318***	0.0385***	0.0479***	0.0535***
	(0.0104)	(0.0074)	(0.0044)	(0.0101)	(0.0047)	(0.0061)
L.interaction1	0.0076***	0.0079***				
	(0.0019)	(0.0009)				
L.capitalratio1	-0.0024***	-0.0025***				
	(0.0005)	(0.0002)				
L.interactionT			0.0090***	0.0088***		
			(0.0001)	(0.0015)		
L.totalcapitalratio			-0.0035***	-0.0035***		
			(3.74e-05)	(0.0004)		
L.interactionE					0.0042***	0.0040***
					(0.0005)	(0.0010)
L.equityratio					-0.0043***	-0.0042***
					(0.0001)	(0.0002)
L.lnasset	6.13e-05	0.0009	0.0008	0.0016	0.0043***	0.0054***
	(0.0038)	(0.0023)	(0.0007)	(0.0016)	(0.0008)	(0.001072)
L.lnroe	-0.0006	-0.0005	0.0033***	0.0031***	0.0032***	0.0031***
	(0.0008)	(0.0006)	(0.0005)	(0.0009)	(0.0005)	(0.0006)
L.nclnlsr	-0.0035***	-0.0036***	-0.0029***	-0.0028***	-0.0032***	-0.0032***
	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0002)
L.lnGDP	-0.0007	0.00734	0.0101***	-0.0037	0.0142***	0.0025
	(0.0091)	(0.0091)	(0.0024)	(0.0087)	(0.0024)	(0.0089)
L.lnpersonalincome	0.0134*	0.0038	0.0156***	-0.0025	0.0177***	0.0013
	(0.0071)	(0.0063)	(0.0025)	(0.0075)	(0.0026)	(0.0067)
Constant	0.2190***		0.1430***		0.1460***	
	(0.0018)		(0.0016)		(0.0016)	
Observations	59,863	59,538	142,576	141,909	142,576	141,909
R-squared	0.3030	0.9200	0.3510	0.8530	0.3160	0.8450
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES		YES		YES	
State-Year FE		YES		YES		YES
F	316.7	55.65	2524	99.95	2155	155.9

Note: This table shows the results when the dependent variable is calculated based on category, total liquidity creation scaled by gross total assets (Catfat). All regressions include interaction terms of pricing power in the market (Lerner index) with three capital adequacy indicators, which are interaction1, interactionT and interactionE, respectively. The same set of control variables are included in the regressions shown in Table 4-3. Columns (1)-(2) are the results for capital adequacy is measured by the Tier-1 capital ratio. Columns (3)-(4) are the results for capital adequacy is measured by the total capital ratio and Columns (5)-(6) are the results for capital adequacy is measured by the equity capital ratio. Columns (1), (3) and (5) include bank and year fixed effects. Columns (2), (4) and (6) include bank and state-year fixed effects. All the variables are one-year lag in the regression and t-statistics are depicted in brackets. */**/*** denote the significance at the 10%, 5% and 1% levels, respectively.

4.4.4 Bank Competition and Different Components of Liquidity Creation

In this next section, by dividing the liquidity creation into three categories, the asset-side, liability-side on-balance sheet liquidity creation and off-balance-sheet liquidity creation, we would explore further about how bank competition and capital adequacy would jointly impact on these different types of liquidity creation differently. The

results are summarised in Table 4-6. Columns 1-3, 4-6 and 7-9 report the results when the asset-side, liability-side and off-balance-sheet liquidity creation measurements are used respectively as the independent variable.

It can be found that there is a positive relationship between the pricing power (less bank competition) of banks and liquidity creation measured by the asset-side and off-balance sheet-based measurements. This indicates that banks with higher market power tend to lend more and engage more in balance-sheet and off-balance sheet long-term lending. For banks with a stronger pricing power, they tend to be market leaders with relatively larger funding base. This provides them with a stronger negotiation power when it comes to corporate lending. As a result, for banks with stronger pricing power, they tend to enhance the flow of credit in the economy via the bank lending channel. On the other hand, a significant negative relationship between the pricing power of banks and the liability-side liquidity creation is also detected for almost all regressions. This indicates that when the banking market is concentrated, they may exploit their pricing power by offering lower interest rate to depositors. This may divert investors' funding to other more profitable opportunities, leading to decreased liquidity creation.

We then look at the impact of different types of capital adequacy measurements on liquidity creation and their interaction with banking market competition. Consistent with the findings reached in earlier section when the overall liquidity creation measurement is used, a lower capital ratio tends to improve the liquidity creation no matter which measurement is used. When the interaction between banking competition and capital ratio is considered, a significant positive relationship with liquidity creation can be detected in most of the cases. This again confirms that tightened regulatory control on capital adequacy would lead to increased liquidity creation in a less competitive banking environment. The higher capital ratio required is acting as a safety net for savings, reducing the banks' credit risk exposure to some extent. However, it should also be aware that when the capital adequacy is measured by the equity-based

ratio, a significant negative relationship is detected between its interaction term with banking competition and asset-side liquidity creation. This means that higher equity would weaken the liquidity creation ability of banks with high pricing power. According to the liquidity creation theory, banks create liquidity when illiquid assets are transformed into liquid liabilities, but not when they are transformed into illiquid claims such as equity (Fu et al., 2015). Meanwhile, having more equity capital may impede banks to extend more illiquid loans and this may further reduce their liquidity creation capacity. Also, a higher level of equity may make banks make them reluctant to attract additional deposits, leading to the reduction of funding pool for lending. Consequently, less liquidity would be created.

We now look at the control variables. For the bank-level control variables, large banks are more likely to create liquidity through asset-side activities but reduce liability-side liquidity creation and off-balance-sheet side activities. This means that large banks are more willing to supply liquidity to the economy via expanded loans while as large banks have higher market share, they may decrease the price of deposit, which lead investors losing interest to bank deposit, therefore, liability-side liquidity creation reduces. As for profitability, a significantly positive relationship with liquidity creation is found in most of the regressions. This is consistent with the earlier research of Berger at al. (2016) and Hacketha et al. (2010) that a higher profitability can help banks increase liquidity creation under all measurements. Regarding credit risk, again, a significant negative relationship with liquidity creation is detected in all regressions. The increased credit risks may increase the uncertainties in the financial sector, making banks more reluctant to lend but to keep more capital in fear of suffering significant losses (Hsieh and Lee, 2020). This has reduced liquidity creation in all aspects. Lastly, for the macroeconomic variables, state GDP (lnGDP) and state personal income (lnpersonalincome), both of them have a significant positive relationship with liquidity creation in most of the cases. This confirms that better economic condition and higher level of personal income could all stimulate increased bank liquidity creation, and this is mainly due to increased market confidence (Davydov et al., 2018).

Table 4-6 The results for liquidity creation decomposition

Variables	(1) Asetside_LC	(2) Aetside_LC	(3) Assetside_LC	(4) Labilityside_LC	(5) Labilityside_LC	(6) Labilityside_LC	(7) Offcat	(8) Offcat	(9) Offcat
L.Lerner	0.0424***	0.0461***	0.0233***	-0.0224***	-0.0252***	0.0101	0.0236***	0.0139***	0.0115***
	(0.0081)	(0.0035)	(0.0037)	(0.0048)	(0.0023)	(0.0023)	(0.0059)	(0.0018)	(0.0019)
L.interaction1	0.0060***			0.0009***			0.0006***		
	(0.0013)			(0.0003)			(0.0002)		
L.capitalratio1	-0.0020***			-0.0003***			-0.0002***		
	(0.0004)			(8.66e-05)			(6.88e-05)		
L.interactionT		0.0074***			0.0012***			0.0003***	
		(0.0001)			(7.01e-05)			(5.46e-05)	
L.totalcapitalratio		-0.0029***			-0.0005***			-0.0002***	
		(2.94e-05)			(1.92e-05)			(1.50e-05)	
L.interactionE			-0.0028***			-0.0004			-0.0002
			(0.0004)			(0.0003)			(0.0002)
L.equityratio			-0.0003***			-0.0036***			4.34e-05
			(8.64e-05)			(5.35e-05)			(4.24e-05)
L.lnasset	0.0079***	0.0165***	0.0235***	-0.0053***	-0.0137***	-0.0171***	0.0002	-0.0019***	-0.0014***
	(0.0030)	(0.0006)	(0.0006)	(0.0018)	(0.0004)	(0.0004)	(0.0016)	(0.0003)	(0.0003)
L.lnroe	-0.0026	-0.0017	0.0018***	0.0021***	0.0038***	0.0004*	-4.59e-05	0.0011***	0.0013***
	(0.0006)	(0.0004)	(0.0004)	(0.0004)	(0.0002)	(0.0002)	(0.0004)	(0.0002)	(0.0002)
L.nclnlsr	-0.0018***	-0.0008***	-0.0012***	-0.0008***	-0.0005***	-0.0006***	-0.0010***	-0.0016***	-0.0017***
	(0.0003)	(0.0001)	(0.0001)	(0.0002)	(7.97e-05)	(7.84e-05)	(0.0001)	(6.21e-05)	(6.21e-05)
L.lnGDP	0.0161*	0.0115***	0.0144***	0.0135	0.0073***	0.0064***	-0.0015	0.0055***	0.0056***
	(0.0094)	(0.0019)	(0.0020)	(0.0084)	(0.0012)	(0.0012)	(0.0066)	(0.0010)	(0.0010)
L.lnpersonalincome	0.0010	0.0035*	0.0056***	0.0011	0.0052***	0.0054***	0.0089**	0.0101***	0.0102***
	(0.0069)	(0.0020)	(0.0020)	(0.0038)	(0.0013)	(0.0013)	(0.0036)	(0.0010)	(0.0010)
Constant	0.0027**	-0.0305***	-0.0253***	0.1750***	0.1280***	0.1260***	0.0413***	0.0457***	0.0461***
	(0.0014)	(0.0013)	(0.0013)	(0.0007)	(0.0008)	(0.0008)	(0.0006)	(0.0006)	(0.0007)
Observations	59,863	142,576	142,576	59,863	142,576	142,576	59,863	142,576	142,576
R-squared	0.1470	0.1640	0.1040	0.4480	0.4670	0.4840	0.0320	0.0350	0.0340
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
F	243.9	918.2	541.5	1007	4091	4380	37.09	170.0	164.6

Note: This table shows the results when the dependent variable-total liquidity creation scaled by gross total assets (Catfat), is decomposed into its three components. capitalratio1 represents the Tier-1 capital ratio, and interaction1 equals Lerner index * capitalratio1. totalcapitalratio represents total regulatory capital ratio and interactionT equals Lerner index * totalcapitalratio. equityratio

represents ratio of equity to total assets and off-balance sheet exposures and interactionE equals Lerner index * equityratio. Lerner measures the bank competition which represents pricing power of bank. Lnasset is the natural logarithm of gross total assets, where gross total assets equal total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). All the bank-level control variable is one-year lag in all the regression. Columns (1)-(3) show the results for asset-side liquidity creation (Assetside LC), Columns (4)-(6) are the results for liability-side liquidity creation (Liabilityside LC) and Columns (7)-(9) are the results for off-balance sheet liquidity creation (Offcatt) as dependent variables. All regressions include bank and year fixed effect. */**/*** denote the significance at the 10%, 5% and 1% levels, respectively.

4.4.5 The Impact of Bank Size on Liquidity Creation

In this part, we further divide the whole sample into three categories according to the size of the banks, as measured by the gross total assets (GTA). Then following the research of Berger and Bouwman (2009), we try to investigate in each group, whether the pricing power of banks and capital requirements may impact on the liquidity creation capacity of banks. The results are presented in Table 4-7 below. We use the category-based liquidity creation measurement including off-balance sheet items (Catfat) to proxy banks' liquidity creation capacity. The results are consistent with the conclusions reached in earlier sections. Banks with higher pricing power tend to be able to create more liquidity. However, it should also be aware that such positive impact of pricing power on liquidity creation is significantly greater for small and medium-sized banks than for large-sized banks no matter which measurement is used to capture bank capital adequacy. This is in line with Petersen and Rajan (1995), who also argues that the positive relationship should mainly be observed for small banks as they tend to rely more on relationship lending. When the banking market is relatively competitive, small banks are more likely to reduce liquidity creation to avoid increased default risk exposure, as they have less possibility to relationship lending. While for large banks, large amount of loans has already been accumulated in their balance sheet as fixed assets only account for a relatively small percentage of bank assets. Therefore, regardless of their market power, large banks should have a stronger liquidity creation capacity compared with the small- and medium-sized banks. This explains the weak positive relationship between the pricing power of banks and liquidity creation capacity

when the large banks are investigated. As for capital adequacy, again, a negative relationship between the capital ratio and liquidity creation is detected. A higher capital ratio would tie up more bank capital, leaving banks with a smaller funding for lending. The only exception is the equity-based capital ratio. When it is used to proxy bank capital and when large banks are under investigation, the tested relationship is insignificant.

As for the interaction terms, when capital adequacy is proxied by Tier 1 or Total capital ratio, its joint effect with banks' pricing power suggest that they could act jointly to increase the liquidity creation capacity of banks, disregard of the size of banks. However, when capital adequacy is measured by the equity-based capital ratio, its joint impact with bank's pricing power is found of having a negative impact on banks' liquidity creation. The tested relationship is only significant for small banks. This might because for small banks, they have a smaller asset base. When the equity accounts for a larger percentage, banks are left with very limited amount of deposits for future lending. This has therefore reduced their lending capacity. While for large- and medium-sized banks, although higher equity reduces their lending capacity, banks with higher pricing power still allow them to attract sound level of deposits. This explains why the tested relationship is negative but insignificant.

In terms of control variables, the tested results are in general in line with expectations. The profitability effect is more significant for smaller banks. This might because small banks are more sensitive to profit surge while large banks have relatively more diversified funding sources. Similarly, higher level of credit risks tends to have more significant negative impact on both small- and medium-sized banks as large banks tend to have stronger risk absorption capacity. For the macroeconomic variables, the positive effect of state GDP on liquidity creation is more significant for large and medium-sized banks. Amid an upward movement of the business cycle, larger banks tend to benefit more due to their relatively closer relationship with large- and medium-sized enterprises.

In addition, the governments' implicit guarantees due to "too big to fail" concerns has also reduced the funding costs of these banks (Berger et al., 2009). Finally, for the level of personal income, it is found of having a more significant positive relationship with small- and medium-sized banks. This is as expected as smaller banks rely more on the savings of the individuals. On the other hand, as smaller banks tend to be more prudent, increased personal income allows higher level of deposit payments. This has effectively increased banks' confidence, making it possible for more loans to be generated.

4.4.6 Robustness Test

In this section, two robustness tests will be conducted to verify the reliability of our tested results. First of all, we replace our category-based liquidity creation measurement to a maturity-based one and then investigate its relationship with bank competition and capital adequacy requirements. The results are reported in Table 4-8.

It can be found that all conclusions reached in earlier sections remain hold. Banks tend to create more liquidity when they have higher pricing power. A higher capital ratio reduces the liquidity created by banks. The interaction term is significantly positive, indicating that the capital adequacy enhances liquidity creation by banks with higher market power. As for control variables, again, the statistical results remain constant. Larger banks, faster economic growth and higher level of profitability and personal income are found of contributing positively to liquidity creation whereas a higher level of credit risk exposure reduces banks' liquidity creation. Therefore, the conclusions reached in earlier section are robust.

In the second test, we try to eliminate the impact of equity on liquidity creation as according to Fu et al., (2015), equity capital may allow banks to impede more illiquid loans and hence may weaken their liquidity creation ability. However, in the previous regression specification, the current bank equity is included (with a weight of -½) in

our dependent variables and the lagged equity-based capital ratio is used as our key exogenous variable. To ameliorate this potential concern, we apply an alternative “cat fat” liquidity creation measure that excludes equity (Catfat_eq). This measure does not penalize banks for funding part of their activities with equity capital (Berger and Bowman, 2009). This has therefore increased the amount of liquidity creation for all banks, especially for banks holding a relatively large amount of equity capital. The tested results are shown in Table 4-9. All our findings remain robust after excluding equity from the dependent variable, with the only exception of the coefficient of bank size. This might because the portion of equity takes a larger part of the funding sources for small banks when compared with large banks. However, high equity is considered as highly illiquid liability, which would destroy liquidity creation. When it is removed, this has effective improved the liquidity creation capacity of small banks.

Table 4-7 The heterogenous effect to different bank size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	(small) Catfat	(medium) Catfat	(large) Catfat	(small) Catfat	(medium) Catfat	(large) Catfat	(small) Catfat	(medium) Catfat	(large) Catfat
L.Lerner	0.0343***	0.124***	0.0851**	0.0256*	0.1450***	0.0722	0.0479***	0.1160***	0.0376
	(0.0110)	(0.0325)	(0.0353)	(0.0143)	(0.0351)	(0.0610)	(0.0049)	(0.0189)	(0.0268)
L.interaction1	0.0074***	0.0090***	0.0051*						
	(0.0020)	(0.0023)	(0.0027)						
L.capitalratio1	-0.0023***	-0.0057***	-0.0060***						
	(0.0006)	(0.0010)	(0.0010)						
L.interactionT				0.0097***	0.0100***	0.0116***			
				(0.0019)	(0.0023)	(0.0024)			
L.totalcapitalratio				-0.0035***	-0.0073***	-0.0071***			
				(0.0005)	(0.0007)	(0.0014)			
L.interactionE							-0.0060***	-8.44e-05	-0.0033
							(0.0006)	(0.0022)	(0.0024)
L.equityratio							-0.0047***	-0.0053***	0.0008
							(0.0001)	(0.0005)	(0.0008)
L.lnroe	0.00013	-0.0039	-0.0068	0.0036***	-0.0034	-0.0064	0.0035***	-0.0043	-0.0019
	(0.0008)	(0.0028)	(0.0056)	(0.0012)	(0.0029)	(0.0052)	(0.0005)	(0.0021)	(0.0034)
L.nclnlsr	-0.0035***	-0.0033**	-0.0016	-0.0031***	-0.0041**	-0.0017	-0.0033***	-0.0048***	-0.0046***
	(0.0004)	(0.0013)	(0.0015)	(0.0008)	(0.0017)	(0.0027)	(0.0002)	(0.0007)	(0.0010)
L.lnGDP	-0.0039	0.0508**	0.0315**	0.0135	0.0484**	0.0131	0.0149***	0.0336***	0.0154**
	(0.0109)	(0.0234)	(0.0147)	(0.0086)	(0.0214)	(0.0109)	(0.0031)	(0.0107)	(0.0062)
L.lnpersonalincome	0.0121	0.0049	0.0133	0.0135*	0.0199	0.0183	0.0146***	0.0270***	0.0145*
	(0.0089)	(0.0139)	(0.0195)	(0.0080)	(0.0146)	(0.0226)	(0.0030)	(0.0097)	(0.0076)
Constant	0.2100***	0.3220***	0.1880***	0.1360***	0.1920***	0.1470***	0.1380***	0.2040***	0.1630***
	(0.0022)	(0.0168)	(0.0493)	(0.0057)	(0.0130)	(0.0408)	(0.0021)	(0.0086)	(0.0273)
Observations	52,658	4,464	2,741	130,135	7,579	4,862	130,135	7,579	4,862
R-squared	0.3120	0.3490	0.2080	0.3580	0.3420	0.1480	0.3220	0.2920	0.1030
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
F	291.8	26.39	13.19	457.0	24.82	7.744	2020	89.40	16.94

Note: All regressions include interaction terms of pricing power in the market (Lerner index) with three capital adequacy indicators, which are interaction1, interactionT and interactionE, respectively. The same set of control variables are included in the regressions shown in Table 4-3. Columns (1)-(3) are the results for capital adequacy is measured by the Tier-1 capital ratio. Columns (4)-(6) are the results for capital adequacy is measured by the total capital ratio and Columns (7)-(9) are the results for capital adequacy is measured by the equity capital ratio. Columns

(1), (4) and (7) test the effect on small-sized banks. Columns (2), (5) and (8) are for medium-sized banks. Columns (3), (6) and (9) test the effect on large-sized banks. All the regressions include bank and year fixed effects. All the variables are one-year lag in the regression and t-statistics are depicted in brackets. */**/*** denote the significance at the 10%, 5% and 1% levels, respectively.

Table 4-8 Robustness test-alternative liquidity creation measurement

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Matfat	Matfat	Matfat	Matfat	Matfat	Matfat
L.Lerner	0.0335***	0.0361***	0.0295***	0.0454***	0.0463***	0.0621***
	(0.0119)	(0.0083)	(0.0053)	(0.0110)	(0.0056)	(0.0069)
L.interaction1	0.0078***	0.0080***				
	(0.0020)	(0.0010)				
L.capitalratio1	-0.0024**	-0.0024***				
	(0.0005)	(0.0002)				
L.interactionT			0.0091***	0.0090*		
			(0.0002)	(0.0015)		
L.totalcapitalratio			-0.0035**	-0.0035***		
			(4.44e-05)	(0.0004)		
L.interactionE					-0.0058***	-0.0053**
					(0.0006)	(0.0012)
L.equityratio					-0.0041***	-0.0041***
					(0.0001)	(0.0002)
L.lnasset	0.0192***	0.0175***	0.0085***	0.0093**	0.0052***	0.0058***
	(0.0041)	(0.0025)	(0.0009)	(0.0017)	(0.0009)	(0.0012)
L.lnroe	-0.0009	-0.0012	0.0019**	0.0013	0.0019***	0.0014**
	(0.0009)	(0.0008)	(0.0006)	(0.0010)	(0.0006)	(0.0007)
L.nclnlsr	-0.0030*	-0.0029***	-0.0028***	-0.0028***	-0.0032***	-0.0032***
	(0.0004)	(0.0003)	(0.0002)	(0.0004)	(0.0002)	(0.0002)
L.lnGDP	-0.0194	-0.0019	0.0080***	-0.0060	0.0121***	0.0009
	(0.0136)	(0.0187)	(0.0030)	(0.0117)	(0.0030)	(0.0122)
L.lnpersonalincome	0.0122	0.0192	0.0078**	-0.0036	0.0057*	0.0002
	(0.0104)	(0.0121)	(0.0030)	(0.0099)	(0.0030)	(0.0093)
Constant	0.2590***		0.1460***		0.1500***	
	(0.0020)		(0.0019)		(0.0019)	
Observations	59,863	59,538	136,654	135,987	136,654	135,987
R-squared	0.3310	0.8840	0.3990	0.8120	0.3760	0.8050
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES		YES		YES	
State-Year FE		YES		YES		YES
F	364.4	33.82	3076	52.79	2790	104.3

Note: This table shows results when the dependent variable is calculated based on maturity, total liquidity creation scaled by gross total assets (Matfat). All regressions include interaction terms of pricing power in the market (Lerner index) with three capital adequacy indicators, which are interaction1, interactionT and interactionE, respectively. The same set of control variables are included in the regressions shown in Table 4-3. Columns (1)-(2) are the results for capital adequacy is measured by the Tier-1 capital ratio. Columns (3)-(4) are the results for capital adequacy is measured by the total capital ratio and Columns (5)-(6) are the results for capital adequacy is measured by the equity capital ratio. Columns (1), (3) and (5) include bank and year fixed effects. Columns (2), (4) and (6) include bank and state-year fixed effects. All the variables are one-year lag in the regression and t-statistics are depicted in brackets. */**/*** denote the significance at the 10%, 5% and 1% levels, respectively.

Table 4-9 Robustness test-endogenous test

Variables	(1) Catfat_eq	(2) Catfat_eq	(3) Catfat_eq	(4) Catfat_eq	(5) Catfat_eq	(6) Catfat_eq
L.Lerner	0.0545***	0.0553***	0.0715***	0.0785***	0.0606***	0.0659***
	(0.0104)	(0.0073)	(0.0139)	(0.0089)	(0.0113)	(0.0060)
L.interaction1	0.0063***	0.0065***				
	(0.0017)	(0.0008)				
L.capitalratio1	-0.0021***	-0.0022***				
	(0.0005)	(0.0002)				
L.interactionT			0.0075***	0.0072***		
			(0.0015)	(0.0012)		
L.totalcapitalratio			-0.0030***	-0.0030***		
			(0.0004)	(0.0003)		
L.interactionE					0.0057***	0.0055***
					(0.0016)	(0.0009)
L.equityratio					-0.0013***	-0.0011***
					(0.0003)	(0.0002)
L.lnasset	-0.0065*	-0.0056**	-0.0009	-0.0003	-0.0050**	-0.0060**
	(0.0030)	(0.0022)	(0.0027)	(0.0015)	(0.0025)	(0.0011)
L.lnroe	0.0014*	0.0013**	-2.57e-05	-0.0002	0.0024***	0.0024***
	(0.0008)	(0.0007)	(0.0011)	(0.0080)	(0.0008)	(0.0006)
L.nclnlsr	-0.0033***	-0.0035***	-0.0028***	-0.0028***	-0.0031***	-0.0031***
	(0.0003)	(0.0003)	(0.0006)	(0.0003)	(0.0004)	(0.0002)
L.lnGDP	0.0008	0.0134	0.0106*	-0.0019	0.0138**	0.0031
	(0.0095)	(0.0107)	(0.0064)	(0.0092)	(0.0064)	(0.0092)
L.lnpersonalincome	0.0141**	0.0056	0.0143**	-0.0012	0.0162**	0.0025
	(0.0072)	(0.0066)	(0.0072)	(0.0075)	(0.0073)	(0.0062)
Constant	0.2740***		0.1940***		0.1990***	
	(0.0017)		(0.0042)		(0.004)	
Observations	59,863	59,538	142,576	141,909	142,576	141,909
R-squared	0.3140	0.9150	0.3580	0.8460	0.3270	0.8380
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES					
State-Year FE		YES	YES	YES	YES	YES
F	333.7	53.86	477.7	83.36	452.7	96.48

Note: This table shows t results when the dependent variable is calculated based on category, total liquidity creation without equity scaled by gross total assets (Catfat_eq). All regressions include interaction terms of pricing power in the market (Lerner index) with three capital adequacy indicators, which are interaction1, interactionT and interactionE, respectively. The same set of control variables are included in the regressions shown in Table 4-3. Columns (1)-(2) are the results for capital adequacy is measured by the Tier-1 capital ratio. Columns (3)-(4) are the results for capital adequacy is measured by the total capital ratio and Columns (5)-(6) are the results for capital adequacy is measured by the equity capital ratio. Columns (1), (3) and (5) include bank and year fixed effects. Columns (2), (4) and (6) include bank and state-year fixed effects. All the variables are one-year lag in the regression and t-statistics are depicted in brackets. */**/*** denote the significance at the 10%, 5% and 1% levels, respectively.

4.5 Conclusion

The ongoing global economic turmoil and the 2008 financial crisis have led to increased debate over the role banks played in liquidity creation. Various government policies were initiated to restore market confidence and encourage more bank lending. One

initiative is through introducing more competition into the banking sector. The initial incentive is that increased competition could stimulate financial innovation, facilitate information dissemination and enhance market confidence. This would in turn lead to increased liquidity creation. However, the empirical studies reached mixed results. Two school of thoughts, the "competition-fragility" and the "competition-stability" theories are widely quoted to explain the relationship between bank competition and liquidity creation. In this study, employing data of the US banking market over 1997 to 2020, we try to investigate whether a higher pricing power of banks would lead to increased liquidity creation. Meanwhile, we also take the impact of capital adequacy ratio and size of the banks into consideration. As for bank competition, it is proxied by the Lerner index and for liquidity creation, we not only consider the overall liquidity creation but also further divide it into the asset-side, liability-side and off-balance-sheet liquidity creation. The fixed effect model is applied, and several important conclusions are reached in our study.

First of all, we find that banks with higher pricing power, tend to create more liquidity. This is in line with "competition-fragility" theory that competition undermines liquidity creation by increasing the fragility of banks. However, when we look at the individual components of liquidity creation, it is found that banks with higher pricing power may reduce their liability-side liquidity creation. This might be because in powerful banks may reduce the interest rate offered to enhance its charter. This would in turn lead to a reduction of the deposits attracted. As for the capital adequacy ratio, it has a negative impact on banks' liquidity creation as more capital is tied up to safeguard the interests of depositors. When the joint impact of bank competition and capital adequacy ratio is considered, they are found of contributing positively to banks' liquidity creation. It therefore indicates that tighter regulator control would increase market confidence, and this is especially the case when the banking sector is relatively concentrated.

Secondly, we take the size effect into consideration and try to investigate whether the

liquidity creation capacity of large-, medium- and small-sized banks are affected differently by the pricing power of banks and the capital ratios. It is concluded that the positive impact of pricing power on liquidity creation is greater for small- and medium-sized banks than for large-sized banks. This indicates that compared with larger banks, smaller banks are more sensitive to the change of power. When the banking market is relatively concentrated, this increases the chance for relationship building. Consequently, more liquidity can be created.

These results are useful for policy makings. It proves that bank market power matters for macroprudential policies. Therefore, the policymakers should monitor the structure of the banking sector not only for financial stability reasons, but also to encourage liquidity creation as it may lead to higher levels of economic growth. In countries with well-developed financial sector like the US, bank consolidation could be encouraged rather than restricted as it may lead to increased liquidity creation. This is especially important when the country is experiencing economic downturn. In addition, although after the 2008 financial crisis, policymakers might face the conflicting objectives between the promoting of economic growth through liquidity creation and increasing capital ratio to minimise risks exposure, they can be achieved simultaneously when it is combined with the right character of the banking market. In a highly regulated industry, like the banking sector, higher level of bank market power does not necessarily mean a bad thing. Instead, it may lead to resource sharing and risk diversification. Therefore, the right balance could be found out by implementing different policies on banks with different sizes and of different market powers.

Chapter 5 Liquidity Creation, Product Market Concentration and Firm Innovation

5.1 Introduction

The banking sector, a critical component of a country's financial system, is believed of playing an important role in promoting a country's economic growth and innovation (Fagiolo et al., 2020). On the one hand, liquidity creation is a core economic function of banks, and it dated back to Adam Smith (1776)[3]. Banks create liquidity by financing long-term illiquid assets with short-term liquid liabilities (Bryant, 1980; Diamond and Dybvig, 1983). By offering liquid deposits to customers and choosing a mixture of liquid and illiquid investment, banks are found of channeling scarce financial resources to important business sectors to promote growth. This is confirmed by earlier studies that there is a positive relationship between liquidity creation and economic growth (Fidrmuc et al., 2015; Berger and Sedunov, 2017; Beck et al., 2020).

On the other hand, it is generally believed that to achieve long-term sustained growth, a country needs to upgrade its economic structure, devoting more resources towards those emerging industries that could generate higher value-added. Investments in research and innovation would be one way for firms to achieve this target. However, such investments tend to be highly risky and large in quantity and they may require long payback period. As a result, it is hard for firms to attract investors directly for R&D investments. This has therefore called for the need of bank lending. By pooling a large amount of savings together, banks are capable of providing financial support to such highly risky long-term projects (Wagner et al., 2007). Meanwhile, to diversify risk

[3] Adam Smith (book II, chapter II, 1776) emphasizes the importance of banks' liquidity creation. In addition, he shows how it helped commerce in Scotland in the 18th century. He notes that "the trade and industry of Scotland have increased very considerably during this period and that the banks have contributed a good deal to this increase".

exposure, banks are also found of cherry-picking projects that have the most productivity-enhancing potential (King and Levine, 1993; Bencivenga and Smith, 1991). In this way, banks have directly promoted the innovation productivity of firms as only those most promising projects are funded. Since innovation is widely regarded as the main driver for economic growth, a thorough understanding of the relationship between bank liquidity creation and firm innovation has therefore become quite important to identify the channels through which financial development contributes to economic development. Benfratello et al. (2008) argue that the development of banking market can enhance the process innovation, while has no robust impact on product innovation. In contrast, Hsu et al. (2014) find that the innovation in industries with highly eternal financial dependence would be discouraged by credit market. However, little has been done to explore further about the channel through which liquidity created by banks has contributed to innovation, except for the study of Yasar (2021).

In this paper, employing a unique supervisory data set from the US banks, we try to investigate the interrelationship between bank liquidity creation, product market concentration, and firm innovation. In particular, the following questions will be tested. Does bank liquidity creation enhance firms' innovation? What is the moderated impact of product market concentration on the relationship between bank liquidity creation and firms' innovation? Whether such joint impact acts differently on the input and output of firms' innovation. What is the impact of the financial crisis on the impact of bank liquidity creation and bank liquidity creation change on firms' innovation activities?

This study contributes to the subject area in the following ways. First of all, it enriches the finance and growth literature by investigating comprehensively the role played by bank liquidity creation in firms' innovation activities. In addition to innovation outputs, as studied by Yasar (2021), we also consider the impact of bank liquidity on firms' innovation efficiency. Secondly, to the best of our knowledge, this is the first study that considers the role played by product market structure in shaping the relationship

between bank liquidity creation and innovation. Due to the close relationship between the competition level of firms and the profit potential of the industry, the liquidity created by banks may generate a diverse impact on firms' innovation capacity depending on their needs for funds. A highly competitive product market may squeeze the profit margin of firms, making liquidity created by banks more valuable. Therefore, in this paper, we try to fill in the research gap by considering the moderation effect of product market structure on the relationship between banks' liquidity creation and firms' innovation activities.

The rest of paper is organised as the following. Section 2 reviews the literature on bank liquidity creation, product market concentration and firm innovation. Section 3 describes the methodology employed for empirical analysis. Section 4 presents the data and variables and summarises the research findings and this is followed by Section 5 with two robustness tests. In the end, the last Section 6 draws the conclusions with some policy implications.

5.2 Literature Review

5.2.1 Bank Liquidity Creation and Firm Innovation

Economic growth and the development of the financial sector have always been interrelated. The earlier study of King and Levine (1993) proves that better financial systems improve the probability of successful innovation and thereby accelerate economic growth. In addition, as two major components of the financial sector, the development of the stock market and banking industry are both found of contributing positively to a country's economic growth, capital accumulation and productivity growth (Levine and Zervos, 1998). In particular, for countries with more advanced financial systems, the provision of additional financial capital to industrial sectors allows them to experience disproportionately faster-than average growth speed (Rajan and Zingales, 1995, 1998). Such positive impact is mainly realized through the

optimisation of resource allocation, the improvement of total factor productivity and the reduction of costs of external finance by banks (Beck et al., 2000). Despite the importance of the banking sector, little has been done to investigate empirically about how liquidity creation is acting on real economic activities. Employing data of Russia over the period of 2004 to 2012, the study of Fidrmuc et al. (2015) is among the first few empirical studies that identify a positive relationship between liquidity creation and economic growth. Later, Berger and Sedunov (2017) improve the earlier study by considering the influence of both on-balance and off-balance liquidity creation together on the real economy. It is concluded that for industries that depend more on banking finance, they are more likely to be affected by the liquidity created by banks. However, Beck et al. (2020) reached mixed results in their study of bank liquidity creation and economic growth among a large sample of different industries from over 100 countries. They argue that bank liquidity creation could only generate weak or even insignificant impact on economic growth if the industries of a country are dominated by intangible investments, whereas a more significant impact could be generated if investments are mainly for tangible assets.

In terms of the determinants of firm innovation, King and Levine (1993) show that by lowering information costs, financial intermediaries foster more efficient resource allocation, leading to accelerated technological innovation and long-run growth. Similar finding is also reached by Ayyagari et al. (2011). They argue that firms' access to external finance is found of acting positively on their innovation capability based on their sample of 47 developing economies. Compared with state-funded firms, private firms tend to be more innovative. Financing from banks is associated with higher levels of innovation efficiency when compared with all types of finance including internal funds, investment funds, trade credit, equity, family and friends, and other informal sources. This might be because banks are more likely to perform a monitoring role in terms the use of fund and the final delivery of outcomes.

Employing data over the period of 1970 to 2005, the study of Chava et al. (2013) reached similar conclusions, but they also pointed out that such a positive impact of bank deregulation on firms' innovation efficiency is more significant among smaller financially constrained firms. Moreover, different types of banking deregulations are also found of generating diversified impacts on firms' innovation behaviours. The intrastate banking deregulation are more likely to lead to a fall in firm innovation, whereas the interstate banking deregulation may cause a contrary effect. This might because the former type of deregulation may increase the competition in the local banking market, squeezing out their profit margin and making them more reluctant to invest in the innovation projects with high risk and high uncertainties. However, for the later type of deregulation, it provides banks with more flexibility. Firms are therefore encouraged to show superior performance so as to attract bank lending at a favourable rate. The later study of Cornaggia et al. (2015) also find that interstate deregulation has increased the innovation capacity of small private firms as they rely more heavily on bank lending. However, for those large, listed firms, the impact tends to be negative, and this is because more funding is channelled to smaller private firms.

Innovation, by nature, tends to be associated with asymmetrical information and moral hazard problems (Hall, 2002). As afinancial intermediary, the information advantage of banks allows them to play a role in mitigating these problems. As a result, one may say that liquidity created by banks has facilitated technological innovation and ultimately triggered the long-run growth of the economy. In particular, as innovation requires long-run commitment and monitoring of capital invested, investors are reluctant to invest directly. This has made lending by banks of critical importance. By pooling large amount of liquid savings together and lend them out as loans with different maturity and interest rate, banks have diversified their risk exposure and facilitated the development of those high-return but illiquid investment opportunities, such as productivity-enhancing innovative projects (King and Levine, 1993b; Bencivenga and Smith, 1991). This has consequently led the long-term growth of the economy. However,

if too much liquidity is created to violate the stability of the financial system, this might generate a significant negative impact on the long-run growth of the economy (Yasar, 2021). As a result, no consensus has been reached regarding the relationship between bank liquidity creation and firm innovation.

5.2.2 Product Market Structure and Firm Innovation

As for the impact of product market structure on firm innovation, it is also inconsistent. The earlier work of Schumpeter (1943) and Arrow (1962) point out that under perfect competition when firms could only make normal profits, endogenous innovation is practically impossible as it requires substantial capital investment. Technological progress requires the presence of (some) market power (Romer, 1990; Aghion and Howitt, 1992) and is costly to produce as knowledge is non-rival and can be appropriated by others. As a result, a negative linear relationship is predicted. By reducing monopoly profits that acts as a reward to innovation, competition may demotivate innovations among market leaders, dragging down economic growth. Similarly, based on public firms in the US, Atanassov et al. (2007) find a positive relationship between industry concentration (Herfindahl index) and patent filings, despite the relationship being nonlinear. In contrast, Arrow (1962) argues that firms in a monopolistic situation would only innovate to replace a rent ("replacement" effect) that they already have whereas firms operating in a competitive environment are more likely to innovate as they may gain the full return on innovation as they have no chance to enjoy any monopoly profit. It is therefore concluded that competition promotes innovation especially if it can provide smaller firms a level of play filed.

Interestingly, the research of Aghion et al. (2005) find that the two opposing views related to the level of product market concentration and firm innovation may exist simultaneously. The tested relationship is affected by a series of other factors such as the initial level of competition, firms' (and industries') technological distance to the

frontier and level of technological rivalry. They argue that the innovation incentive of firms is actually driven by the difference between the post-innovation and pre-innovation profits and their position on the technology frontier. Firms tend to have higher innovation incentives when the technology rivalry is strong (disparity is low) as competition may reduce their pre-innovation rents by a larger percentage than the post-innovation rents. On the other hand, in levelled industries or neck-and-neck sectors, where firms operate at the same technological level, increased product market competition will encourage them to innovate in order to acquire a leading position in the sector or to escape direct competition (Aghion et al., 2001). On the contrary, in asymmetry sectors, increased competition may discourage innovation among laggard firms as it decreases the short-run extra potential profit gained from catching up with the leaders (Schumpeterian effect). This may drive down the average innovation efforts of the whole industry. Therefore, if firms operate in industries with diversified technological competence and if the laggard firms account for a larger percentage, increased competition may depress innovation as it lowers the profit potential of firms. In general, reduced competition of the product market is believed to create a potentially countervailing effect on incentives to innovate, and this may lead to the development of a monotonic-increasing or a non-monotonic relationship between the two.

From the discussion above, it is clear that no consensus has been reached on the relationship between firm innovation and product market structure. Nevertheless, as innovation contributes significantly to economic growth, it is therefore important to have a clear understanding of the relationship between the two. In addition, as liquidity created by banks may also impact firm innovation directly, it is, therefore, worthwhile to explore the interactive effect of bank liquidity creation and product market concentration on the innovation activities of firms. As a result, the following hypotheses are proposed for this research:

H1: Bank liquidity creation may increase firms' innovation, as it provides increased

capital for research and development (R&D) activities.

H2: The impact of bank liquidity creation on firm innovation may be weakened in a more concentrated product market as a monopolistic environment would reduce firms' incentive to innovate.

5.3 Methodology

To assess how bank liquidity creation and product market concentration affect firms' innovation activities jointly, the following model is developed:

$$I_{fist} = a_0 + a_1 Bank\ Liquidity\ creation_{st-1} + a_2 Bank\ Liquidity\ creation_{st-1} * Product\ market\ concentration_{ist-1} + a_3 Product\ market\ concentration_{ist-1} + a_4 C_{ft-1} + a_5 S_{st-1} + Year_t + Industry_s + \varepsilon_{ist} \cdots\cdots\cdots\cdots \text{(Eq. 5-1)}$$

where f,t,i and s and s denote company, year, industry and state respectively. I_{fist} represents firm innovation, and it is measured by the innovation output, which is represent by the logarithm of one plus the number of patents filed per firm, and innovation efficiency, measured by the logarithm of one plus number of patents generated by per million-dollar R&D investment (Patent / R&D), as well as innovation input (R&D expenditure) of firms. Following the research of Berger and Bouwman's (2009), we use the category-based measures and maturity-based measures to capture bank liquidity creation in the main test and the robustness test respectively. For the product market concentration, it is measured by the asset-based Herfindahl index (HHI_at) in the main test and by the number of employment-based (HHI_emp) and the sale-based Herfindahl index (HHI_sale) in the robustness test respectively. C_{ft-1} is the vector of firm-level control variables at time t-1 and S_{st-1} represents the state-level control variables at time t-1. $Year_t$ and $Industry_s$ captures the year fixed effects and industry fixed effects.

5.4 Data and Empirical Results Analysis

Our data are collected from various sources. Data for corporate innovation are collected from data package provided by Kogan et al., (2017). Considering the availability of both bank liquidity creation and firm innovation data, our sample period is restricted from 1997 to 2019, with 36,748 observations included in the regression analysis. We exclude sample patents granted to universities, governments and foreign companies which rely weakly on banking finance. The firm-level data are collected from COMPUSTAT, and the state-level control variables are collected from the database of the Federal Reserve Bank of ST. Louis.

5.4.1 Dependent Variable

Following the study of Chen et al. (2018), corporate innovative outputs are captured by the logarithm of one plus the number of patents filed per firm. For innovation efficiency, it is measured by the logarithm of one plus number of patents generated by per million-dollar R&D investment (Patent / R&D), and the logarithm of firm R&D expenditure (lnrd) to measure the input of firm innovation, following the research of Tian et al. (2019) and Dugan et al. (2016), respectively.

5.4.2 Measurement of Liquidity Creation

Following the research of Berger and Bouwman (2009), we use four measures for liquidity creation: two category-based measures and two maturity-based measures. In classifying bank activities other than loans, we use both product category and maturity information, but for loans, they are classified either by category or by maturity only. For this reason, Berger and Bouwman (2009) create both category- and maturity-based liquidity creation measures, where the category-based measures classify loans based on category only and the maturity-based measures classify loans based on maturity only. First of all, in terms of the category-based measures, balance-sheet and off-balance-

sheet activities are classified as liquid, semi-liquid, or illiquid according to product category, while the maturity-based measures classify loans as illiquid or semi-liquid depending on whether their maturity date is within a year or not. Secondly, the classified items are assigned a weight, following the liquidity-creation theory. To be more specific, a weight of 0.5 is assigned to illiquid assets, liquid liabilities, and illiquid off-balance-sheet items. A weight of 0.5 is assigned to liquid assets, illiquid liabilities, and liquid off-balance-sheet items, and a weight of 0 is assigned to semiliquid assets and liabilities. These weights are assigned based on the assumption that when banks transform $1 of illiquid (liquid) assets or off-balance-sheet items into $1 of liquid (illiquid) liabilities, $1 of liquidity is created (destroyed). Then in the third step, items are combined as classified and weighted to construct four liquidity-creation measures, two include off-balance-sheet activities (cat/mat fat), and two without (cat/mat nonfat). In general, the "cat fat" measure is preferred, as it divides liquidity of loans according to the ease, timing, and cost for customers to obtain funds from banks rather than by term to maturity only, as the maturity-based measurements do (Berger and Bouwman, 2009).

Pane A in Table 5-1 summarises the above discussions. Then in Panel B, we present the calculations of "cat(mat) fat" and "cat(mat) nonfat", and the measurements of three components of liquidity creation, namely, the asset-side liquidity creation, the liability-side liquidity creation and off-balance sheet liquidity creation, respectively.

Finally, to make the liquidity creation measures comparable across banks, we normalise bank liquidity creation by the bank's gross total assets, which equals the sum of total assets, allowances for loan and lease losses, and allocated transfer risk reserve (a reserve for certain foreign loans). We winsorize the four liquidity creation ratios at the 2.5% and 97.5% levels.

Table 5-1 Liquidity creation measurement

Step 1: Bank activities are classified as liquid, semiliquid, and illiquid, based on the activities category in Panel A.

Step 2: We assign weights to all bank activities classified in Step 1.

Step 3: We combine the bank activities classification in Step 1 with weights in Step 2 in two ways

to construct liquidity-creation measures by using the "cat" ("mat") based on the activities category (maturity), and by alternatively including off-balance-sheet activities (fat) or excluding these activities (nonfat). In addition, we establish the three components of liquidity creation, detailed in Panel B. In addition, we consider the three components of liquidity creation, which are asset-side liquidity creation, liability-side liquidity creation and off-balance-sheet liquidity creation.

Panel A: Liquidity classification of bank activities				
Asset				
Illiquid asset (weight=1/2)		Semiliquid asset (weight=0)		Liquid assets (weight=-1/2)
(Cat)	(Mat)	(Cat)	(Mat)	(Cat)
Corporate& commercial loans	All loans and leases with a remaining maturity > 1 year	Residential mortgage loans	All loans and leases with a remaining maturity <= 1 year	Cash and due from banks
Investments in property		Other mortgage loans		Trading securities and at fv through income
Foreclosed real estate		Other consumer/retail loans		Tradable derivatives
Fixed assets		Loans and advances to banks		Available-for-sale securities
Goodwill		Reverse repos and cash collateral		Held to maturity securities
Other intangibles				At-equity investments in associates
Other assets				Other securities
Liabilities plus Equity				
Liquid liabilities (weight=1/2)		Semiliquid liabilities (weight=0)		Illiquid liabilities plus equity (weight=-1/2)
Customer deposits — current		Customer deposits — term		Senior debt maturing after 1 year
Customer deposits — savings		Deposits from banks		Subordinated borrowing
Tradable derivatives		Repos and cash collateral		Other funding
Trading liabilities		Other deposits and short-term borrowings		Credit impairment reserves
		Fair value portion of debt		Reserves for pensions and other
				Current tax liabilities
				Deferred tax liabilities
				Other deferred liabilities
				Other liabilities
				Total equity
Off-balance-sheet activities				
Illiquid activities (weight=1/2)		Semiliquid activities (weight=0)		Liquid activities (weight=-1/2)
Net standby letters of credit		Net credit derivatives		Net participations acquired
Commercial and similar letters of credit		Net securities lent		Interest rate derivatives
Other contingent liabilities				Foreign exchange derivatives
Unused commitments				Equity and commodity derivatives
Panel B: Liquidity creation formulas				
Cat(Mat)fat=	1/2*illiquid assets+1/2*liquid liabilities+1/2*illiquid activities+0*semiliquid assets+0*semiliquid liabilities+0*semiliquid activities -1/2*liquid assets-1/2*illiquid liabities or equity-1/2*liquid activities			
Cat(Mat) nonfat=	+1/2*illiquid assets+1/2*liquid liabilities+0*semiliquid asset+0*semiliquid liabilities-1/2*liquid assets-1/2*illiquid liabilities-1/2*equity			
Assetside_LC=	1/2*illiquid assets - 1/2*liquid assets			
Liailityside_LC=	1/2*liquid liabilities - 1/2*illiquid liabilities			
Offcat(mat)fat_LC=	Cat(Mat)fat-Cat(Mat)nonfat			

5.4.3 Control Variables

In terms of control variables, we use return on assets (ROA) to control for the availability of internal resources in financing innovation (Himmelberg and Petersen, 1994). On the one hand, as firms with a high ROA tend to have higher profit and hence, more retained earnings, this may allow them to have more capitals to be used for R&D activities. Therefore, a positive relationship is expected between the profitability of firms and their innovation capacity. However, Branch (1974) argues, managers in industries, which are typically in the mature or declining stage of the life cycle, may only be induced to pursue the strategy of innovation when profits are abnormally low. When profits are higher, they are more prone to complacency. Therefore, the relationship between profitability and innovation is unclear.

The second control variable is firms' leverage (Leverage), and it is defined as debt-to-equity ratio of firms. In general, R&D is considered to be highly risky, and it may lead to substantial opportunity costs to firms. As suggested by Branch (1974) that debt or the issuance of new equity securities is a dubious source of funding for new projects, because of the risk and long-time horizon involved in innovative activities. Therefore, a higher leverage ratio may reduce the innovation capacity of firms due to increased scrutinization and pressure imposed by lenders and shareholders.

Moreover, we also include firm size as a control variable, and it is measured by the logarithm of firm assets (Size). According to Schumpeterian hypothesis, large firms are more efficient in transforming R&D inputs into innovative activities than small firms (Beneito et al., 2014). This is partly due to funding constraints, small firms that engage in R&D may expose themselves into substantial risks, as a large proposition of their resources is invested into one single project. While for their larger counterparts, they have the capacity to invest into a few R&D projects. This has effectively reduced their risks exposure. Therefore, a positive relationship is expected between firm size and innovation.

In terms of firm asset tangibility (Asset tangibility), it is defined as Property, Plant and Equipment divided by book value of total assets. It is included to control for the role of financial capacity. On the one hand, for firms with a higher level of tangible assets, it would be easier for them to get bank loans due to the availability of collaterals. In the presence of asymmetric information, tangible assets are more likely to serve as collateral and may help to alleviate financial constraints, therefore, firms may increase their R&D investments, leading to more innovation outputs (Chen et al., 2018). As a result, a positive relationship is expected between asset tangibility and firm innovation is expected. On the other hand, according to the substitutive resource-based perspective, tangible assets and innovation are substitutes, either can sustain firms' competitive advantage (Schroeder et al. 2002). Similarly, Pham et al. (2018) find a negative relationship between firm asset tangibility and firm innovation. Therefore, a negative relationship is expected between asset tangibility and firm innovation. Overall, the relationship between firm tangible asset and firm innovation is unclear.

In addition, we also control for time-varying state's economic activity by the annual growth rate of gross state product (GDP_growth). According to Acharya et al. (2009), the risk-shifting incentive encourages banks to hold risky and illiquid assets during boom periods because risky investments are more likely to pay off well during boom periods. Since business cycle fluctuations are closely linked to fluctuations in banks searching for risky loans, more risky innovative projects might be invested during economic booms. Therefore, a positive relationship between economic growth and firm innovation is expected. In addition, We winsorize all control variables at the 2.5% and 97.5% levels.

5.4.4 Statistics of Variables

Table 5-2 presents the descriptive statistics for all variables used in the following

empirical analysis. The sample consists of annual state level observations of 50 US states over the period of 1997-2019. In terms of the firm innovation, in average, each sample firm have 5 patents, the innovation efficiency is 35% and R&D expenditure is about 14.9 million. The means (standard deviations) of full bank liquidity creation (Catfat), asset side liquidity creation (Assetside_LC), liability side liquidity creation (Liabilityside_LC), and off-balance sheet side liquidity creation (Offcatfat) are -1.000 (3.083), 0.005 (0.077), 0.181 (0.057) and -1.185 (3.042), respectively. This indicates off-balance-sheet activities are the main components of bank liquidity creation. As for product market concentration, it is averaged at 0.2, suggesting that the product market relatively competitive in general. A typical sample firm has a book value of assets of US$2.03 billion, ROA of -11.2%, financial leverage of 37.8% and an asset tangibility ratio of 41.7%. The average state GDP growth rate is about 4.5% over the sample period.

Table 5-2 Summary statistics of all key variables

Variable	Obs	Mean	Std.Dev.	Min	Max
Lnpant number	41,548	1.4700	1.5300	0	9.1150
Lnpant_efficiency	35,546	0.3000	0.4910	0	9.3930
Lnrd	36,424	2.7660	1.7600	0.0030	6.9560
Catfat	41,548	-1.0000	3.0830	-10.6800	1.4280
Offcatfat	41,548	-1.1850	3.0420	-10.9600	1.4270
Assetside_LC	41,548	0.0050	0.0770	-0.1550	0.1370
Liabilityside_LC	41,548	0.1810	0.0570	0.0660	0.3110
HHI_at	41,548	0.2000	0.1890	0	1.0000
size	41,498	5.3160	2.7060	-6.9080	14.800
ROA	41,323	-0.1120	0.5000	-2.2500	0.3020
Leverage	37,291	0.3780	1.0810	-2.6050	4.3980
Asset tangibility	40,999	0.4170	0.3430	0.0120	1.4270
GDP growth	39,384	0.0450	0.0250	-0.0270	0.0930

5.4.5 Descriptive Statistics on Bank Liquidity Creation, Product Market Concentration and Firm Innovation

Before we run the regression analysis, we first of all conduct some descriptive analysis. In Table 5-3, we test the correlation relationship between all key variables and summarise the results, in which bank liquidity creation is proxied by our “preferred”

category-based liquidity creation measurement (Catfat). The low correlation coefficients suggest that the explanatory variables are not highly correlated and hence there is no multicollinearity problem. In addition, a positive relationship between bank liquidity creation (Catfat) and firm innovation, and a negative relationship between product market concentration and firm innovation have also been detected, consistent with our expectations.

Then, we do descriptive analysis to identify the relationships among the bank liquidity creation, the product market concentration and firm innovation. Table 5-4 reports the preliminary statistics according to different quantiles of sample distribution. For firm innovation, it is measured by both of patent numbers approved (Inpat_number) and the innovation efficiency (Inpat_efficiency).

In general, it can be found that when the product market concentration is high and when more liquidity is created by banks, firms are more active in innovation. It seems that the concentration level of the product market tends to have a more diversified impact on firm innovation, and this is best reflected by the mean number of patents obtained. This is as expected as low concentration is associated with high compensation and reduced profit margin. This would leave firms with limited funding for R&D expenditure.

We then look at the cross impact of product market concentration and liquidity creation on firm innovation and summarise the results in Table 5-5. It can be found that when the market concentration is not high (medium and low), there is a is an inverted U-

shaped relationship between bank liquidity creation and number of patents granted. When the market concentration is high, it can be found that there is a U-shaped relationship between bank liquidity creation and number of patents. It is not surprise that in a highly concentrated product market and when banks are provided with sufficient liquidity, firms, in particular those market leaders which enjoy certain degree of monopoly power, could have more innovation outputs.

Table 5-3 Correlation between main variables

Variables	Lnpat number	Lnpat_ efficiency	Lnrd	Catfat	Offcatfat	Assetside_ LC	Liabilityside_ LC	HHI_at	Size	ROA	Leverage	Asset_ tangibity	GDP_ growth
Lnpat_number	1.00												
Lnpat_efficiency	0.44***	1.00											
Lnrd	0.74***	-0.05***	1.00										
Catfat	0.02***	0.02***	0.01*	1.00									
Offcatfat	0.02***	0.02***	0.01	1.00***	1.00								
Assetside_LC	0.09***	0.04***	0.06***	0.49***	0.47***	1.00							
Liabilityside_LC	0.09***	0.05***	0.08***	0.10***	0.07***	0.22***	1.00						
HHI_at	-0.07***	0.03***	-0.08***	0.06***	0.05***	0.08***	0.15***	1.00					
Size	0.60***	0.02***	0.78***	-0.04***	-0.04***	0.07***	0.16***	0.01**	1.00				
ROA	0.22***	-0.01	0.28***	-0.01	-0.01	0.02***	0.01***	0.01	0.28***	1.00			
Leverage	0.10***	0.03***	0.11***	-0.02***	-0.02***	0.01***	0.06***	0.02***	0.22***	0.14***	1.00		
Asset_tangibi	-0.03***	0.07***	-0.17***	0.02***	0.02***	-0.01**	0.03***	0.06***	-0.01	-0.01*	0.03***	1.00	
GDP_growth	-0.02***	0.05***	-0.04***	0.09***	0.09***	-0.02***	-0.09***	-0.07***	-0.07***	0.004	-0.01***	-0.03***	1.00

Note:*** p<0.01, ** p<0.05, * p<0.1

Table 5-4 The impact of product market concentration and bank liquidity creation on Firms' innovation

	lnpat_number	lnpat_efficiency
Product market concentration terciles		
Low product market concentration	1.330	0.295
Medium product market concentration	1.510	0.296
High product market concentration	1.540	0.317
Bank liquidity creation terciles		
Low bank liquidity creation	1.430	0.270
Medium bank liquidity creation	1.490	0.296
High bank liquidity creation	1.470	0.343

Note: Low-, medium- and high-bank market concentration correspond to values of bank market concentration below the 25th percentile of the sample distribution, between the 25th and the 75th percentiles of the sample distribution and above the 75th percentile of the sample distribution, respectively. Low-, medium- and high-bank liquidity creation correspond to values of the bank liquidity creation below the 25th percentile of the sample distribution, between the 25th and the 75th percentiles of the sample distribution and above the 75th percentile of the sample distribution, respectively.

Table 5-5 The cross impact of product market concentration and bank liquidity creation on Firms' innovation

		lnpat_number	lnpat_efficiency
Low product market concentration	Low bank liquidity creation	1.412	0.325
	Medium bank liquidity creation	1.600	0.284
	High bank liquidity creation	1.429	0.325
Medium product market concentration	Low bank liquidity creation	1.461	0.239
	Medium bank liquidity creation	1.544	0.308
	High bank liquidity creation	1.501	0.351
High product market concentration	Low bank liquidity creation	1.314	0.381
	Medium bank liquidity creation	1.243	0.292
	High bank liquidity creation	1.442	0.334

Note: Low-, medium- and high-product market concentration correspond to values of product market concentration below the 25th percentile of the sample distribution, between the 25th and the 75th percentiles of the sample distribution and above the 75th percentile of the sample distribution, respectively. Low-, medium- and high-bank liquidity creation correspond to values of the bank liquidity creation below the 25th percentile of the sample distribution, between the 25th and the 75th percentiles of the sample distribution and above the 75th percentile of the sample distribution, respectively.

In general, it seems that a medium level of market concentration is more beneficial for firms' innovation as firms are motivated to compete for the market leader position via

R&D. The relatively low level of the average number of patents applied among firms in the highly concentrated market might because the small firms are more repressed, leaving with limited capacity and capital for innovation.

On the other hand, when considering innovation efficiency, the situation is more complex. In general, when market concentration is not high (low and medium), higher liquidity created by banks would improve the innovation efficiency of firms. However, when the market is highly concentrated, increased liquidity created by banks may drag down the average innovation efficiency as firms may not use the capital carefully when they are provided with affluent capital.

In summary, the descriptive analysis highlights the close but complex relationship among bank liquidity creation, product market concentration and innovation. In the next section, we would investigate the relationship further and control for some unobserved factors that might influence the relationships detected.

5.4.6 Empirical Analysis

First of all, we test the interactive effect between bank liquidity creation and product market concentration on firms' innovation and summarise the results in Table 5-6. The dependent variable is measured by the number of patents (lnpat_number) in Model 1 and 2, innovation efficiency (lnpat_efficiency) in Model 3 and 4, and the R&D expenditure (lnrd) in Model 5 and 6, respectively. We include year and industry fixed effect in all regressions.

It can be found that there is a positive relationship between bank liquidity creation and firms' innovation outputs. This is consistent with our hypothesis 1 and the conclusions reached in earlier studies (Berger and Sedunov, 2017). The additional financial support provided by banks may provide firms with the needed capital for innovation.

Consequently, a higher level of R&D inputs is generated. As for the influence of product market concentration, it can be found that it has generated a negative impact on the number of patents and R&D expenditure. This is as expected and consistent with the conclusions reached by (Levin et al., 1985).

In terms of the moderation effect of product market concentration on banks' liquidity creation and firms' innovation, it can be found that there is a significant negative relationship when the innovation is proxied by the number of patents approved (lnpat_number) and innovation efficiency (lnpat_efficiency) (Model 2 and 4). In other words, when the product market is concentrated, it would weaken the positive impact of bank liquidity creation on firms' innovation activities. This is consistent with hypothesis 2 and the research of Fosu (2013). This might be because if the product market is highly concentrated, the increased liquidity created by banks are more likely to be absorbed by those large companies which tend to have less incentive to innovate as they are more willing to maintain the *state quo* and enjoy the monopoly profits. For the rest of the firms, funding available for R&D remains limited and this explains why the positive impact of liquidity creation on firm innovation would be impaired when the market is concentrated. However, when the innovation is proxied by the R&D expenditure, a contrary conclusion would be reached. The significant positive coefficient of the interactive term interAP_catfat in Model 6 suggests that the positive effect of bank liquidity creation on firms R&D expenditure could be further enhanced if the product market is concentrated. This is not surprised as monopolist firms tend to have relatively large amount of capital reserves, allowing them to spend more money on R&D, in particular if banks are willing to fund the investment partially (Yanadori and Cui, 2013).

In terms of the control variables, the significantly positive coefficient of size suggests that large firms tend to innovate more. This is consistent with the conclusion reached by Schumpeter (1942) that with more retained earnings and easier access to the capital

market, large firms tend to have stronger innovation capacity. As for ROA, it is found of having a significantly negative effect on firm innovation. According to the study of Branch (1974), managers in matured industries are more prone to complacency facing high level of profit generated. They are more willing to maintain the status quo, rather than investing actively in R&D and bearing the pressure of making substantial losses. In terms of firm's leverage level, we find that there is a negative relationship between firm leverage level and firm R&D expenditure. This is consistent with the study of Long and Malitz (1985), who suggest that as investments in R&D are unable to be used as collaterals for debt instruments, firms with high gearing level may not be able to secure debt financing easily. As a result, this might reduce their innovation capacity, and this could be evidenced by the negative relationship between firms' leverage ratio and number of patents approved. However, a positive relationship between firms' leverage ratio and the innovation efficiency (Patent/R&D) has also been detected. This might because of the monitoring role played by banks. Consequently, this has significantly increased the success rate of innovation.

Regarding asset tangibility, a proxy of firms' transparency, there is a significantly negative relationship between the transparency level of firms and the average of the number of patents approved, as well as with firm R&D expenditure. This suggests that firms with more tangible assets tend to have a lower level of innovation outputs. However, when the innovation output is measured by efficiency, a positive relationship with tangibility is detected. This might be because although firms with more fixed assets could innovate efficiently, they are a bit reluctant to innovate. This is consistent with the substitutive resource-based perspective that tangible assets and innovation are acting as substitutes to each other, they both could contribute positively to the creation of firms' competitive advantages (Pham et al., 2018; Schroeder et al., 2002).

As for the macroeconomic control variable, GDP growth rate, it is found of having a significantly positive relationship with the number of patents approved and firms'

innovation efficiency. This is as expected and consistent with the conclusion reached by earlier study of Acharya et al. (2009). When the overall economic environment is expanding, firms and banks tend to be more positive about future growth. Consequently, more liquidity could be created, making firms more willing to and capable to innovate more.

To investigate further about the diversified impacts of different types of bank liquidity creations on firms' innovation behaviour, we decompose bank liquidity creation into three parts, off-balance liquidity creation, asset-side liquidity creation and liability-side liquidity creation and summarise their tested relationships separately in Table 5-7. Columns (1-3), Columns (4-6) and Columns (7-9) present the results when firms' innovation is measured by the number of patents granted (lnpat_number), the innovation efficiency (lnpat_efficiency) and the logarithm of firm R&D expenditure (lnrd), respectively. For both asset- and off-balance side liquidity creation, they could trigger firms' innovation positively, regardless of the measurement used to capture the innovation behaviour of firms. This is because bank loans and off-balance guarantees like loan commitments can fund customers' investments, especially for those without capital market opportunities (Berger and Sedunov, 2017). However, for the liability-side liquidity creation, it could affect innovation efficiency positively but the R&D expenditure negatively. This might be because, for liability-side bank liquidity creation, it is mainly related to the creation of more demand depositors. As the demand deposits are mainly contributed by individual savers who tend to be more risk averse, banks are therefore pressurised to monitor the investment more closely. Therefore, there is a positive relationship between liability-side liquidity creation and innovation efficiency. On the other hand, in fear of losing depositors, banks are also reluctant to invest the saving collected into highly risky R&D projects. This explains the negative relationship between liability-side bank liquidity creation and R&D expenditure.

In terms of the moderation effect of product market concentration, as measured by

asset-based HHI, a statistically negative relationship is detected between the relationship of asset-, or off-balance side liquidity creation and the number of patents granted (lnpat_number), or the innovation efficiency (lnpat_efficiency). It is therefore suggested that a higher level of market concentration would weaken the positive impact generated by additional liquidity creation on firms' innovation outputs. This is consistent with the conclusion reached in the baseline model and our hypothesis 2. However, when the innovation is measured by the R&D expenditure, a positive relationship could be found for the above relationship, indicating that a high level of market concentration would generate a positive moderation effect to the existing relationship between liquidity creation and firm innovation. This is as expected as a less competitive product market may allow firms to enjoy a higher level of supernormal profits. When combined with sufficient liquidity created by banks, more capital could then be directed into R&D activities.

In terms of the moderation effect of market concentration on the liability-side liquidity creation, a significant negative impact could be identified when firms' innovation is proxied by the number of patents approved, and R&D expenditure. As the tested relationship between the liability-side liquidity creation and the number of patents created is insignificant in the main test, a statistically negative relationship identified for the interaction term only suggests the existence of a marginally negative impact of product market concentration on the tested relationship between the above two variables. Finally, as for the statistically negative moderation effect of market concentration on the relationship between liability-side liquidity creation and R&D expenditure, it suggests that concentration in product market enhances the negative effect of liability-side bank liquidity creation on firm innovation activities. This is as expected. It suggests that the higher level of the market concentration is, the less likely that the increased liquidity creation on the liability-side would generate any positive impact on firms' R&D investments. This might be because the increase in liability-side liquidity creation tends to be associated with increased current depositors, who tend to

be risk-averse. In fear of losing depositors, banks are reluctant to invest the savings collected into highly risky R&D projects. The situation would become even worse when the market is concentrated as large firms tend to divert more savings away from the smaller firms due to their relatively large size and more established market reputation. Consequently, the smaller firms would be left with even less capital for R&D investments. Therefore, the previously identified negative relationship between liability-side liquidity creation and R&D investments would be further consolidated when the market is highly concentrated. However, as for the relationship between liability-side liquidity creation and firms' innovation efficiency, it seems unable to be moderated by the competitiveness of the product market.

As a result, it seems that in general, a higher level of product market concentration would weaken the positive impact, or consolidate the negative impact, generated by increased liquidity on firms' innovation activities. Or in other words, a more competitive product market may maximise the positive impact brought about by increased liquidity on firms' innovation outputs.

As for other control variables, the results remain consistent with previous findings. Firms that are large in size tend to be more innovative, whereas firms with lower profitability, lower leverage level and tangible assets could generate more innovation outputs. For a positive external environment, proxied by the GDP growth rate, it could contribute positively to firm innovation as well.

In this final part, we would like to investigate how the effect of bank liquidity creation on innovation output varies over the financial crisis, and non-crisis periods. The results are reported in Table 5-8.

The collapse of Lehman Brothers in late 2008 marked the peak of the financial turmoil. Since then, the interbank market condition deteriorated, with the volume traded

plummeted. Consequently, this has led to severe liquidity shortage (Ivashina and Scharfstein, 2010; Iyer et al., 2014). Such lending constraints were transmitted to the real sector, leading to reduced corporate investments and employment (Campello et al., 2010; Chodorow-Reich, 2014; Cingano et al., 2016). As a result, we want to find out the impact of such large-scale liquidity crunch on the firms' innovation activities. First of all, we split the whole sample into two parts, the financial crisis periods (FC) from 2008 to 2010, and the non-crisis period (NFC) and then rerun the previous model. The results are reported in Table 5-8.

Table 5-6 Basic results

Variables	(1) lnpat_number	(2) lnpat_number	(3) lnpat_efficiency	(4) lnpat_efficiency	(5) lnrd	(6) lnrd
Catfat	0.0171***	0.0217***	0.00282***	0.0070***	0.0153***	0.00793***
	(0.00185)	(0.00295)	(0.000741)	(0.00125)	(0.00172)	(0.00292)
interAP_catfat		-0.0240**		-0.0230***		0.0402***
		(0.0118)		(0.00556)		(0.0129)
HHI_at	-0.0708**	-0.0792**	0.106***	0.100***	-0.393***	-0.384***
	(0.0361)	(0.0364)	(0.0151)	(0.0152)	(0.0346)	(0.0347)
size	0.432***	0.432***	0.00622***	0.00618***	0.688***	0.688***
	(0.00305)	(0.00305)	(0.00122)	(0.00122)	(0.00282)	(0.00282)
ROA	-0.616***	-0.616***	-0.0173***	-0.0173***	-1.040***	-1.040***
	(0.0153)	(0.0153)	(0.00606)	(0.00606)	(0.0139)	(0.0139)
Leverage	-0.0434***	-0.0434***	0.00508***	0.00507***	-0.0644***	-0.0643***
	(0.00418)	(0.00418)	(0.00172)	(0.00172)	(0.00396)	(0.00395)
asset_tangibility	-0.0792***	-0.0789***	0.0770***	0.0768***	-0.595***	-0.595***
	(0.0168)	(0.0168)	(0.00681)	(0.00681)	(0.0157)	(0.0157)
GDP_growth	2.515***	2.513***	0.185	0.180	3.474***	3.481***
	(0.363)	(0.363)	(0.144)	(0.144)	(0.334)	(0.334)
Constant	-1.074***	-1.061***	0.335***	0.347***	-0.241	-0.259
	(0.160)	(0.160)	(0.0696)	(0.0697)	(0.158)	(0.158)
Observations	36,748	36,748	31,590	31,590	32,453	32,453
R-squared	0.436	0.436	0.032	0.032	0.718	0.718
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
F	630.6	617.0	22.96	22.85	1830	1791

Note: Catfat represents the category-based bank liquidity creation. Inter_AP measures the interactive item between bank liquidity creation (Catfat) and asset-based HHI. All

estimations include year and industry fixed effects, and full set of control variables. Robust standard errors in parentheses ***p< 0.01, **p<0.05, *p<0.1.

Table 5-7 Bank liquidity creation components

Variables	(1) lnpat_number	(2) lnpat_number	(3) lnpat_number	(4) lnpat_efficiency	(5) lnpat_efficiency	(6) lnpat_efficiency	(7) lnrd	(8) lnrd	(9) lnrd
Offcatfat	0.0214***			0.00677***			0.00807***		
	(0.00299)			(0.00127)			(0.00296)		
interAP_offcatfat	-0.0220*			-0.0225***			0.0433***		
	(0.0120)			(0.00563)			(0.0130)		
Assetside_LC		1.277***			0.441***			0.179*	
		(0.113)			(0.0451)			(0.104)	
interAP_assetside		-2.185***			-1.101***			-0.544	
		(0.423)			(0.186)			(0.421)	
Liabilityside_LC			-0.226			0.392***			-1.267***
			(0.174)			(0.0701)			(0.161)
interAP_liabilityside			-1.929***			0.0159			-3.184***
			(0.533)			(0.240)			(0.534)
HHI_at	-0.0822**	-0.0253	0.339***	0.0960***	0.128***	0.0932**	-0.374***	-0.359***	0.282***
	(0.0368)	(0.0377)	(0.107)	(0.0153)	(0.0158)	(0.0463)	(0.0350)	(0.0364)	(0.104)
size	0.432***	0.431***	0.432***	0.00619***	0.00594***	0.00648***	0.688***	0.688***	0.687***
	(0.00305)	(0.00304)	(0.00305)	(0.00122)	(0.00122)	(0.00122)	(0.00282)	(0.00283)	(0.00282)
ROA	-0.616***	-0.617***	-0.613***	-0.0173***	-0.0175***	-0.0190***	-1.040***	-1.041***	-1.032***
	(0.0153)	(0.0153)	(0.0154)	(0.00606)	(0.00605)	(0.00606)	(0.0139)	(0.0139)	(0.0139)
Leverage	-0.0434***	-0.0438***	-0.0438***	0.00507***	0.00490***	0.00488***	-0.0643***	-0.0647***	-0.0644***
	(0.00418)	(0.00418)	(0.00419)	(0.00172)	(0.00172)	(0.00172)	(0.00395)	(0.00396)	(0.00395)
asset_tangibility	-0.0787***	-0.0795***	-0.0728***	0.0769***	0.0767***	0.0732***	-0.595***	-0.596***	-0.579***
	(0.0168)	(0.0168)	(0.0169)	(0.00681)	(0.00680)	(0.00682)	(0.0157)	(0.0157)	(0.0157)
GDP_growth	2.515***	2.569***	2.762***	0.184	0.153	0.234	3.472***	3.669***	3.670***
	(0.363)	(0.362)	(0.362)	(0.144)	(0.144)	(0.144)	(0.334)	(0.334)	(0.332)
Constant	-1.059***	-1.083***	-1.056***	0.347***	0.329***	0.267***	-0.258	-0.267*	0.0197
	(0.160)	(0.160)	(0.162)	(0.0697)	(0.0696)	(0.0701)	(0.158)	(0.158)	(0.159)
Observations	36,748	36,748	36,748	31,590	31,590	31,590	32,453	32,453	32,453
R-squared	0.436	0.437	0.435	0.032	0.034	0.033	0.718	0.717	0.719
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
F	616.9	619.4	614.8	22.78	24.40	23.29	1792	1785	1803

Note: Offcatfat represents off-balance bank liquidity creation based on category-based measurement, and interAP_offcatfat is the interaction between off-balance bank liquidity creation and asset-based HHI. Assetside_LC is asset-side bank liquidity creation based on category-based measurement, and interAP_assetside is the interaction between asset-

side bank liquidity creation and asset-based HHI. Laibilityside_LC is liability-side bank liquidity creation based on category-based measurement, and interAP_liabilityside is the interaction between liability-side bank liquidity creation and asset-based HHI. All estimations include year and industry fixed effects, and full set of control variables. Robust standard errors in parentheses ***p< 0.01, **p<0.05, *p<0.1.

Table 5-8 The effect of financial crisis on firm innovation

	(FC)	(NFC)	(FC)	(NFC)	(FC)	(NFC)
Variables	lnpat_number	lnpat_number	lnpat_efficiency	lnpat_efficiency	lnrd	lnrd
T_catfat	0.0245***	0.0191***	0.00570**	0.00700***	0.0134**	0.00512
	(0.00726)	(0.00326)	(0.00245)	(0.00144)	(0.00659)	(0.00328)
interAP_catfat	-0.0483*	-0.0129	-0.0218**	-0.0235***	0.0299	0.0482***
	(0.0264)	(0.0134)	(0.00966)	(0.00664)	(0.0258)	(0.0151)
HHI_at	-0.0851	-0.0700*	0.0920***	0.103***	-0.472***	-0.352***
	(0.101)	(0.0391)	(0.0339)	(0.0169)	(0.0906)	(0.0376)
size	0.465***	0.428***	0.0225***	0.00335**	0.699***	0.687***
	(0.00827)	(0.00328)	(0.00268)	(0.00136)	(0.00723)	(0.00306)
ROA	-0.654***	-0.612***	-0.0243*	-0.0172**	-1.021***	-1.045***
	(0.0391)	(0.0167)	(0.0127)	(0.00679)	(0.0337)	(0.0152)
Leverage	-0.0599***	-0.0410***	-0.00350	0.00656***	-0.0723***	-0.0634***
	(0.0124)	(0.00444)	(0.00413)	(0.00189)	(0.0111)	(0.00423)
asset_tangibility	-0.0989**	-0.0738***	0.0774***	0.0775***	-0.576***	-0.596***
	(0.0451)	(0.0181)	(0.0148)	(0.00757)	(0.0398)	(0.0170)
GDP_growth	-1.373	3.394***	-0.636**	0.338**	1.147	4.067***
	(0.874)	(0.402)	(0.285)	(0.165)	(0.768)	(0.373)
Constant	-1.088***	-1.157***	0.221	0.329***	0.318	-0.351**
	(0.415)	(0.171)	(0.158)	(0.0761)	(0.478)	(0.166)
Observations	5,236	31,512	4,689	26,901	4,769	27,684
R-squared	0.443	0.435	0.050	0.027	0.718	0.720
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
F	153.2	564.5	9.107	17.40	447.9	1651

Note: Catfat represents the category-based bank liquidity creation. Inter_AP measures the interactive item between bank liquidity creation (Catfat) and asset-based HHI. FC represents the financial crisis period (2008-2010), NFC is non-financial crisis period. All estimations include year and industry fixed effects, and full set of control variables

In general, the results confirm that liquidity created by banks is acting positively on firms' innovation during both of the financial crisis and non-crisis period. However, such a positive impact seems to be more significant during the financial crisis periods for innovation quantities (lnpat_number & lnrd). This is consistent with the theoretical model proposed by Aghion and Saint-Paul (1998) that firms tend to behave differently during the booming and contraction periods. During recession, firms tend to invest more in innovation due to lower opportunity costs involved. In terms of firm innovation efficiency, the result is more significant during non-financial crisis period, and this might because a favourable external environment may also lead to increased competition. Firms are forced to improve their innovation efficiency to gain competitive advantages.

5.5 Robustness Test

To test the robustness of the test results, we perform a series of alternative tests by changing the measurement of key variables. Firstly, in Table 5-9, we use alternative measurement of product market concentration into the number of employment-based Herfindahl index (HHI_emp) and sale-based Herfindahl index (HHI_sale), respectively. The dependent variable is represented by the number of patents in Model 1-2, the innovation efficiency in Model 3-4 and R&D expenditure in Model 5-6. In general, the moderation effect of market concentration on the relationship between bank liquidity creation and firm innovation output is negative, but is positive for innovation inputs. This is consistent with the conclusions reached in Table 5-6, where the product market concentration variable is represented by the asset-based Herfindahl index (HHI_at).

Secondly, we replace the measurement of firms' innovation with the following-year value of the number of patents (lnpat_number_3), innovation efficiency (lnpat_efficiency_3), and R&D expenditure (lnrd_3) and report the results in Table 5-10, model (1)- (3), respectively. This is in response to the argument that the increased

liquidity creation may generate a delayed impact on firms' innovation as it may take time for firms to react and to transfer increased capital investments into actual R&D outputs. We use the average value of the dependent variable during the period of t to t+3 for the tests. The results remain roughly the same. It can be found that bank liquidity creation plays a positive role in firm innovation outputs and inputs, and this is consistent with hypothesis 1. In terms of the moderation effect, the significantly negative coefficient of the interaction term in model (2) suggests that in a more concentrated product market, the positive effect of bank liquidity creation on the innovation efficiency of firms would be weakened. While the positive coefficient of the interaction term in model (3) indicates that a higher level of market concentration would enhance the positive impact generated by liquidity creation on firms' R&D investments. This is because, in a highly concentred product market, the leading firms may enjoy a certain level of monopoly power. Consequently, the positive impact generated by liquidity creation on firms' innovation efficiency would be weakened as monopolistic firms tends to have relatively low-cost efficiency. This is consistent with the "quiet life" hypothesis that firms enjoying market power tend to operate inefficiently rather than to reap all potential rents (Nickell et al. 1997) whereas the positive relationship between liquidity creation and R&D expenditure would be consolidated as large firms tend to have more capital for R&D investments.

In the last robustness test, we replace the proxy of bank liquidity creation with a maturity-based measurement and present the results in Table 5-11. The conclusions reached in the early part of the study remain solid, with only the exception when product market concentration is measured by the asset-based Herfindahl index. Under this condition, the moderation effect on the number of patents approved is positive but insignificant, the reason may be maturity-based bank liquidity creation is not as accurate as category-based bank liquidity creation measurement.

Table 5-9 Robustness test-the alternative measurements of product market concentration

Variables	(1) lnpat_number	(2) lnpat_number	(3) lnpat_efficiency	(4) lnpat_efficiency	(5) lnrd	(6) lnrd
Catfat	0.0245***	0.0222***	0.00711***	0.00594***	0.0151***	0.0108***
	(0.00262)	(0.00265)	(0.00108)	(0.00110)	(0.00252)	(0.00255)
Inter_EP	-0.0406***		-0.0272***		0.00102	
	(0.0109)		(0.00522)		(0.0120)	
HHI_emp	-0.215***		0.0499***		-0.379***	
	(0.0370)		(0.0154)		(0.0353)	
Inter_SP		-0.0319***		-0.0213***		0.0274**
		(0.0111)		(0.00528)		(0.0121)
HHI_sale		-0.0116		0.0799***		-0.198***
		(0.0375)		(0.0158)		(0.0362)
size	0.431***	0.432***	0.00619***	0.00613***	0.688***	0.689***
	(0.00305)	(0.00305)	(0.00123)	(0.00122)	(0.00283)	(0.00283)
ROA	-0.614***	-0.616***	-0.0165***	-0.0165***	-1.040***	-1.043***
	(0.0153)	(0.0153)	(0.00606)	(0.00606)	(0.0139)	(0.0139)
Leverage	-0.0433***	-0.0435***	0.00529***	0.00520***	-0.0651***	-0.0650***
	(0.00418)	(0.00418)	(0.00172)	(0.00172)	(0.00396)	(0.00396)
asset_tangibility	-0.0745***	-0.0805***	0.0803***	0.0791***	-0.600***	-0.605***
	(0.0168)	(0.0168)	(0.00680)	(0.00680)	(0.0157)	(0.0157)
GDP_growth	2.406***	2.585***	0.128	0.145	3.538***	3.677***
	(0.362)	(0.362)	(0.144)	(0.144)	(0.334)	(0.334)
Constant	-0.932***	-1.110***	0.385***	0.360***	-0.231	-0.395**
	(0.161)	(0.161)	(0.0699)	(0.0698)	(0.158)	(0.158)
Observations	36,748	36,748	31,590	31,590	32,453	32,453
R-squared	0.437	0.436	0.031	0.032	0.718	0.717
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
F	618.4	617.0	22.26	22.39	1789	1783

Note: Catfat represents the category-based bank liquidity creation. Inter_EP measures the interactive item between bank liquidity creation (Catfat) and number of employment-based HHI, and Inter_SP measures the interactive item between bank liquidity creation (Catfat) and sale-based HHI. All estimations include year and industry fixed effects, and full set of control variables. Robust standard errors in parentheses ***p< 0.01, **p<0.05, *p<0.1.

Table 5-10 Robustness test-alternative measure of firm innovation

Variables	(1) lnpat_number_3	(2) lnpat_efficiency_3	(3) lnrd_3
Catfat	0.0222***	0.00720***	0.00938***
	(0.00344)	(0.00134)	(0.00350)
interAP	-0.0200	-0.0243***	0.0373**
	(0.0140)	(0.00627)	(0.0164)
HHI_at	-0.138***	0.0985***	-0.349***
	(0.0439)	(0.0160)	(0.0415)
size	0.460***	0.0149***	0.692***
	(0.00362)	(0.00129)	(0.00334)
ROA	-0.649***	-0.0368***	-0.966***
	(0.0188)	(0.00672)	(0.0172)
Leverage	-0.0523***	0.00286	-0.0780***
	(0.00526)	(0.00190)	(0.00490)
asset_tangibility	-0.132***	0.0826***	-0.694***
	(0.0206)	(0.00741)	(0.0192)
GDP_growth	1.512***	-0.0500	3.161***
	(0.427)	(0.151)	(0.392)
Constant	-1.199***	0.257***	-0.0982
	(0.193)	(0.0773)	(0.196)
Observations	24,290	20,927	21,516
R-squared	0.495	0.043	0.740
Year FE	YES	YES	YES
Industry FE	YES	YES	YES
F	565.3	22.42	1452

Note: Catfat represents the category-based bank liquidity creation. Inter_AP measures the interactive item between bank liquidity creation (Catfat) and asset-based HHI. lnpat_number_3 represents the average value of the logarithm of one plus the number of patents filed per firm from time t to t+3, lnpat_efficiency_3 represents the average value of the logarithm of one plus number of patents generated by per million-dollar R&D investment from time t to t+3, lnrd_3 represents the average value of the logarithm of one plus the R&D expenditure per firm from time t to t+3. Robust standard errors in parentheses ***p< 0.01, **p<0.05, *p<0.1.

Table 5-11 Robustness test-alternative measure of bank liquidity creation

Variables	(1) lnpat_number	(2) lnpat_number	(3) lnpat_number	(4) lnpat_efficiency	(5) lnpat_efficiency	(6) lnpat_efficiency	(7) lnrd	(8) lnrd	(9) lnrd
Matfat	0.0219***	0.0247***	0.0224***	0.00731***	0.00731***	0.00628***	0.00726**	0.0147***	0.0101***
	(0.0031)	(0.0028)	(0.0028)	(0.0013)	(0.0012)	(0.0012)	(0.0031)	(0.0027)	(0.0027)
Inter_AP	-0.021			-0.025***			0.046***		
	(0.0126)			(0.00603)			(0.0138)		
HHI_at	-0.0779**			0.103***			-0.372***		
	(0.0373)			(0.0158)			(0.0355)		
Inter_EP		-0.0367***			-0.0277***			0.00555	
		(0.0115)			(0.00560)			(0.0127)	
HHI_emp		-0.215***			0.0529***			-0.369***	
		(0.0379)			(0.0160)			(0.0360)	
Inter_SP			-0.0280**			-0.0229***			0.0330**
			(0.0117)			(0.00572)			(0.0129)
HHI_sale			-0.0147			0.0824***			-0.189***
			(0.0384)			(0.0164)			(0.0369)
size	0.434***	0.433***	0.434***	0.00552***	0.00552***	0.00546***	0.691***	0.690***	0.692***
	(0.00315)	(0.00315)	(0.00315)	(0.00128)	(0.00128)	(0.00128)	(0.00291)	(0.00291)	(0.00291)
ROA	-0.615***	-0.613***	-0.615***	-0.0205***	-0.0198***	-0.0198***	-1.029***	-1.029***	-1.031***
	(0.0159)	(0.0159)	(0.0159)	(0.00633)	(0.00633)	(0.00633)	(0.0143)	(0.0143)	(0.0143)
Leverage	-0.0683***	-0.0682***	-0.0685***	0.00651***	0.00690***	0.00674***	-0.103***	-0.104***	-0.104***
	(0.00572)	(0.00572)	(0.00572)	(0.00237)	(0.00237)	(0.00237)	(0.00536)	(0.00537)	(0.00537)
asset_tangibility	-0.0842***	-0.0798***	-0.0859***	0.0824***	0.0859***	0.0846***	-0.633***	-0.638***	-0.643***
	(0.0180)	(0.0179)	(0.0179)	(0.00733)	(0.00732)	(0.00732)	(0.0167)	(0.0166)	(0.0167)
GDP_growth	2.769***	2.648***	2.839***	0.219	0.173	0.191	3.506***	3.532***	3.682***
	(0.377)	(0.377)	(0.377)	(0.151)	(0.151)	(0.151)	(0.346)	(0.346)	(0.346)
Constant	-1.090***	-0.961***	-1.135***	0.342***	0.378***	0.354***	-0.285*	-0.253	-0.417***
	(0.163)	(0.163)	(0.163)	(0.0712)	(0.0714)	(0.0714)	(0.159)	(0.160)	(0.160)
Observations	34,919	34,919	34,919	29,954	29,954	29,954	30,784	30,784	30,784
R-squared	0.437	0.437	0.437	0.030	0.029	0.030	0.721	0.720	0.720
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
F	600.5	601.8	600.4	20.66	20.07	20.24	1762	1760	1754

Note: All estimations include year and industry fixed effects, and full set of control variables. Matfat represents the maturity-based bank liquidity creation. Inter_AP measures the interactive item between bank liquidity creation (Matfat) and asset-based HHI. Inter_EP measures the interactive item between bank liquidity creation (Matfat) and number of employment-based HHI, and Inter_SP measures the interactive item between bank liquidity creation (Matfat) and sale-based HHI. Robust standard errors in parentheses

5.6 Conclusion

Although a large number of earlier studies were conducted to testify to the positive relationship between bank liquidity creation and economic growth, limited research was done to investigate through which channel liquidity created by banks triggers economic growth. This paper answers this question. We investigate empirically whether higher liquidity created by banks could promote more innovative activities by firms under different product market conditions.

Employing data from 50 US states over the period of 1997-2019, we first investigate the relationship between bank liquidity creation and firm innovation activities using the fixed effect model. Following the research of Berger and Bouwman (2009), the liquidity created by banks is proxied by both category- and maturity-based bank liquidity creation measurements, and firms' innovations are captured by three variables, the number of patents approved, innovation efficiency, and R&D expenditures, respectively. A positive relationship does find between bank liquidity creation and firm innovation, and this is consistent with the conclusions reached in earlier studies (Berger and Sedunov, 2017). It is not surprising that when firms could access to wide funding opportunities, they are more willing to innovate as this could help them build up competitive strength in the future. When the budget is quite tight and the market liquidity is constrained, firms tend to limit their investments in fear of increased uncertainties.

We then test the moderation effect of product market concentration on the relationship between bank liquidity creation and firms' innovation. The negative moderation effect effects are confirmed in most of the statistics when different types of liquidity creation are considered and when different measurements of firm innovation are employed. It is therefore suggested that a relatively competitive product market may assist firms to get more patents approved or achieve a higher level of innovation efficiency when

additional liquidity is created. This might be because firms in a more competitive market are better motivated to invest in innovation activities to bypass the direct competition and to build future competitive strength. However, when considering the innovation input measured by the R&D expenditure, a positive moderation effect could be found for the above relationship. This supports the argument that a less competitive product market may allow firms to enjoy a higher level of supernormal profits and when this is combined with sufficient liquidity created by banks, more capital could then be directed into R&D activities. All the conclusions reached are robust when we take the influence of the financial crisis and different measurements of product market concentration into consideration.

Based on the discussion above, valuable policy implications could be drawn. First of all, as industry concentration has a negative effect on firm innovation, effective policies should be implemented to prevent the merger of companies that may become industry monopolies. Secondly, during a period of financial crisis or recession, liquid created by banks would become even more important as it may directly encourage more innovation by firms. This may assist the recovery of the overall economy, stimulate industrial upgrading and also allow firms to build up competitive strength for the future. Thirdly, due to limited financial resources available, policies should be put in place to encourage firms to improve innovation efficiency. These may include the injection of additional competition to the industry and the provision of more off-balance, and/or asset-side liquidities.

Chapter 6 Conclusion

It is well-documented that banks, as a key financial intermediary, are playing a critical role in the healthy functioning of modern economies. Levied on their comparative advantages in information gathering, screening and monitoring, economies of scale and scope are achieved which has therefore promoted the efficient and effective allocation of scarce financial resources (Diamond, 1984). This thesis is built on the immense structural change in the US banking market, which is initiated in 1976 along with a wave of intrastate deregulations, later, the US banking sector experienced a full-scale inter-state national deregulation in the early 1990s. This has led a sharp decline of the number of banks in the US and the emergence of a few ‘‘mega’’ banks. Meanwhile, triggered by technological advancement and improved scale and scope economies, banks are expected to further develop its role as the financial intermediary continuously. Therefore, this study mainly focuses on the period after deregulation, starting from 1997.

In this study, focusing on the US banking industry, we aim to verify the importance of banking market structure from different perspectives, which are real economy and banking market itself, respectively. Employing data of the US market over the period of 1997 to 2020, in Chapters 3 and 4, I tested the role of banking market structure played in both the real economy (product market structure) and the performance of banks (bank liquidity creation), respectively. Later, considering bank liquidity creation as a main contributor to economic growth, I further explored how changes in bank liquidity creation have affected the real economy as measured by firm innovation (Chapter 5). There are several differences between this thesis and previous studies related to banking literature. The first one is my empirical study extends beyond the examination of the typical impact of bank market structure on the real economy. To start my analysis, I revisit how the favourable impact of banking market structure on industry structure by examining the varying degrees of sensitivity to bank concentration within both the home-state and a broader regional area. Secondly, this paper extends the data sample to

a more general non-financial industries, not only focus on manufactural industry. Thirdly, alone the application of comprehensive bank liquidity creation measurement provided by Berger and Bouwan (2009), I firstly analyse the role of bank liquidity creation on firm innovation efficiency.

In general, it is concluded that a higher level of bank concentration would lead to a lower amount of credit created in the real economy, and hence reduced product market competition. This is in line with the market power hypothesis (MP). However, it has also been found that for industries with a higher level of external financial dependence, the increased bank concentration could effectively promote competition among companies, resulting in potential efficiency gains. This is in support of the information-based hypothesis (IBH). As for the relationship between bank market power and liquidity creation, after controlling the characteristics of banks and the macroeconomic situation of different states, the results confirm that banks with stronger market power tend to create more liquidity. This is in line with the "competition-fragility" theory that competition undermines liquidity creation by increasing the fragility of banks. In addition, it has also been found that the positive impact of banking pricing power on liquidity creation is greater for small- and medium-sized banks than for large-sized banks. Lastly, regarding the role played by bank liquidity on the real economy, employing the bank liquidity creation measurements developed by Berger and Bouwman (2009), it is found that when increased liquidity is created by banks, firms are more willing to innovate as this may assist them build up long term sustained competitive advantages. In particular, such positive relationship would be further consolidated when the market is competitive as monopolistic firms tend to have less incentive to innovate and are more willing to enjoy the status quo.

For each of the empirical chapter, additional robustness tests were applied to ensure the reliability of the conclusions reached. In particular, when alternative measures of bank market structure, CRn (concentration ratio), HHI and Lerner index, capital adequacy

ratios, bank liquidity creation and firm innovation are used, the tested results remain robust. Meanwhile, to deal with the endogeneity concerns, I used various types of methods, such as lagged value, changing the contents of the variable, and high-dimension fixed effect. Again, the results remain consistent and robust.

Based on the conclusions reached, the following policy implications could be deduced. The findings in Chapter 3 show that banking market concentration affects the competition level of the product market, but the impact varies in different time periods and/or among firms with different financial conditions. Therefore, for policymakers who involve in the decision of banking regulatory changes, they cannot simply rule out regulatory changes aimed at fostering competition in the banking market, as this could have significant repercussions not only on credit supply, but also on its effective resource allocation across different types of borrowers and segments of the economy. In addition, considering the role bank market structure played in the performance of banks, the policymakers should monitor the structure of the banking sector not only for financial stability reasons, but also to encourage liquidity creation as it may lead to higher levels of economic growth. Specially, in countries with well-developed financial sectors like the US, banking consolidation could be encouraged rather than restricted as it may lead to increased liquidity creation. Moreover, the findings in Chapter 5 indicate that during a period of financial crisis or recession, liquid created by banks would become even more important as it may directly encourage more innovation by firms.

Nevertheless, this thesis also bears some limitations, which call for future research. Firstly, Chapter 3 and Chapter 5 could be extended with larger sample size and the current study is mainly restricted by the coverage of Compustat database. Secondly, the banking market structure measures used in this thesis are HHI, CRn, and Lerner index. However, these indexes would only be a good approximation of banking market power and concentration of credit if firms rely on banks for financing. As a result, alternative

proxies for banking market structure could be developed taking firms' capital structure into consideration.

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