Essays on Financial Stability

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by

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Abstract

Financial stability relies on the cooperation of many departments. It could include household financial resilience, financial system security and macroeconomic stability. Financial system stability is significant, given that a stable system could efficiently allocate resources and assess financial risk. Thus, it is vital to figure out how to maintain financial stability. This thesis examines the influencing factors on financial stability by using global data, especially U.S. data. The first essay empirically analyses the effect of financial inclusion constructed by principle component analysis (PCA) on financial stability. Using data from 93 countries from 2004 to 2018, our results conclude that the impact of financial inclusion on financial stability is ambiguous due to the different indicators of financial stability. Additionally, we also find that the results vary in different groups of countries based on income level.

The second essay highlights that expansionary government spending could increase bank liquidity creation by using U.S. data. This effect holds under the World Uncertainty. Additionally, we point out that partisan effect, political election cycle and geopolitical risk do not have effect on this relationship.

The third essay investigates how the growth of bank liquidity creation affects systemic risk constructed by conditional value-at-risk (CoVaR). By using the large U.S. bank data, we conclude that bank liquidity creation increases systemic risk. Also, we find that the connection among large banks could reduce the risks raised by bank liquidity creation.

Overall, this thesis provides further implications for authorities to provide regulations to maintain financial stability. It highlights that policies to promote financial inclusion should be different based on the income level of countries. Moreover, regulators should focus more on the quality of financial inclusion. Also, it suggests that expansionary fiscal policy could be a useful tool to release the credit market. Finally, our thesis indicates micro- and macro-prudential regulations should be taken to avoid the risk raised by bank liquidity creation. Additionally, the authorities need to reconsider the optimal size of

financial institutions and financial systems.

Declaration

I certify that the thesis I have submitted for examination for the award of a Ph.D. degree by the University of Sheffield is solely my own work, other than where I have clearly indicated otherwise (in which case the extent of any work produced jointly by myself and any other person is clearly identified in it). The copyright of this thesis rests with the author. Quotation from this thesis is permitted, provided that appropriate acknowledgement is made. This thesis may not be reproduced without my prior written consent. I warrant that this authorisation does not, to the best of my knowledge, infringe the rights of any third party.

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Chapter 1

Introduction

1.1 Background

Recent banking sector turmoil has raised concerns about the resilience of the financial system. Since the global financial crisis, the failures of Silicon Valley Bank, Signature Bank of New York and Credit Suisse have posed great challenges to the financial system. As a result, the U.S. bank regulators and Swiss National Bank provide additional liquidity to stabilize the market. In addition, COVID-19 shocks might constrain the financial credit market and economic activities. Additionally, geopolitical risk has a rapid growth over the past years. The Russian-Ukraine war worsens financing conditions and leads to a vulnerable commodity market. Along with increasing military spending, this leads to disputes between the nations. Moreover, it also intensifies financial restrictions and increases risk aversion, which in turn is detrimental to macro-financial stability. Financial development, liquidity risk and political risk are combined as the potential reasons behind those events. To minimize the damage caused by the above risks, authorities and regulators are responsible for identifying and formulating policies to reduce risks and maintain financial stability.

Financial stability is a complex system that requires the cooperation of many sectors. Households, firms and government play significant roles in promoting financial stability. This thesis highlights security in the financial system, given the financial development risk, government spending shock risk, geopolitical risk, and the risk of bank liquidity creation growth. Those risks may lead to liquidity and maturity mismatch, and the interconnectedness between institutions may cause propagation from one institution to the financial system, and finally the entire economy.

Our thesis aims to explain the above potential financial risks with three chapters. In the first chapter, we explore how financial market development could affect financial stability. We investigate the effect of financial inclusion on financial stability, where we use single indicators for financial stability.

In Chapter 2, we examine the effect of government spending shock on bank liquidity cre-

ation. Bank liquidity plays a material role in maintaining bank stability and financial system stability. Thus, it is significant to figure out the amount of bank liquidity, which is bank liquidity creation, generated by banks and how government spending shocks affect bank liquidity creation. Since both government spending and bank liquidity creation could be affected by political interventions, we also explore the impact of political factors on this relationship, especially geopolitical risk factors such as the World Uncertainty Index, Geopolitical Acts and Geopolitical Threats.

Finally, in the third chapter, we focus on the financial systemic risk by constructing the systemic risk indicator– conditional value at risk (CoVaR). We explore how bank liquidity creation affects systemic risk. Systemic risk not only refers to the idiosyncratic risk, but also focuses on the ripple effect among the financial institutions. Thus, we construct the interconnection between big banks and explore the role bank networks have in the relationship between government spending shock and bank liquidity creation.

1.1.1 Thesis Overview

The structure of the thesis is shown as follows. Chapter 2 shows the effect of financial inclusion on financial stability; Chapter 3 examines the impact of government spending shock on bank liquidity creation. Also, we examine the role of political uncertainty such as partisan effect and geopolitical risk in this relationship; Based on Chapter 3, Chapter 4 examines the effect of bank liquidity creation on systemic risk. We also explore the role of bank networks in this relationship; Chapter 5 includes conclusions from three essays, limitations of current research, policy implications and potential future research.

1.1.2 Chapter 2 Overview

This chapter examines the impact of financial inclusion on financial stability.

Financial inclusion refers to individuals having affordable financial services and participating in a formal financial system. Financial inclusion has been found to have a significant effect on poverty reduction, economic growth and gender equality. However, its impact on financial stability is ambiguous, given the different measurements of financial inclusion and financial stability. By using the global data, we adopt the new measurements of financial inclusion to assess its effect on financial stability.

Our data set contains 93 countries and the time period ranges from 2004 to 2018. We use Principle Component Analysis (PCA) to construct the financial inclusion index, including access and usage dimension indicators. We use four indicators to represent financial system resilience: bank capital to total assets (BCTA), liquid assets to deposits and short-term funding (LA), non-performing loans to gross loans (NPLs), and provisions to non-performing loans (PNPLs). We use generalized method-of-moments (GMM) estimators to solve the endogeneity problem in the dynamic panel data. Additionally, we also calculate the long-term effect by adding the lag term of financial inclusion. Besides, we divide the countries based on income level: high-income, upper-middle, low and low-middle-income countries. We also control secondary school enrolment, government

effectiveness, regulation quality and mobile cellular subscription.

Our results show that financial inclusion might benefit financial stability through its reduction on the NPLs in upper-middle and high-income countries, but it causes instability in low and low-middle-income countries, given it increases the NPLs. Furthermore, financial inclusion shows a positive effect on bank liquid assets (LA) in upper-middle-income countries, which indicates financial inclusion has a synergy with financial stability in upper-middle-income countries. Finally, financial inclusion causes a negative but insignificant effect on bank capital (BCTA) and provisions to non-performing loans(PNPLs). GDP growth per capita has a positive relationship with financial stability while financial openness shows the reverse pattern. Additionally, secondary school enrolment, government effectiveness, regulation quality and mobile cellular subscription all contribute to financial stability.

1.1.3 Chapter 3 Overview

This chapter examines the effect of government spending shock on bank liquidity creation. We also explore the role of political uncertainty.

Bank liquidity creation could provide liquidity to households and firms during the crisis period, which is the critical role of banks. Many previous literatures show the impact of bank liquidity creation. For example, bank liquidity creation could promote GDP growth, improve bank profitability, and predict financial crises and recessions. Since bank liquidity creation has a significant role in economic activities, many empirical studies have investigated its determinants. Bank competition, bank size, and bank capital are found to have significant effects on bank liquidity creation. However, researches on policy interventions on bank liquidity creation are limited. Monetary policy was regarded as a useful tool to boost liquidity. However, with the low-interest rate and the diminishing returns of QE, monetary policy may have its limitation. A growing number of studies show that fiscal policy could release the credit market, which inspires us to investigate the effect of fiscal policy on bank liquidity creation.

We use the two-stage least square methodology and also cluster the state-fixed effects. We divide bank liquidity creation into five categories: aggregate bank liquidity creation, on-balance sheet liquidity creation, off-balance sheet liquidity creation, asset side liquidity creation, and liability side liquidity creation. We use the military spending database, which is the third-largest government spending, as the proxy for fiscal policy. Additionally, military spending is less affected by the local economic condition compared to other government spending, which could relieve the endogeneity problem. Besides, we also control local market bank competition, bank size, population, and income.

Moreover, the previous literature indicates that military spending is politically related. Meanwhile, some researchers also find that bank liquidity creation could be affected by political affairs. Thus, we examine the effect of political uncertainty on bank liquidity creation through military spending. Finally, we use the Bartik instrument for military

spending, given the potential endogeneity problem.

Our results show that military spending (fiscal policy) could boost bank liquidity creation, especially on-balance sheet liquidity creation. The result exists when military spending is affected by the World Uncertainty Index, and the effect is greater when we use the Bartik instrument to remove the bias. Besides, we also find that Patisan effect, Presidential turnover, Economic policy uncertainty, and Geopolitical risk have no effect on bank liquidity creation through military spending.

1.1.4 Chapter 4 Overview

This chapter examines the relationship between bank liquidity creation and systemic risk. Also, we explore the role of bank networks in this relationship.

Crises such as the Covid-19 pandemic outbreak and the Great Recession could spark the liquidity crisis, which may cause a liquidity shortage to the public. To address this problem, banks might inject liquidity into the financial system to maintain a stable economic environment. Bank liquidity creation comes from two perspectives: on-balance-sheet liquidity creation shows that banks transfer illiquid assets into liquid liabilities, and off-balance-sheet liquidity creation mainly comes from loan commitments.

A strand of empirical studies has listed the benefits of bank liquidity creation. They conclude that bank liquidity creation could promote economic growth, predict the financial crisis and it could improve bank performance such as profitability. Additionally, bank liquidity creation is positively related to economic output and the business cycle. However, bank liquidity creation may plant seeds of a crisis. High liquidity creation could cause asset price bubbles and finally result in financial instability. Also, researchers highlight that excessive liquidity creation makes banks lack sufficient liquid assets to meet the liquidity requirements of their clients, which leads to bank run. What is worse, these potential individual risks may have ripple effects and increase systemic risk. Meanwhile, since the 2008 financial crisis, financial networks have been found to play a significant role in propagating individual risk in systemic risk. Thus, we also examine the role of the bank network.

We collect the data by using Python, and the data sources include FRED, S&P capital and Yahoo Finance. We use the feasible generalized least squares method (FGLS) to examine the effect of bank liquidity creation on systemic risk. We use the principle component analysis (PCA) to construct the networks among the large banks.

Our conclusions show that, except for liability side liquidity creation, aggregate liquidity creation, on-balance sheet liquidity creation, asset side liquidity creation, and off-balance

sheet liquidity creation could deepen the systemic risk. Moreover, we also find that although the bank network does not affect systemic risk, it could reduce the risk raised by bank liquidity creation.

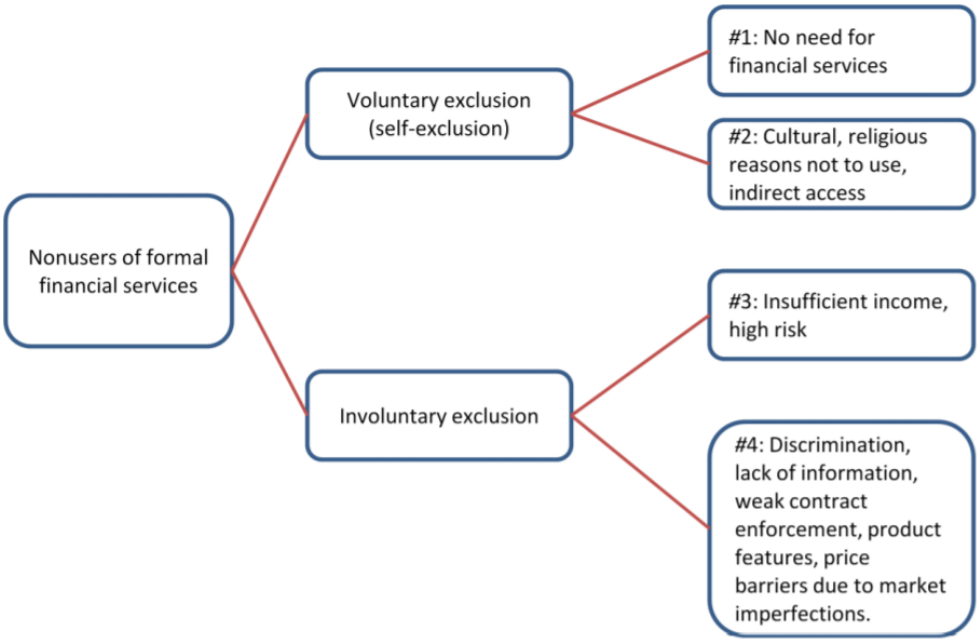
Chapter 2

Financial inclusion and financial stability

2.1 Introduction

Financial inclusion refers to individuals having affordable financial services and participating in a formal financial system. The empirical studies show financial inclusion could benefit the public by reducing poverty and promoting gender and income inequality (C.-Y. Park and Mercado, 2015; Kim, Yu, and Hassan, 2018; Sharma, 2016). However, many people are still financially excluded. Massara, Mialou, et al. (2014) conclude that financially excluded populations are divided into two groups: voluntary and involuntary (see figure2.1).

Figure 2.1: Financial Exclusion



Source: (Massara, Mialou, et al., 2014)

The voluntary group abandons formal financial services for cultural reasons or without financial requirements. Thus, it is hard to persuade these people to engage with a formal financial system. However, the involuntary group includes people who are financially excluded due to discrimination or lack of information (group #4 in figure 2.1), and this group may still seek formal financial services. Financial exclusion could cause many disadvantages to this population. For example, financial exclusion may cause inconvenience

and worsen the financial situation to low-income groups, especially those in less developed regions. From the banking transaction perspective, one of the findings is that only using cash might cause more cost, given cash machines have been removed in financially included society (Bayot, 2013). Meanwhile, financially excluded individuals may miss discounts that financial institutions offer for using certain electronic facilities. Besides, from the social perspective, Bayot (2013) also concludes that financial exclusion might impair social relationships. Without bank savings, it might be unsafe to stock large amounts of cash at home. Individuals might have difficulties making investments and handling an emergency without any savings. Also, borrowing from family may cause family conflicts. Finally, from the credit perspective, individuals might need to pay higher interest than formal credit markets when borrowing.

Since financial exclusion has numerous disadvantages, it is imperative to eliminate it and ensure more individuals are included in formal financial systems.

The development of financial inclusion varies in different regions. In less developed regions such as Africa, it still focuses on access to formal financial services. Conventionally, financial inclusion focuses on ATMs and bank branches' proliferation. With the development of technology, those areas gradually rely on mobile payment and online banking due to the low cost and convenience. For example, I. Ndlovu and M. Ndlovu (2013) show that mobile payments contribute to the reduction in financial exclusion and promote productivity in Zimbabwe. Similarly, Evans (2018) argue that mobile phones could increase the accessibility to formal financial services in Africa. In developing regions such as China, although there are sufficient facilities to provide formal financial services to the public, it is still difficult to encourage individuals to use formal financial credit. Comparing to other BRICS countries, Fungáčová and Weill (2015) finds that in China, most of the financial exclusion is voluntary as the individuals mainly borrow from family and friends rather than financial institutions. In developed areas, entering the credit market for individuals might be a first priority for financial inclusion. Additionally, Ozili (2020) concludes that

individuals at low-income levels are easily excluded by formal financial systems as they can not pay the credit provisions or do not have collateral assets. Thus, to include this group in the credit market, governments may need to provide subsidies for bank loans, and formal financial institutions may also need insurance in case of default.

Since 2010, many countries have realized the significance of financial inclusion, and some have made financial inclusion a national strategy. According to the World Bank (*Financial Inclusion* 2020), in 2011, two-thirds of adults worldwide still do not have a bank account, which might be due to the lack of formal financial services and information. World Bank aims to let 1 billion people access bank accounts with professional assistance by 2020. Professional assistance starts with 25 countries having around 70 percent of people globally who are excluded from formal financial services. The policy concentrates on increasing the access of vulnerable groups such as low-income and female, and promoting financial education. By the end of 2017, this target has already given 738 million people access to the bank account. Moreover, The latest research (*Advancing the Digital Financial Inclusion of Youth | GPFI* 2020) now has focused on financial inclusion for the young generation, given the close relationship between young people and technology. GPFI also promotes opportunities for small and medium entrepreneurs (SMEs) to access formal financial services. Digital finance as a platform, could reduce SMEs access barriers, which may promote employment and reduce poverty within societies. Additionally, the COVID-19 shock puts digital financial inclusion in high demand. Digital payments have provided a more useful and safer method for people to access formal financial services.

Since many authorities have focused on financial inclusion, it is significant to figure out its definition, determinants and impact on economic activities.

Many papers have discussed the concepts of financial inclusion, but the components of financial inclusion are still inconclusive. According to Massara, Mialou, et al. (2014), financial inclusion has three dimensions based on different perspectives. The first is the outreach (access) dimension which indicates the opportunity for individuals to use for-

mal financial services. Cámara and Tuesta (2014) show that greater access would not guarantee better financial inclusion because there might exist a break-even point. Beyond this point, the marginal increase in access does not improve financial inclusion, but below this break-even point, access could still promote financial inclusion. Conventionally, there are two basic indicators for this dimension, which are ATMs and commercial bank branches both geographically and demographically. Currently, the development of financial innovations may reduce the geographic barrier. Online banking and mobile payment replace the traditional access method gradually. Furthermore, the G20 announced indicators such as E-money (electronic money) accounts for this dimension. The second is the usage dimension, which targets at the population who are within the outreach of formal financial facilities but rarely use them. It might be more significant to ascertain that the formal financial services are been used properly. Thus, the indicators for this dimension focus on credit and deposit accounts. Similar to the access dimension, the G20 also lists new indicators, such as mobile transaction use and cashless transactions, which are related to financial technology innovation. Apart from the above two dimensions, there exists a quality dimension, which measures the quality of current financial services. World Bank (*Financial Inclusion* 2020) demonstrates the quality dimension highlights the knowledge and the ability of individuals to handle complicated financial products. The Alliance for Financial Inclusion(AFI)[1] suggests measuring this dimension via the following categories: financial education, transparency, affordability, convenience and customer protection. Meanwhile, the G20 has announced the indicators for quality dimension, which includes financial knowledge, financial behaviour and credit barriers.

In the previous studies, many papers(C.-Y. Park and Mercado, 2015; Kim, Yu, and Hassan, 2018; Sharma, 2016) have shown the benefits of promoting financial inclusion. For example, financial inclusion has positive effect on poverty reduction, economic growth and income equality reduction. Moreover, other findings point out that financial inclu-

[1] AFI: please see reference

sion could limit money-laundering and terrorist financing (Čihák, Mare, and Melecky, 2016), but the most significant relationship between financial inclusion and financial stability is ambiguous. Currently, there is a debate on this relationship. On the one side, researchers believe financial inclusion benefits financial stability through diversifying bank deposits, improving monetary policy transmission and making healthier individuals and SMEs. While on the other side, researchers argue the rapid growth of financial inclusion without regulation brings potential default risk, which may jeopardize financial stability. The current empirical studies may have data limitations, and the single measurement of the variables may reduce the reliability of the results. Given that data is much easier to obtain than before, we are going to generate a more reliable conclusion of this relationship by using multidimensional measurements of variables. The contributions of this chapter are listed as follows:

Firstly, this chapter constructs a country-level financial inclusion index, and then it investigates whether there is a synergy between financial inclusion and financial stability by using the index rather than single indicators.

Secondly, although some papers (Ahamed and Mallick, 2019; Morgan and Pontines, 2014; Čihák, Mare, and Melecky, 2016; Ahamed and Mallick, 2019) use empirical evidence to show the impact of financial inclusion on financial stability, there are still many details such as the integrity of the data that need to be improved. This chapter uses a large database with the dynamic panel GMM model to provide more accurate results. Moreover, this chapter also explores the long-term effect of financial inclusion on financial stability.

Section 2 presents the literature review. It contains detailed concepts, measurements and the development of financial inclusion and financial stability. Section 3 shows the data and descriptive statistics, Section 4 is the methodology, Section 5 is the empirical analysis and Section 6 is the conclusion.

2.2 Literature Review

2.2.1 Conceptualising financial inclusion and financial stability

The main target of financial inclusion is to provide the unbanked population with useful and affordable financial services. Concepts of financial inclusion are quite similar in the existing literature. For example, Hannig and Jansen (2010) claim financial inclusion is about ensuring the financially excluded population could access formal financial services. The World Bank indicates financial inclusion means letting individuals and businesses have affordable formal financial services that could meet their financial requirements. Compared to financial inclusion, the definition of financial stability is more complicated to explain. The World Bank has divided financial stability into two parts. The first is firm-level stability, and the most common indicator for this is the z-score, which captures the bank solvency risk. The second part is the system-level stability. Many literature has tried to investigate an indicator at a systemic level, but there is no agreement on that. Similarly, researchers have different definitions of financial stability in different studies. The European Central Bank (cited in Dienillah, Anggraeni, and Sahara (2018)) regards financial stability as the capability of the financial system to withstand shocks and the financial system would optimize the allocation of savings. Borio (cited in Dienillah, Anggraeni, and Sahara (2018)) defines financial stability in time and cross-sectional dimensions. The time dimension targets the aggregate financial systemic risks that could be handled properly over time, while the cross-section dimensional risks could be handled properly at a particular time point.

2.2.2 Measuring financial inclusion and financial stability

The effects of financial inclusion on financial stability are mixed in the existing literature, given the researchers adopt various indicators in different papers. Thus, it seems imperative to classify the measurements of financial inclusion and financial stability .

Many indicators have been used to proxy financial inclusion, and the trend is from a single indicator to multiple dimensional index. Firstly, many papers regard accessible financial services as the most significant target. Geographic and demographic indicators are normally used to measure the financial inclusion level. For example, Morgan and Pontines (2014) use the number of bank branches per 100,000 people and the number of bank accounts per 1,000 people to proxy access to financial inclusion. Although individuals might access to financial services or have a bank account, they may still not use it. This could also be regarded as financial exclusion. Therefore, other researches focus on the usage dimension. Apart from the above measurements, some papers construct a composite index for multidimensional financial inclusion. Sarma (2008) construct a financial inclusion index based on three dimensions: bank penetration, availability and usage dimension. The author uses the number of people with bank accounts and the number of bank outlets(per 1000 population)as indicators of bank penetration and availability, respectively. Moreover, the usage dimension is demonstrated by the indicators of credit and deposit as the proportion of the country's GDP. Sarma's paper allocates the same weight to each dimension, which assumes each dimension will have the same effect on financial inclusion. However, other authors argues that different dimensions contribute differently to the index, so it might be more reasonable for different dimensions to have different weightings. Ahamed and Mallick (2019), based on the analysis of Massara, Mialou, et al. (2014), constructs the index by using the principal component analysis method to allocate the appropriate weight for each dimension, which currently provides an accurate and convincing weight to different dimensions, and this chapter follows this method.

Financial stability has a similar development trend as financial inclusion. Initially, financial stability, in many studies, also starts from proxy by a single indicator, such as bank z-score or non-performing loans (Morgan and Pontines, 2014; Han and Melecky, 2013; Ahamed and Mallick, 2019). Then, researchers realize that a single indicator is not enough to measure financial stability. Therefore, indices are constructed for finan-

cial stability, which could measure multidimensional financial stability. Čihák, Mare, and Melecky (2016) uses an orthogonal components method to construct the financial stability index. Dienillah, Anggraeni, and Sahara (2018) use another method developed by Albulescu and Goyeau to construct the financial stability index. This chapter only uses single indicators due to the availability of data. However, to provide persuasive results, we use different indicators to proxy financial stability, which will show how financial inclusion could affect financial stability at disaggregated levels.

2.2.3 The relationship between financial inclusion and financial stability

Many empirical studies have explored the nexus between financial inclusion and financial stability, but the results are inconclusive.

The prevailing view is that financial inclusion has a positive relationship with financial stability through many channels. Firstly, the diversified banking deposit source has been regarded as the most significant channel to enhance this relationship. From the demand side, it could help individuals smooth consumption while for the supply side, it could maintain the resilience of the financial system. Han and Melecky (2013) examine this viewpoint by investigating the movement between broader access to the 2008 crisis and the dynamics of bank deposit growth during the crisis. Their result concludes that increasing access to bank deposits could maintain a stable bank funding base during the crisis period, and this phenomenon is more pronounced in mid-income countries. Morgan and Pontines (2014) also claims that a greater and stable deposit base will decrease the liquidity risks of banks, thereby maintaining the stability of the financial system. Additionally, García and José (2016) concludes that a more resilient financial system stems from diversified deposit sources. Secondly, some researchers argue that financial inclusion will improve the transmission of monetary policy, which may lead to systemic risk. For example,Mehrotra and Yetman (2015) show that financial inclusion improves the

transmission of monetary policy by providing more affordable formal financial services to customers, and the same opinion is held by Morgan and Pontines (2014). Finally, apart from the previous reasons, other literature argues that financial inclusion could benefit customers directly, and in return, it could reduce risks to the banks. Cull, Aslı Demirgüç-Kunt, and Lyman (2012) show financial inclusion brings healthier households and small business sectors, so macroeconomic and financial systems may be more stable with fewer default loans. Additionally, Morgan and Pontines (2014) show that financial inclusion offers more lending opportunities to small and medium companies, which reduces non-performing loans and the default rate of financial institutions.

Apart from the positive effect on financial stability, there are still other benefits. For example, Cull, Aslı Demirgüç-Kunt, and Lyman (2012) show that financial inclusion could reduce income equality, which could lead to social and political stability, and in turn, this stability will benefit the financial system's stability. Han and Melecky (2013) show that financial inclusion could not only be a complement to macro-prudential policies, but might also increase the quality of micro-supervision by reducing information asymmetry. Although many papers claim that financial inclusion could promote financial stability, other papers hold opposite views.

Most of the opposing opinions argue that financial inclusion could cause financial instability because of the default risk. The rapid development of financial inclusion may increase credit without regulation or supervision, which may bury the potential default risk. Čihák, Mare, and Melecky (2016) argues that the negative effect of financial inclusion may stem from customers who are not creditworthy. For example, the subprime mortgage market in the United States and the Andhra Pradesh micro-fiancne crisis in India. This opinion is also held by García and José (2016), who has shown the potential risks caused by low-income individuals lack of credit recording and collateral, and this information asymmetry would lead to inefficiency of the financial system. Furthermore, Ozili (2020) illustrates the problem with extreme financial inclusion, which allows all individuals ac-

cess to formal financial services by ignoring their actual financial situation. As a result, this could place the financial system at risk of default and defraud. Additionally, other risks have been mentioned in the previous literature (García and José, 2016; Khan, 2011). For example, financial innovations could promote financial inclusion, but they might also increase uncertainty such as extra costs. Meanwhile, outsourcing activities could lead to a reputation risk for a bank. Finally, micro-finance institutions promoting financial inclusion can also be problematic with the concentration and funding risks, and this finally causes systemic risk.

2.2.4 Other variables that might influence this relationship

The above papers mainly focus on the relationship between financial inclusion and financial stability. Moreover, there are many other studies focusing on this relationship from different perspectives.

Firstly, many countries target promoting financial inclusion, but extreme financial inclusion could jeopardise financial stability. Thus, it might be necessary to ascertain the optimal financial inclusion level, which could maximize the synergy between financial inclusion and financial stability. Ozili (2020) concludes the following conditions of optimal financial inclusion. First, grant access to basic financial services should be guaranteed. Based on that, there should be a price that is affordable to the excluded individuals to access the formal financial system, and this price should also make suppliers willing to offer the service. Apart from the theory discussion, VO et al. (2019) use the panel threshold estimation technique, with data from 22 emerging and frontier countries during the 2008-2015 period, to investigate the optimal level of financial inclusion and its effect on macroeconomic stability. Their empirical results show that the range of 0.033 to 0.063 is the threshold value.

Second, since the development of financial inclusion is accompanied with risk, some authors propose potential solutions to manage the risk. From the supply side, it might be

significant to strengthen the supervision and formulate the related standards to avoid the risk. Han and Melecky (2013) claims that financial inclusion just raises the institutional level risk, since it is not the systemic risk, so it could be controlled by using prudential tools. The same opinion is also be mentioned by other authors (García and José, 2016; Khan, 2011). From the demand side, many researchers hold the view that financial education and financial literacy play a vital role in mitigating the risk. Al-Smadi et al. (2018) emphasize that to reduce the risk of participating the financial system, regulation and supervision might not be enough, and that financial teaching is also necessary to help users make better decisions in respect of saving and investments. Additionally, some studies also illustrate that financial education should not only apply to the demand side, but also may be applied to the supply side, which could encourage the financial institutions to produce more high-quality products for the financial markets (Soskic, 2011). Last, Fintech gradually plays a significant role in the process of financial inclusion, and an increasing number of papers are trying to analyze the impact of Fintech on this relationship. Namely, the opinion is that digital finance could promote financial stability indirectly through its positive effect on financial inclusion. Ozili (2018) investigates the impact of digital finance on financial inclusion and financial stability, and concludes that digital finance reduces the residents' cost in achieving financial services, and finally increased financial inclusion level will contribute to financial stability.

2.3 Data and descriptive statistics

We collect a large set of data to investigate the nexus between financial inclusion and financial stability. It contains 93 countries, and the time period is yearly which ranges from 2004 to 2018. The data sources are as follows: all variables used to construct the financial inclusion index are collected from the Financial Access Survey, IMF. Data of the four financial stability indicators are collected from Global Financial Development Database, World Bank. Among all the control variables, GDP growth per capita and secondary school enrolment come from the World Development Database, World Bank. The financial openness data comes from Chinn and Ito's financial openness index (Chinn and Ito, 2008), while the data on government effectiveness and regulatory quality come from the Worldwide Governance Indicators.

Many indicators have a complete data set covering all time periods, but a few have missing values. To deal with this problem, the analysis uses the average value or chooses the proxies[2] [3] to fix them.

2.3.1 Financial inclusion index

This chapter follows Ahamed and Mallick (2019), which uses the Principle Component Analysis (PCA) to construct the financial inclusion index.

The dimension of financial inclusion

Financial inclusion is regarded as the unbanked population could access to affordable formal financial services. Based on the previous findings, not all of the financially excluded population can be involved in a formal financial system. As can be seen from Figure 2.1,

[2]Use Number of household sector deposit accounts with commercial banks per 1,000 adults / Number of depositors with commercial banks 1,000 adults to proxy Number of deposits accounts with commercial banks per 1,000 adults

[3]Use Number of household sector loan accounts with commercial banks per 1,000 adults / Number of borrowers with commercial banks 1,000 adults to proxy Number of loan accounts with commercial banks per 1,000 adults

the IMF classifies the excluded population into voluntary and involuntary groups. It is difficult to persuade the voluntary population into a formal financial system as their voluntary excluded reasons such as cultural or religious are hard to eliminate. There are other individuals who are willing to participate in the formal financial system, but due to problems like information asymmetry, those individuals are still excluded from the formal financial systems. Thus, financial inclusion ensures these involuntary groups could have affordable financial services. Given the data limitation, this chapter chooses two financial inclusion dimensions: outreach and usage dimension. To proxy each dimension, the existing literature has shown many indicators. We list the selected indicators as follows:

Variable selection

The first is the outreach dimension, which illustrates that individuals could access a formal financial system geographically. To achieve this, financial institutions need to have high penetration.[4] Thus, this analysis collects the supply-side data in two categories: demographic and geographic penetration of bank ATMs and branches. The number of the bank branches and ATMs per 1000 square kilometers are used to represent the geographic indicators, while the number of bank branches and ATMs per 100,000 people are the demographic indicator. However, extensive access does not comply with the same level of financial inclusion. Even within the scope of formal financial services, individuals may not use them. To ensure those formal services have been used, the index proposes usage as the second dimension. Cámara and Tuesta (2014) argue that the indicators should reflect individuals receiving payment and saving money by using formal financial services. Thus, we use the number of deposit account and loan accounts per 1,000 adults to represent the usage dimension. The following Table 2.1 lists details of the selected variables.

[4]High penetration means financial services do not have a shortage of physical points.

Table 2.1: List and description of the variables

Variable	Description
Outreach dimension	
Numbers of ATMs per 1,000 square kilometers	Sum of all ATMs multiplied by 1,000 and divided by total area of the country in square kilometers.
Numbers of bank branches per 1,000 square kilometers	Commercial bank branches are retail locations of resident commercial banks and other resident banks that function as commercial banks that provide financial services to customers and are physically separated from the main office but not organized as legally separated subsidiaries.
Numbers of ATMs per 100,000 people	Automated teller machines are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place.
Numbers of bank branches100,000 people	Commercial bank branches are retail locations of resident commercial banks and other resident banks that function as commercial banks that provide financial services to customers and are physically separated from the main office but not organized as legally separated subsidiaries.
Usage dimension	
Number of deposit accounts with commercial banks per 1,000 adults	Depositors with commercial banks are the reported number of deposit account holders at commercial banks and other resident banks functioning as commercial banks that are resident non-financial corporations (public and private) and households. For many countries data cover the total number of deposit accounts due to lack of information on account holders. The major types of deposits are checking accounts, savings accounts, and time deposits.
Number of loan accounts with commercial banks per 1,000 adults	Borrowers from commercial banks are the reported number of resident customers that are non-financial corporations (public and private) and households who obtained loans from commercial banks and other banks functioning as commercial banks. For many countries data cover the total number of loan accounts due to lack of information on loan account holders.

Computation process

There are three steps to construct the index. The first is to normalize the data, which could rescale all the elements between 0 and 1. The existing literature lists many normalization methods. For example, standardization, which makes the variable with mean 0 and standard deviation 1. Additionally, the min-max method makes the minimum value 0 and the maximum 1. Furthermore, the distance-to-reference method which measures the distance of data to a given point. Here the chapter chooses the last method, the given point is the maximum value of different variables across countries.

$$\mathrm{NX}_{in} = \frac{\mathrm{X}_{in}}{\mathrm{M}_i} \tag{2.1}$$

i represents different variables, n denotes different countries. N is the notation for normalization, X_{in} is the original data, and M_i is the maximum value across countries.

Statistical process of dimensions

In this section, we will use Principle Component Analysis (PCA) to assign proper weights to different indicators. The key idea of PCA is to reduce dimensions and convert multiple indicators into a comprehensive index. Mathematical details are shown as follows:

$$X = \begin{bmatrix} & & & \\ x_{11} & . & . . & x_{k1} \\ & & & \\ x_{1n} & . & . . & x_{kn} \end{bmatrix}$$

matrix X has n observations on k variables, and PCA is to detect the independence relationship among the k set of variables. It converts the variables into a few selected principle components which are linearly independent of one another. The first one has the maximum possible variance, and the second has the second maximum possible variance.

$$Z_1 = a_{11}x_1 + a_{12}x_2 + ... + a_{1k}x_k$$
$$Z_2 = a_{21}x_1 + a_{22}x_2 + ... + a_{2k}x_k$$

...

$$Z_n = a_{n1}x_1 + a_{n2}x_2 + ... + a_{nk}x_k$$

which could be concluded as

$$Z = \sum_{i=1}^{n} A_{ij}X_i, for(j = 1, 2, ..., n) \tag{2.2}$$

In the above formulates, $Z = [Z_1, Z_2, ...Z_n]$ are the principle components, a_{ij} are the weights, x_i are the original variables.

Firstly, for the outreach dimension, the eigenvalues of four principle components are 2.55,0.91,0.48 and 0.06 respectively. As there is only one eigenvalue is greater than 1, so we keep the first component and must use its relevant weights (see Table 2.2).

Thus, the estimation of financial outreach dimension will be

$$\text{OD} = \beta_1\text{Bran2} + \beta_2\text{Branp} + \beta_3\text{ATMs2} + \beta_4\text{ATMsp} \tag{2.3}$$

where OD is financial outreach dimension, Bran2 (ATMs2) is the number of bank branches (ATMs) per 1000 square kilometers, Branp (ATMsp) is the number of bank branches (ATMs), $\beta_1 = 0.5448, \beta_2 = 0.4462, \beta_3 = 0.5392, \beta_4 = 0.4619$.

Similarly, to financial usage dimension, Table 2.2 shows the eigenvalue of the first component is greater than 1 and its relevant weights are both 0.7071

Hence, the formulate to construct this dimension will be

$$\text{UD} = \gamma_1\text{Depo} + \gamma_2\text{Loan} \tag{2.4}$$

where UD is financial usage dimension, Depo is bank of deposit accounts per 1,000 adults, Loan is bank of loan account per 1,000 adults, γ_1=0.7071,γ_2=0.7071

Lastly, for the financial inclusion index, the eigenvalue of the first component is greater than 1, and it assigns the same weight (0.7071) for both dimensions. As a result,

$$\text{FII} = \alpha_1 \text{OD} + \alpha_2 \text{UD} \tag{2.5}$$

where FII is financial inclusion index, α_1=0.7071,α_2=0.7071.

This result may illustrate that the residents make full use of the existing financial service, and it also consists with the finding in Ahamed and Mallick (2019). We normalise the financial inclusion data to 0-1 to get intuitive final results. The bigger the number, the higher the financial inclusion level. The following figures show the results.

As Figure 2.2 shows, Afghanistan and China have the lowest and highest index in developing countries [5], which are 0.015 and 0.65 respectively, and the average financial inclusion index is 0.20 in developing countries. Among the developed countries (Figure 2.3), Belgium has the highest financial inclusion index of 0.96 while Saudi Arabia has the lowest financial inclusion index at 0.19.

[5]Developed and Developing countries' classification based on (Ahamed and Mallick, 2019)

Table 2.2: Principle component analysis for financial inclusion index

Outreach dimension	Notation	Comp1	Comp2	Comp3	Comp4
Eigenvalue		2.54957	0.907389	0.479399	0.0636411
Percentage of Variance(C)		0.6374	0.8642	0.9841	1.0000
Indicators					
Geographic penetration of Branches	Bran2	0.5448	-0.4341	0.3082	-0.6479
Demographic penetration of Branches	Branp	0.4462	0.5766	0.6223	0.2850
Geographic penetration of ATMs	ATMs2	0.5392	-0.4722	-0.2477	0.6519
Demographic penetration of ATMs	ATMsp	0.4619	0.5062	-0.6755	-0.2721
Usage dimension		Comp1	Comp2		
Eigenvalue		1.6023	0.397768		
Percentage of Variance(C)		0.8011	1.0000		
Indicators					
Bank of Deposit accounts	Depo	0.7071	0.7071		
Bank of Loan accounts	Loan	0.7071	-0.7071		
Financial inclusion		Comp1	Comp2		
Eigenvalue		1.58741	0.415285		
Percentage of Variance(C)		0.7924	1.0000		
Indicators					
Outreach dimension	OD	0.7071	0.7071		
Usage dimension	UD	0.7071	-0.7071		

Note: Comp* means component loading of different indicators; Percentage of Variance(C) means cumulative percentage of Variance;Bran2(ATMs2) is the number of bank branches(ATMs) per 1000 square kilometers;Branp(ATMsp)is the number of bank branches(ATMs); Depo is bank of deposit accounts per 1,000 adults, Loan is bank of loan account per 1,000 adults; OD(UD) is financial inclusion outreach(usage) dimension

Figure 2.2: Financial Inclusion Index of Developing Countries

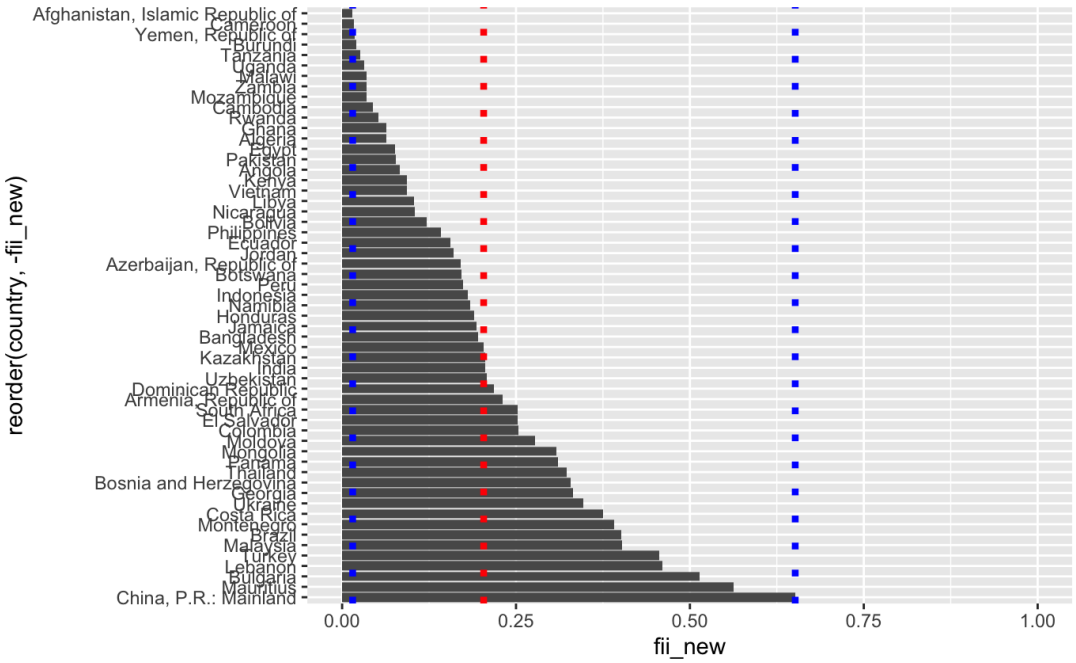
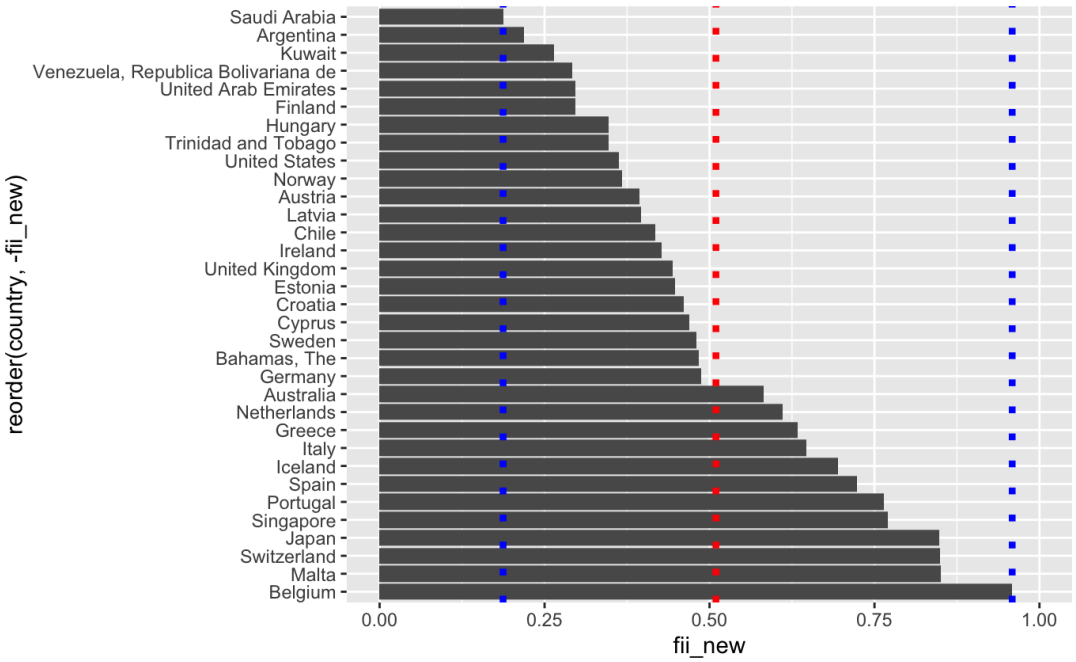


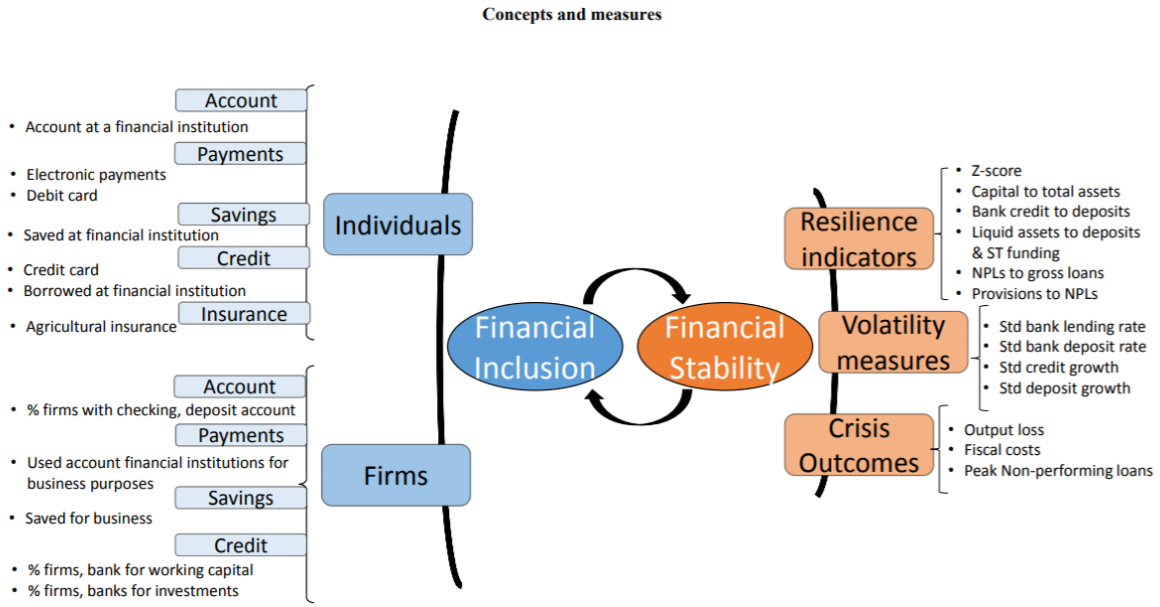
Figure 2.3: Financial Inclusion Index of Developed Countries



2.3.2 Financial stability indicators

Apart from the financial inclusion index, this chapter has tried to construct a financial stability index as a dependent variable. However, due to technical problems, data limitations and a lack of key references, it is impossible to construct the index in this chapter. Therefore, we choose some financial stability indicators as the dependent variables.

Figure 2.4: Financial Stability Indicators



Source: Čihák, Mare, and Melecky (2016)

As shown from Figure 2.4, the World Bank divides financial stability into three categories: resilience indicators, volatility measures and crisis outcomes. We only concentrate on resilience indicators, which are bank capital to total assets (BCTA), liquid assets to deposits and short-term funding (LA), non-performing loans to gross loans (NPLs), provisions to non-performing loans (PNPLs).

Bank liquid asset to deposits and short-term funding captures liquid risk. Based on the previous evidence, financial inclusion could reduce the liquid risk by improving the deposit for banks (Han and Melecky, 2013). However, as can be seen from figure 2.5, it is found that financial inclusion brings fewer liquid assets, which may increase liquid risks.

Figure 2.5: The Relationship between FII and Bank Liquid Asset

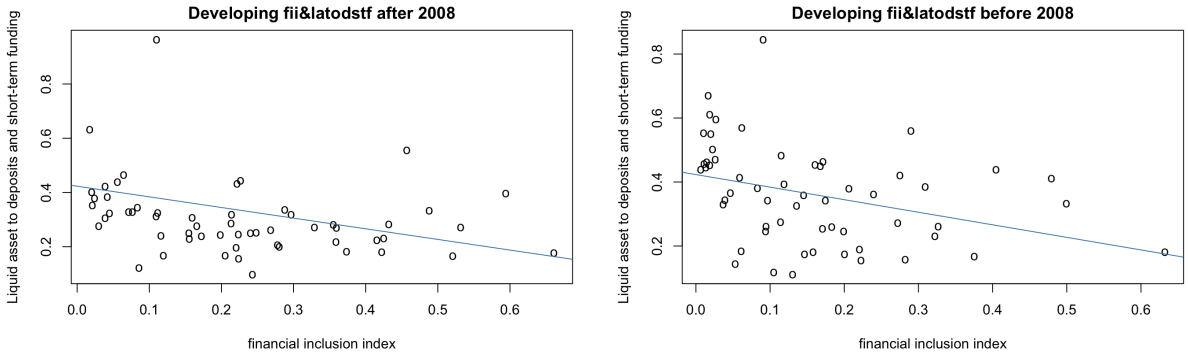
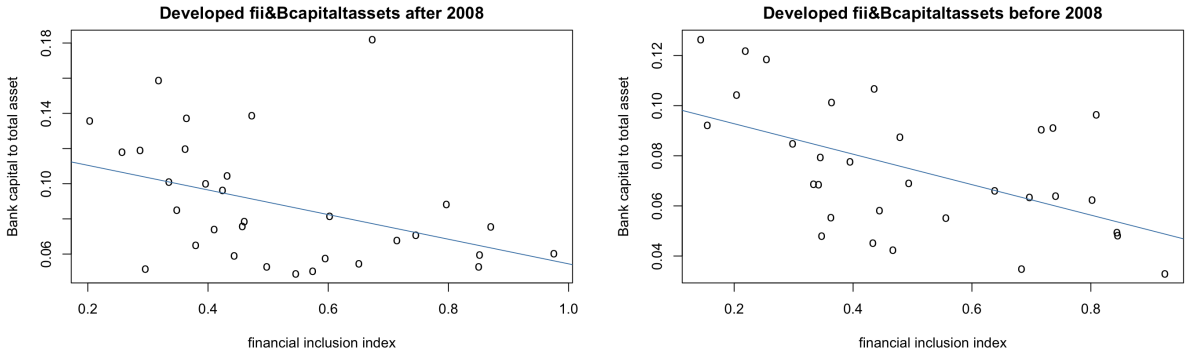


Figure 2.6: The Relationship between FII and Bank Capital



With the development of financial inclusion, it is expected that bank capital will increase. However,as figure 2.6 shows, with the growth of financial inclusion, bank capital decreases,which illustrates that banks have less ability to take risks.

Non-performing loans to gross loans(NPLs) measures the bank credit risk. The existing literature has shown that non-performing loans will decrease, given that financial inclusion leads to healthier individuals and SMEs (Morgan and Pontines, 2014; Widarwati, Sari, and Nurmalasari, 2019). Similarly, as the preliminary results show, with the growth of financial inclusion, non-performing loans show a downward trend meaning credit risk declines.

Finally, figure 2.8 illustrates the provisions to non-performing loans declines as the fi-

Figure 2.7: The Relationship between FII and Non-performing Loans

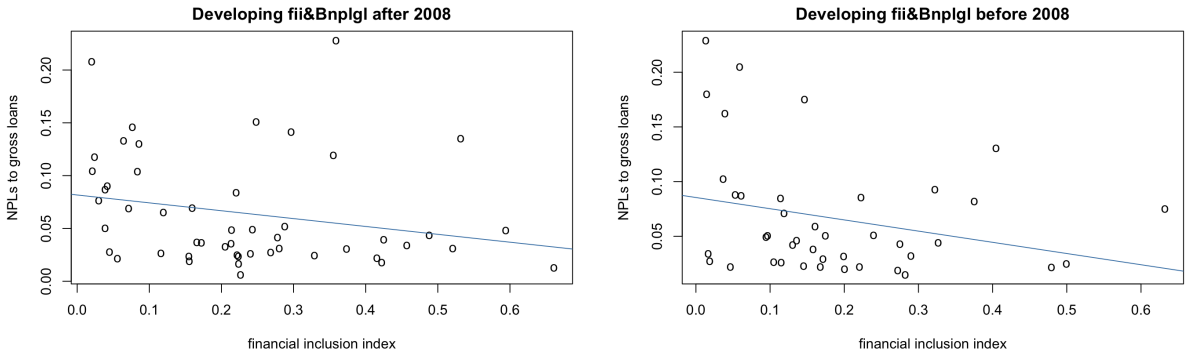
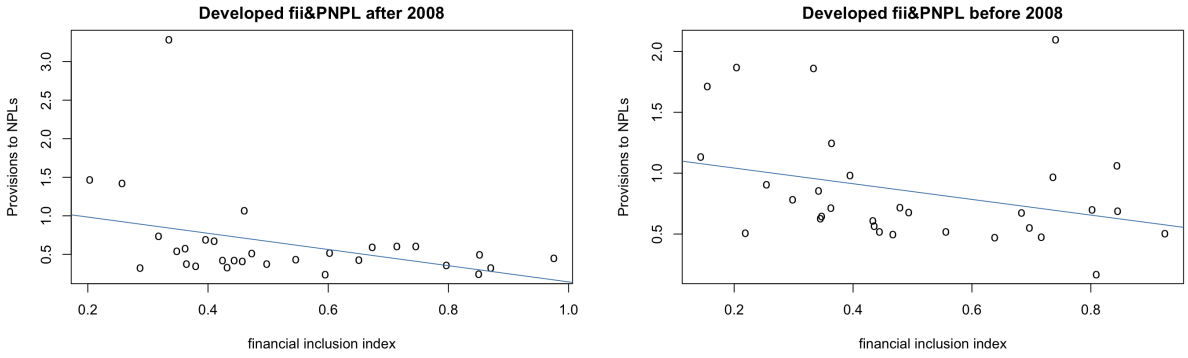


Figure 2.8: The Relationship between FII and Provisions to Non-performing Loans



nancial inclusion increases, which indicates financial stability increases. These results are in line with the previous findings that financial inclusion reduces provisions to non-performing loans (VO et al., 2019).

2.3.3 Control variables

To ensure the accuracy of the nexus between financial inclusion and financial stability, this analysis adds some control variables that might affect this relationship. The change of GDP per capita growth [6] may affect the level of financial inclusion, so it is vital to control for this influencing factor. Secondary school enrolment is regarded as a beneficial factor in the relationship between financial inclusion and financial stability Čihák, Mare, and Melecky (2016). Individuals with better education may promote financial literacy to improve the quality of financial inclusion, which could improve financial stability. Financial openness has a negative effect on the financial stability. The policy implication of the previous literature illustrates that it is important for the policymaker to understand this interrelationship as the related policies could have a significant impact on the nexus. Meanwhile, Čihák, Mare, and Melecky (2016) argue that an inclusive financial sector governance structure also contributes to this relationship. As a result, we assume that government efficiency could positively affect financial stability. Additionally, many empirical studies have mentioned that credit risk raised by financial inclusion might lack certain regulation, supervision and collateral[7]. Thus, a high-quality regulation and supervision could reduce the probability of these risks. Mobile cellular subscription represents the development of financial technology, which could benefit financial stability through its positive effect on financial inclusion (Čihák, Mare, and Melecky, 2016; Ozili, 2020).

[6] Ahamed(2019) investigates the relationship between financial inclusion and bank stability, and their paper also take GDP per capita as an important control variable.

[7] According to Khan (2011), financial inclusion could jeopardise credit standards and lower the market access limitations of financial institutions, which will lead to instability.

2.3.4 Summary statistics

Table 2.3: Summary statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Bank Capital to Total Assets	1019	0.097	0.035	0.027	0.230
Liquid Assets to Deposits and Short-term Funding	1302	0.325	0.162	0.0141	1.306
Non-performing Loans to Gross Loans	1032	0.057	0.064	0.001	0.545
Provisions to Non-performing Loans	983	0.774	0.528	0.008	6.041
Financial Inclusion Index	1350	0.316	0.232	0.002	1
GDP Growth Rate Per Capita	1395	0.0248	0.056	-0.624	1.218
Secondary School Enrollment	999	0.875	0.271	0.110	1.639
Financial Openness	1274	0.640	0.369	0	1
Government Efficiency	1394	0.263	0.947	-2.244	2.437
Regulation Quality	1394	0.263	0.922	-2.334	2.261
Mobile Cellular Subscription	1390	0.938	0.419	0.014	2.126

Table 2.4: Correlations coefficients for all the variables

	BCTA	LATSF	NPLs	PNPLs	FII	GDP	SE	FO	GE	RQ	LMB
BCTA	1.000										
LATSF	-0.114^{*}	1.000									
NPLs	0.091^{*}	-0.051	1.000								
PNPLs	0.060	0.011	-0.200^{*}	1.000							
FII	-0.418^{*}	-0.119^{*}	-0.123^{*}	-0.174^{*}	1.000						
GDP	0.155^{*}	0.023	-0.0104^{*}	0.084^{*}	-0.103^{*}	1.000					
SE	-0.236^{*}	-0.043	-0.208^{*}	-0.091^{*}	0.714^{*}	-0.138^{*}	1.000				
FO	-0.262^{*}	-0.008	-0.141^{*}	-0.161^{*}	0.401^{*}	-0.095^{*}	0.520^{*}	1.000			
GE	-0.486^{*}	-0.063^{*}	-0.251^{*}	-0.257^{*}	0.733^{*}	-0.097^{*}	0.679^{*}	0.541^{*}	1.000		
RQ	-0.417^{*}	-0.096^{*}	-0.219^{*}	-0.271^{*}	0.703^{*}	-0.077^{*}	0.657^{*}	0.646^{*}	0.943^{*}	1.000	
MB	-0.077^{*}	-0.201^{*}	-0.163^{*}	-0.069^{*}	0.484^{*}	-0.168^{*}	0.645^{*}	0.311^{*}	0.451^{*}	0.450^{*}	1.000

Note:BCTA= bank capital to total assets;LATSF=iquid assets to deposits and short-term funding;NPLs=non-performing loans to gross loans;PNPLs=provisions to non-performing loans;FII= financial inclusion index;GDP= GDP growth rate per capita;SE=secondary school enrollment;FO=financial openness;GE=government efficiency;RQ=quality regulation;LMB= log of mobile cellular subscription.

2.4 Methodology

We use generalized method-of-moments (GMM) estimators [8]with panel data to investigate the nexus between financial inclusion and financial stability. The difference and system GMM (Roodman, 2009) method is suitable for small T and large N datasets, which fits our data set (93 countries and 15 years). Additionally, this method could also handle the following potential problems. For example, dynamic process (dependent variable affected by the previous ones), endogenous regressors[9], predetermined regressors, idiosyncratic disturbances, etc. Besides, we also implement tests for the validity of instruments such as an over-identification test based on the Sargan and Hansen test, which also could test autocorrelation.

The empirical model in this chapter follows (Ahamed and Mallick, 2019). The dependent variable are the indicators of financial stability while the main independent variable is financial inclusion index.

$$\text{Financial stability}_{i,t} = f(\text{Financial inclusion index}_{i,t}, \text{Control variables}_{i,t}) \tag{2.6}$$

Specifically, the GMM model is shown as follows, we show the short-term effect model by adding the control variables stepwise to check the change of the coefficients of financial inclusion first:

$$y_{it} = \gamma y_{i,t-1} + \delta \text{FII}_{i,t} + \beta x_{it} + a_i + u_{it} \tag{2.7}$$

After modifying the model, the next equation could detect the dynamic process (long-term effect) of financial inclusion, and its result could capture the effect of the past value of the financial inclusion index on financial stability. The long-term effect model is shown as follows:

$$y_{it} = \gamma y_{i,t-1} + \delta_1 \text{FII}_{i,t} + \delta_2 \text{FII}_{i,t-1} + \beta x_{it} + a_i + u_{it} \tag{2.8}$$

[8]This estimation has been implemented in Stata based on Roodman (2009)

[9]Financial inclusion index might be endogenous.

The formula to calculate the long-term effect is shown as follows:

$$\frac{\delta_1 + \delta_2}{1 - \gamma} \tag{2.9}$$

where i implies various countries and t is year, γ, δ, β are estimated coefficients, and y represents the financial stability indicators, which are: Bank capital to total assets (BCTA), Liquid assets to deposits and short-term funding (LA), Non-performing loans to gross loans (NPLs), Provisions to non-performing loans (PNPLs). The main dependent variable of FII is the Financial inclusion index (FII). X is control variables which are: GDP growth rate per capita, secondary school enrollment, financial openness, government effectiveness, regulatory quality and mobile cellular subscription.

This analysis uses the following instruments for the implementation of system GMM. The regression uses lag 2 to 5 for bank capital to total asset, lag 2 to 3 for bank liquid assets to deposits and short-term funding, bank non-performing loans, and provisions to non-performing loans. Moreover, to investigate the specific effect with different country groups, in model 3, the regression assigns lag 2 to 5 to bank capital to total asset and bank liquid asset to deposits and total asset, lag 2 to 4 to bank non-performing loans and lag 2 to 3 to provisions to non-performing loans.

2.5 Empirical Results

Table 2.6 shows the effect of financial inclusion on four financial stability indicators. The detailed analysis is shown as follows.

2.5.1 Basic Results

Bank capital to total asset

Table 2.6 shows the results of using bank capital to total assets as financial stability indicator. In both the short term and long term,[10] it could be found that financial inclusion has a negative but insignificant effect on bank capital. Thus, it might also illustrate that the development of financial inclusion jeopardizes the financial system resilience.
Regulatory quality has slightly positive effects, and this finding, in favor of the previous discussion, is that financial inclusion could contribute to financial stability under regulation (VO et al., 2019). The results of AR(2) and the Hansen test prove that there is no auto-correlation in the error term and the instrumental variables are valid.

Table 2.5: Long term effect of financial inclusion

	Coef.	Std.Err	Z	P-Value	[95%Conf.Interval]
BCTA	-0.417	2.105	-1.77	0.843	[-4.5420 3.7083]
LA	−0.458**	0.203	-2.26	0.024	[-0.8559 -0.0599]
NPLs	-2.519	3.857	-0.65	0.514	[-10.0783 5.0398]
PNPLs	-1.328	1.913	-0.69	0.488	[-5.0786 2.4218]

Note: BCTA is bank capital to total asset,LA is bank liquid asset to deposits and short-term funding loans,NPLs is non-performing loans to total loans, PNPLs is provisions to non-performing loans.* * *,**,* are significance level at 1%,5% and 10%, respectively.

[10] Table 2.5 shows the long term effect of financial inclusion index.

Table 2.6: Basic Regression Results

Bank Capital to Total Asset		
Variables	Short-term effects	Long-term effects
Lagged dependent	0.969***	0.990***
	[0.054]	[0.048]
Financial inclusion index	-0.017	−0.108**
	[0.010]	[0.053]
Lagged financial inclusion index	–	0.104
	–	[0.064]
GDP growth rate per capita	-0.010	-0.001
	[0.013]	[0.013]
Secondary school enrollment	0.007	0.002
	[0.004]	[0.006]
Financial openness	-0.002	-0.002
	[0.002]	[0.002]
Government effectiveness	-0.001	-0.002
	[0.002]	[0.002]
Regulatory quality	0.003	0.003*
	[0.002]	[0.001]
Mobile cellular subscriptions	-0.000	0.000
	[0.002]	[0.002]
AR(1)	0.000	0.000
AR(2)	0.110	0.183
Hansen(p-value)	0.994	0.397
Observations	696	696

Note:This table provides results by the indicator of financial stability which is Bank capital to total asset(BCTA).All estimations based on system GMM. Robust standard error are reported in the parentheless, AR(1)and AR(2) are first and second order of residual auto-correlation tests.The null hypothesis of the AR(2) test is that the error has no second order correlation.The null hypothesis for Hansen test is that all the instruments are exogenous. ***,**,* are significance level at 1%,5% and 10%, respectively.

Bank liquid assets to deposits and short-term funding

Table 2.7 presents the results that using liquid assets to deposits and short-term funding as the financial stability indicator. As the results show, the financial inclusion index causes both negative effect on liquid assets in both the short and long terms. Specifically, a unit increase of financial inclusion will decrease liquid asset by 0.167 unit and 0.458 unit in the short and long terms , which are at 1% and 5% significance level, respectively.

Among the control variables, government effectiveness has a slight but strong and positive effect on bank liquid assets. This result illustrates that the improvement of government effectiveness will contribute to financial stability, which concurs with (Ahamed and Mallick, 2019; García and José, 2016), that better institutional quality will strengthen the positive effect of financial inclusion on financial stability. Furthermore, AR(2) and Hansen results assure the validity of error term and instruments.

Above all, based on the previous two financial stability indicators, it could be found that there is a trade off between financial inclusion and financial stability, through its reduction on bank capital and bank liquid assets. However, the potential factor for the trade off is more than these two reasons. According to the existing literature, the main reason could be the rapid growth of credit risk raised by an increase of financial inclusion without regulation and supervision (García and José, 2016; Čihák, Mare, and Melecky, 2016). In addition, fintech innovation may aggravate the instability due to its enormous hidden costs such as new facilities' installation. Finally, although financial inclusion leads more population access to the formal financial service, it might be difficult for individuals who lack financial knowledge to survive or manage the complicated financial products on the market.

Furthermore, the empirical results show that financial inclusion may not only cause damage in the short term but also in the long term. As a result, policy makers may need to be cautious about setting financial inclusion as a national strategy, as it is difficult to balance financial inclusion and financial stability.

Table 2.7: Basic Regression Results

Bank Liquid Asset to Deposits and Short-term Funding		
Variables	Short-term effects	Long-term effects
Lagged dependent	0.590***	0.582***
	[0.079]	[0.149]
Financial inclusion index	−0.167*	0.206
	[0.085]	[0.438]
Lagged financial inclusion index	–	-0.398
	–	[0.416]
GDP growth rate per capita	-0.025	-0.078
	[0.103]	[0.097]
Secondary school enrollment	-0.046	-0.051
	[0.038]	[0.039]
Financial openness	-0.013	-0.009
	[0.021]	[0.026]
Government effectiveness	0.054***	0.055**
	[0.019]	[0.021]
Regulatory quality	-0.014	-0.014
	[0.018]	[0.021]
Mobile cellular subscriptions	-0.016	-0.017
	[0.013]	[0.017]
AR(1)	0.001	0.141
AR(2)	0.147	0.141
Hansen(p-value)	0.485	0.400
Observations	840	840

Note:This table provides results by the indicator of financial stability which is Bank liquid asset to deposit and short-term funding(LA). All estimations based on system GMM. Robust standard error are reported in the parentheless, AR(1)and AR(2) are first and second order of residual auto-correlation tests.The null hypothesis of the AR(2) test is that the error has no second order correlation.The null hypothesis for Hansen test is that all the instruments are exogenous. ∗ ∗ ∗,∗∗,∗ are significance level at 1%,5% and 10%, respectively

Non-performing Loans to Total Loans

Here the analysis consider the non-performing loans to total loans (NPLs) as a proxy of financial stability, and the detailed regression results are shown in Table 2.8. Financial inclusion has an negative relationship with non-performing loans in both short and long terms. Although the result is insignificant in the long term, it still illustrates the enhancement of financial stability with the increase of financial inclusion. A plausible reason might be that financial inclusion provides suitable lending, such that make the firms and individuals could avoid bankrupt, which might reduce the possibility of default and defraud (Morgan and Pontines, 2014).

GDP growth rate has a strong and negative effect on NPLs. This might be because that NPLs have a close relationship with economic depression, and economic growth could reduce the amount of NPLs. [11] This results is in a line with previous findings that GDP growth rate has a positive effect on financial stability (García and José, 2016). Furthermore, secondary school enrollment has a negative effect on NPLs.[12] The results indicate that the higher the education level, the more stable the financial system. This might because that with higher education, it is more possible for individuals to attain increased financial knowledge. As a result,the public could have better ability to avoid the potential risks brought by the complicated financial products. Similar results can also be found in the previous studies, and many authors argue the imperative role of financial education and financial literacy on financial stability. For example, Singh (2014) asserts that financial literacy could improve the individuals' financial knowledge and enhance their decision making, which could reduce financial instability. Furthermore, individuals with good financial literacy could benefit the transparency and integrity of financial institutions by becoming part of market supervision. Government effectiveness has a negative effect on NPLs, as discussed above, the institutional quality plays an imperative role on promoting

[11] See Balgova, Nies, and Plekhanov, 2016

[12] A unit increase of education level could reduce the NPLs by 0.028 unit.

financial stability, since it might reduce the default risk of individuals and firms.AR(2) results and Hansen shows the error term does not have the auto-correlation and all the instruments are valid.

Table 2.8: Basic Regression Results

NPLs to Total Loans		
Variables	Short-term effects	Long-term effects
Lagged dependent	1.024^{***}	1.027^{***}
	[0.078]	[0.043]
Financial inclusion index	-0.071^{*}	0.095
	[0.026]	[0.130]
Lagged financial inclusion index	–	-0.028
	–	[0.131]
GDP growth rate per capita	-0.225^{***}	-0.227^{***}
	[0.038]	[0.038]
Secondary school enrollment	-0.030	-0.028^{**}
	[0.013]	[0.013]
Financial openness	0.001	0.000
	[0.004]	[0.004]
Government effectiveness	-0.009	-0.010^{*}
	[0.006]	[0.005]
Regulatory quality	0.003	0.003
	[0.005]	[0.005]
Mobile cellular subscriptions	0.002	0.001
	[0.005]	[0.005]
AR(1)	0.001	0.001
AR(2)	0.157	0.155
Hansen(p-value)	0.435	0.486
Observations	704	704

Note:This table provides results by the indicator of financial stability which is Non-performing loans(NPLs).All estimations based on system GMM. Robust standard error are reported in the parentheless, AR(1)and AR(2) are first and second order of residual auto-correlation tests.The null hypothesis of the AR(2) test is that the error has no second order correlation.The null hypothesis for Hansen test is that all the instruments are exogenous. $***$,$**$,$*$ are significance level at 1%,5% and 10%, respectively.

Provisions to Non-performing Loans

Finally, Table 2.9 presents the impact of financial inclusion on financial stability when the provisions to non-performing loans (PNPLs) used as a proxy of financial stability.Financial inclusion shows a negative short term and long term effect on the provisions to non-performing loans, though the results are not significant. This finding also be found by (VO et al., 2019), in that the increase of financial inclusion level decreases the PNPLs, which might illustrate that financial inclusion reduces the possibility of default.

Among the control variables, mobile cellular subscriptions cause a negative effect as it might have the hidden cost[13]. Regulatory quality causes a negative but slight effect. Similar to the previous tables, AR(2) shows there is no serial correlation in the error term, and Hansen proves all the instrument are valid.

Based on the results of the last two financial stability indicators, it could been found that financial inclusion benefit the financial stability because it reduces NPLs and PNPLs.This mitigate the credit risk and finally strengthens the financial system resilience. Apart from this, the existing literature lists the potential channels via which financial inclusion promotes financial stability. First, the most significant reason is that financial inclusion diversifies the bank deposit source, which enhances financial system resilience. Secondly, Mehrotra and Yetman (2015) argues that the beneficial effect stems from financial inclusion improving the transmission of monetary policy, which also contributes to financial stability. Lastly, Cull, Aslı Demirgüç-Kunt, and Lyman (2012) state that financial inclusion promote the social and political stability, which might in turn could benefit financial stability.

[13]Financial inclusion could benefit the financial stability through its positive effect on financial inclusion, but its extra cost such as installation cost might impair financial stability.

Table 2.9: Basic Regression results

Provisions to Non-performing Loans		
Variables	Short-term effects	Long-term effects
Lagged dependent	1.074***	1.101***
	[0.126]	[0.126]
Financial inclusion index	-0.078	-1.929
	[0.221]	[1.411]
Lagged financial inclusion index	–	2.064
	–	[1.578]
GDP growth rate per capita	0.081	0.327
	[0.387]	[0.434]
Secondary school enrollment	0.031	-0.044
	[0.104]	[0.133]
Financial openness	-0.031	-0.034
	[0.038]	[0.049]
Government effectiveness	0.041	0.027
	[0.039]	[0.032]
Regulatory quality	-0.057	−0.068*
	[0.040]	[0.039]
Mobile cellular subscriptions	0.050	−0.048*
	[0.036]	[0.028]
AR(1)	0.023	0.022
AR(2)	0.348	0.381
Hansen(p-value)	0.407	0.526
Observations	664	664

Note:This table provides results by the indicator of financial stability which is Provisions to non-performing loans(PNPLs).All estimations based on system GMM. Robust standard error are reported in the parentheless, AR(1)and AR(2) are first and second order of residual auto-correlation tests.The null hypothesis of the AR(2) test is that the error has no second order correlation.The null hypothesis for Hansen test is that all the instruments are exogenous. ∗ ∗ ∗,∗∗,∗ are significance level at 1%,5% and 10%, respectively.

Of the six control variables, four seem related to financial inclusion, which are secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions. To ensure the robustness of the effect of financial inclusion on financial stability, the chapter shows that several models have been run to check the coefficients of financial inclusion. In equation 10, the regression removes all the four variables. Based on equation 10, equation 11 adds secondary school enrollment(SE) in, while equation 12 and 13 gradually add government effectiveness(GE) and regulatory quality(RQ) in. Equation 14 has all the four control variables, which is the same as model 1.

$$y_{it} = \gamma y_{i,t-1} + \delta FII_{i,t} + \beta_1 GDP_{it} + \beta_2 FO + a_i + u_{it} \tag{2.10}$$

$$y_{it} = \gamma y_{i,t-1} + \delta FII_{i,t} + \beta_1 GDP_{it} + \beta_2 FO + \beta_3 SE + a_i + u_{it} \tag{2.11}$$

$$y_{it} = \gamma y_{i,t-1} + \delta FII_{i,t} + \beta_1 GDP_{it} + \beta_2 FO + \beta_3 SE + \beta_4 GE + a_i + u_{it} \tag{2.12}$$

$$y_{it} = \gamma y_{i,t-1} + \delta FII_{i,t} + \beta_1 GDP_{it} + \beta_2 FO + \beta_3 SE + \beta_4 GE + \beta_5 RQ + a_i + u_{it} \tag{2.13}$$

$$y_{it} = \gamma y_{i,t-1} + \delta FII_{i,t} + \beta_1 GDP_{it} + \beta_2 FO + \beta_3 SE + \beta_4 GE + \beta_5 RQ + \beta_6 MB + a_i + u_{it}^{14} \tag{2.14}$$

The results are as follows. In the first three regressions, as financial stability indicators are BCTA,LA, and NPLs. The coefficients of financial inclusion maintain the same sign with all the regressions. Although some have slight variation in the size of the value, the results are insignificant. For example, Table 2.10 shows the results of the above five equations when the financial stability indicator is bank capital to total asset, the first financial inclusion coefficient is -0.014, and then it increases to -0.003 at the second column, but it has lost the significance. Moreover, in the last regression (see Table 2.13)

[14]FII is financial inclusion index, GDP is gdp growth rate per capita, FO is financial openness, MB is mobile cellular subscriptions.

when the financial stability index indicator is PNPLs, the sign of the coefficient changes in the last column, but all the coefficients are insignificant. The control variables have the similar situation as the financial inclusion index, and none of the regression have no auto-correlation in the error term and all the instruments are valid.

Table 2.10: Robustness of Financial inclusion index coefficients

Bank Capital to Total Asset					
	0	1	2	3	4
L.BCTA	0.953***	0.966***	0.977***	0.965***	0.969***
	(0.033)	(0.047)	(0.054)	(0.050)	(0.054)
Financial inclusion index	−0.014*	-0.003	−0.019*	−0.017*	-0.017
	(0.008)	(0.016)	(0.011)	(0.010)	(0.010)
GDP growth rate per capita	-0.011	-0.013	-0.012	-0.012	-0.010
	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)
Financial openness	0.003	-0.000	-0.000	-0.002	-0.002
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Secondary school enrollment	-	0.002	0.007	0.006	0.007
	-	(0.008)	(0.005)	(0.004)	(0.004)
Government effectiveness	-	-	0.002	-0.001	-0.001
	-	-	(0.002)	(0.002)	(0.002)
Regulation quality	-	-	-	0.003*	0.003*
	-	-	-	(0.002)	(0.002)
Mobile cellular subscriptions	-	-	-	-	-0.000
	-	-	-	-	(0.002)
AR(1)	0.000	0.000	0.000	0.000	0.000
AR(2)	0.465	0.256	0.241	0.249	0.250
Hansen	0.374	0.545	0.876	0.955	0.994
Observations	899	696	696	696	696

Note:0 means removing all the four potential related control variables: secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions;1 means put secondary school enrolment in the regression; 2 means put secondary school enrolment, Government effectiveness in; 3 means put secondary school enrollment, government effectiveness, regulation quality in; 4 means put secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions in.

Table 2.11: Robustness of Financial inclusion index coefficients

Bank liquid asset to total asset and short term funding					
	0	1	2	3	4
L.LA	0.688***	0.672***	0.672***	0.611***	0.590***
	(0.049)	(0.062)	(0.112)	(0.084)	(0.079)
Financial inclusion index	−0.129***	-0.087	−0.135*	-0.100	−0.167*
	(0.049)	(0.060)	(0.079)	(0.069)	(0.085)
GDP growth rate per capita	-0.012	-0.0184	0.015	0.056	-0.025
	(0.029)	(0.102)	(0.108)	(0.111)	(0.103)
Financial openness	0.027	0.000	-0.003	-0.003	-0.013
	(0.020)	(0.014)	(0.014)	(0.010)	(0.021)
Secondary school enrollment	-	0.002	0.063	0.010	0.046
	-	(0.008)	(0.029)	(0.036)	(0.038)
Government effectiveness	-	-	0.027**	0.055**	−0.054***
	-	-	(0.013)	(0.022)	(0.019)
Regulation quality	-	-	-	−0.030*	-0.014
	-	-	-	(0.017)	(0.018)
Mobile cellular subscriptions	-	-	-	-	-0.016
	-	-	-	-	(0.013)
AR(1)	0.000	0.000	0.002	0.001	0.001
AR(2)	0.149	0.156	0.153	0.146	0.147
Hansen	0.167	0.638	0.549	0.796	0.485
Observations	1144	840	840	840	840

Note:0 means removing all the four potential related control variables:secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions;1 means put secondary school enrolment in the regression; 2 means put secondary school enrolment, Government effectiveness in; 3 means put secondary school enrollment, government effectiveness, regulation quality in; 4 means put secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions in.

Table 2.12: Robustness of Financial inclusion index coefficients

Non-performing loans					
	0	1	2	3	4
L.NPLs	1.038***	1.031***	1.023***	1.034***	1.025***
	(0.036)	(0.042)	(0.045)	(0.042)	(0.044)
Financial inclusion index	0.069***	0.053**	0.080***	0.069***	0.071***
	(0.023)	(0.023)	(0.026)	(0.024)	(0.026)
GDP growth rate per capita	−0.196***	−0.226***	−0.226***	−0.232***	−0.225***
	(0.037)	(0.040)	(0.040)	(0.040)	(0.038)
Financial openness	−0.021***	-0.003	0.002	0.000	0.001
	(0.008)	(0.004)	(0.005)	(0.004)	(0.004)
Secondary school enrollment	-	−0.030**	−0.031**	−0.028**	−0.030**
	-	(0.008)	(0.013)	(0.012)	(0.013)
Government effectiveness	-	-	−0.008**	−0.011**	-0.009
	-	-	(0.004)	(0.005)	(0.006)
Regulation quality	-	-	-	0.005	0.003
	-	-	-	(0.005)	(0.005)
Mobile cellular subscriptions	-	-	-	-	0.002
	-	-	-	-	(0.005)
AR(1)	0.001	0.001	0.001	0.001	0.001
AR(2)	0.583	0.179	0.163	0.157	0.157
Hansen	0.168	0.548	0.423	0.874	0.435
Observations	911	704	704	704	704

Note:0 means removing all the four potential related control variables:secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions;1 means put secondary school enrolment in the regression; 2 means put secondary school enrolment, Government effectiveness in; 3 means put secondary school enrollment, government effectiveness, regulation quality in; 4 means put secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions in.

Table 2.13: Robustness of Financial inclusion index coefficients

Provisions to non-performing loans					
	0	1	2	3	4
L.PNPLs	1.038***	1.062***	1.050***	1.039***	1.074***
	(0.106)	(0.122)	(0.128)	(0.126)	(0.126)
Financial inclusion index	0.382	0.114	0.131	0.167	-0.078
	(0.273)	(0.218)	(0.191)	(0.141)	(0.221)
GDP growth rate per capita	0.212	-0.053	-0.033	0.004	0.081
	(0.352)	(0.357)	(0.344)	(0.337)	(0.387)
Financial openness	−0.160**	−0.090**	−0.065*	-0.026	-0.031
	(0.086)	(0.041)	(0.039)	(0.040)	(0.038)
Secondary school enrollment	-	−0.030**	0.008	-0.009	0.031
	-	(0.008)	(0.083)	(0.062)	(0.104)
Government effectiveness	-	-	-0.030	0.021	0.041
	-	-	(0.022)	(0.032)	(0.039)
Regulation quality	-	-	-	−0.073**	-0.057
	-	-	-	(0.037)	(0.040)
Mobile cellular subscriptions	-	-	-	-	0.050
	-	-	-	-	(0.036)
AR(1)	0.005	0.023	0.023	0.023	0.023
AR(2)	0.349	0.330	0.332	0.335	0.348
Hansen	0.519	0.880	0.883	0.895	0.407
Observations	862	664	664	664	664

Note:0 means removing all the four potential related control variables: secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions;1 means put secondary school enrolment in the regression; 2 means put secondary school enrolment, Government effectiveness in; 3 means put secondary school enrollment, government effectiveness, regulation quality in; 4 means put secondary school enrollment, government effectiveness, regulation quality, mobile cellular subscriptions in.

2.5.2 Heterogeneous effects: based on the income groups

To investigate the disaggregated level impact of financial inclusion on financial stability, this chapter has divided the entire sample into three categories based on income level: low and low-middle-income countries, upper-middle-income countries, and high-income countries. Thus, this section expands model 1, which is shown as follows:

$$Y_{it} = \gamma Y_{i,t-1} + \delta \mathrm{FII}_{i,t} + \beta x_{it} + Dummy1 + Dummy2 + \mathrm{FII} \times Dummy1 + \mathrm{FII} \times Dummy2 + a_i + u_{it} \tag{2.15}$$

Dummy 1 is the dummy variable for upper middle-income countries, dummy 2 is the dummy variable for high-income countries. $FII \times Dummy1$ and $FII \times$ Dummy 2 are the interaction terms.

Foremost, in the low and low-middle-income countries, a greater unit of financial inclusion level increases the non-performing loans by 0.129 units. This indicates that financial inclusion would cause a significant increase in credit risk in low and low-middle-income countries. However, the relationship has a reverse pattern in upper-middle and high-income countries. The opposite results might indicate that in low and low-middle-income countries, individuals might not be creditworthy or they may lack collateral, which causes default risks. Thus, it is imperative to set appropriate regulations for financial inclusion. However, for those individuals and firms in upper-middle and high-income countries, financial inclusion might provide loans for them to survive in a crisis. In other words, financial inclusion may improve the financial health of these individuals and firms, which can ultimately offset the default and defraud risks. Furthermore, bank liquid asset is 0.065 unit less in upper-middle-income countries than in other countries. More generally, in upper-middle-income countries, the financial inclusion index increases bank liquid assets, which illustrates that financial inclusion enhances financial stability, given that financial inclusion extends the bank deposit source which may prevent banks from being overdrawn during a time of crisis. This finding is consistent with Morgan and Pontines

(2014), a higher level of financial inclusion could Stabilize the financial system during a crisis, and the results are especially strong in middle-income countries, even where still have a large share of the financially excluded population. Additionally, although the results are insignificant, financial inclusion decreases the bank liquid assets in low and low-middle-income countries while increasing it in the high-income countries. Finally, compared to other countries, in high-income ones, bank capital, liquid assets and non-performing loans have an upward trend while provisions of non-performing loans decrease, although all the results are insignificant. Overall, it could be concluded that financial inclusion has synergy in upper-middle and high-income countries while there is a trade-off in low and low-middle income with financial stability. This is also proved by (Dienillah, Anggraeni, and Sahara, 2018), who claim financial inclusion only benefits financial stability in high-income countries, whilst lower and upper-middle-income countries have to promote financial inclusion to achieve financial stability.

Table 2.14: Regression Results

Dependent variable($Y_{i,t}$)	BCTA	LA	NPLs	PNPLs
Lagged dependent variable	0.926***	0.706***	1.013***	1.037***
	(0.045)	(0.060)	(0.043)	(0.112)
Financial inclusion index(FII)	-0.012	-0.218	0.129***	-0.350
	(0.038)	(0.166)	(0.028)	(-0.350)
Upper-middle income countries(UMIC)	0.005	−0.065*	0.009	-0.072
	(0.005)	(0.038)	(0.007)	(0.103)
UMIC*FII	-0.002	0.347**	−0.075***	0.443
	(0.033)	0.172	(0.028)	(0.447)
High income countries(HI)	0.003	0.039	0.013	-0.113
	(0.013)	0.051	(0.012)	(0.088)
HI*FII	0.010	0.093	−0.085**	0.533
	(0.050)	(0.163)	(0.034)	(0.408)
Controls	Yes	Yes	Yes	Yes
AR(1)	0.000	0.000	0.001	0.023
AR(2)	0.256	0.152	-.147	0.352
Hansen	1.000	1.000	1.000	1.000
Observations	696	840	704	664

Note: This table provides results by the indicator of financial stability which are Bank capital to the total asset(BCTA), Bank liquid asset to deposit and short-term funding(LA), Non-performing loans(NPLs), Provisions to non-performing loans(PNPLs).All estimations are based on system GMM. Robust standard error are reported in the parentheless, ***,**,* are significance level at 1%,5% and 10%, respectively. Check appendix for the results of control variables

2.5.3 Conclusion

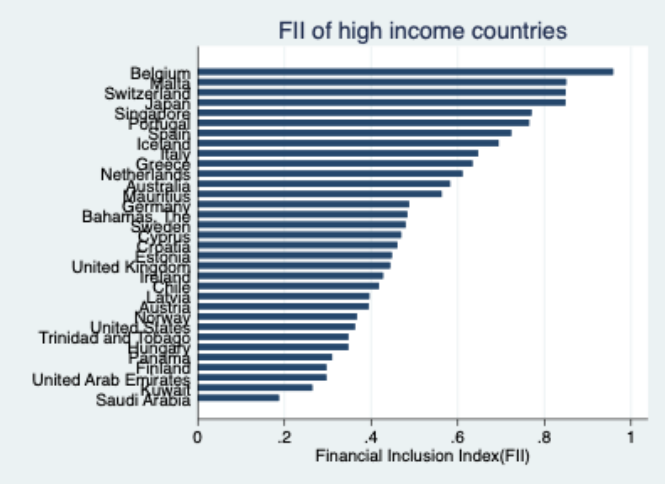
The key question of whether financial inclusion could enhance financial stability depends on the indicators of financial stability. It could be concluded that financial inclusion might benefit financial stability through its reduction on the NPLs in upper-middle and high-income countries, but it causes instability in low and low-middle-income countries, given it increases the NPLs. Furthermore, in general, financial inclusion shows a positive effect on bank liquid assets (LA) in upper-middle-income countries, which indicates financial inclusion has a synergy with financial stability in upper-middle-income countries. Finally, financial inclusion causes a negative effect on bank capital (BCTA) and provisions to non-performing loans (PNPLs), but the results are insignificant. GDP growth per capita has a positive relationship with financial stability while financial openness shows the reverse pattern. Additionally, secondary school enrolment, government effectiveness, regulation quality and mobile cellular subscription all contribute to financial stability.

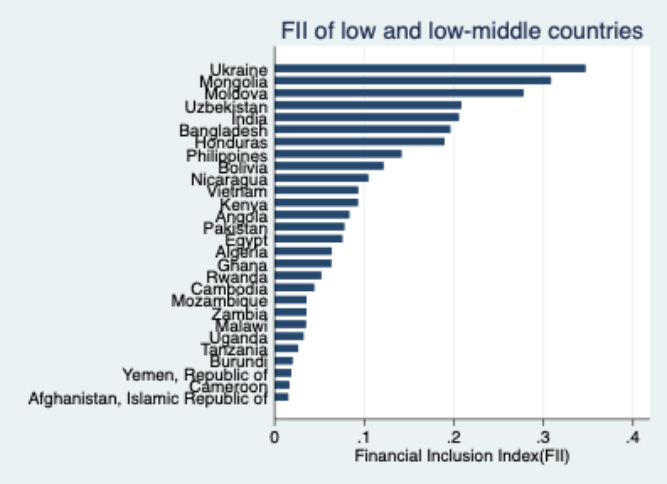
Our results imply that the regulators should build more regulations to provide available services to financially excluded people. Additionally, the government should make financial inclusion the priority and support the financial inclusion process through the policies. Government and financial institutions should have intense collaboration to improve the financial inclusion level. Also, it might be important to promote regional or country-level cooperation, which could benefit financially excluded people globally. Besides, those financial institutions could build more financial infrastructures especially digital finance systems and mobile payment. Finally, it is also vital to promote financial education and improve financial literacy, which are more likely to improve the quality of financial inclusion.

Further research could divide the data into two periods, before and after the 2008 financial crisis. The impact of financial inclusion might be different between the two periods. It could also extend the time period, which could include COVID-19 shock, to examine the effect of financial inclusion. Then, it would also try to construct a financial stability index

such as Z-score and examine its relationship with financial inclusion. Besides, we only use country-level data in our analysis. Regional or bank-level data could be considered in future work.

2.6 Appendix





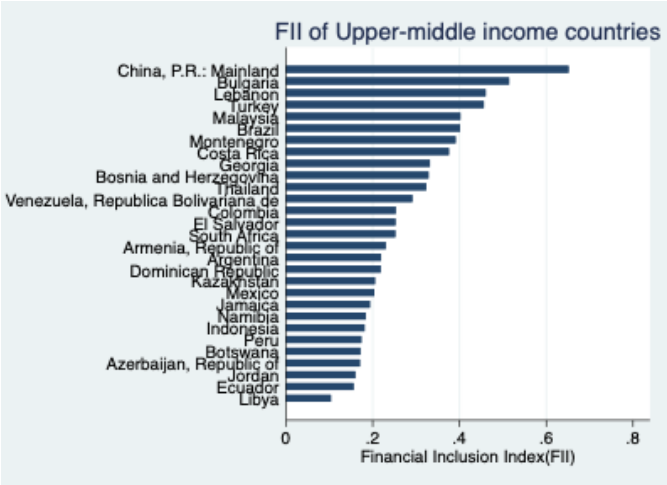


Figure 2.9: Financial inclusion index based on different groups of countries

Table 2.15: List of Countries 1

Developed countries	Developing countries	
Belgium	Mauritius	Honduras
Japan	Bulgaria	Azerbaijan
Malta	Ukraine	Dominican Republic
Spain	Lebanon	Botswana
Portugal	Bangladesh	Indonesia
Switzerland	Malaysia	Philippines
Netherlands	Brazil	Uganda
Estonia	Turkey	Uzbekistan
Italy	Jamaica	Rwanda
Ireland	Costa Rica	Bolivia
Finland	Mongolia	Algena
Bahamas	Thailand	Nicaragua
Chile	Maoedona	Egypt
Greece	India	Pakistan
Latvia	Montenegro	Ghana
Croatia	Bosnia and Herzegovina	Kenya
Hungary	Panama	Angola
Austria	Colombia	Libya
Trinidad and Tobago	Peru	Mozambique
Singapore	El Salvador	Cambodia
Cyprus	Moldova	
Kuwait	Georgia	
Venezuela	Ecuador	
United Arab Emirates	Kazakhstan	
Argentina	South Africa	
Iceland	Jordan	
Saudi Arabia	Armenia	
Norway	Namibia	

Table 2.16: List of Countries 2-World Bank

Low and low-middle income	Upper-middle income	High income
Afghanistan, Islamic Republic of	Argentina	Australia
Angola	Armenia, Republic of	Austria
Bangladesh	Azerbaijan, Republic of	Bahamas, The
Bolivia	Bosnia and Herzegovina	Belgium
Burundi	Botswana	Chile
Cambodia	Brazil	Croatia
Cameroon	Bulgaria	Cyprus
Egypt	Colombia	Estonia
Ghana	Costa Rica	Finland
Honduras	Dominican Republic	France
India	Ecuador	Germany
Kenya	El Salvador	Greece
Malawi	Georgia	Hungary
Moldova	Indonesia	Iceland
Mongolia	Jamaica	Ireland
Mozambique	Jordan	Italy
Nicaragua	Kazakhstan	Japan
Pakistan	Lebanon	Korea, Republic of
Philippines	Libya	Kuwait
Rwanda	Malaysia	Latvia
Tanzania	Mexico	Malta
Uganda	Montenegro	Mauritius
Ukraine	Namibia	Netherlands
Uzbekistan	Peru	New Zealand
Vietnam	South Africa	Norway
Yemen, Republic of	Thailand	Panama
Zambia	Turkey	Portugal
Algeria	Venezuela, Republica Bolivariana de	Saudi Arabia
	China, P.R.: Mainland	Singapore
		Spain
		Sweden
		Switzerland
		Trinidad and Tobago
		United Arab Emirates
		United Kingdom
		United States

Chapter 3

The effect of government spending on bank liquidity creation

3.1 Introduction

Bank liquidity creation, which could provide liquidity to households and firms during the crisis period, is one of the critical roles of banks in modern economies. The liquidity mainly comes from banks transferring illiquid assets into liquid liabilities (on-balance sheet liquidity creation), or loan commitments (off-balance sheet liquidity creation) (Berger and C. Bouwman, 2015). The inverse bank liquidity creation could be used to measure bank liquidity, and it also provides various information of listed banks' and BHCs' debt and equity, which is different from LMI and Basel III ratios.

Many empirical studies have investigated the significant impact of bank liquidity creation. For example, bank liquidity creation could benefit GDP growth (Berger and Sedunov, 2017; Hsieh and C.-C. Lee, 2020). Additionally, Duan and Niu (2020) shows that bank liquidity creation could improve bank performance such as bank profitability. Alaoui Mdaghri (2022) claims that bank liquidity creation reduces non-performing loans. Moreover, bank liquidity creation could also predict financial crises, recessions, and exacerbate the fluctuation in the business cycle (Berger and Sedunov, 2017; Chatterjee, 2018; Niu, 2022). Since bank liquidity creation plays a vital role in economic activities, it might be worth investigating its determinants. A series of bank characteristics such as bank competition, bank size, and bank capital are found to have a significant effect on bank liquidity creation (Jiang, Levine, and C. Lin, 2019; Berger and C. H. Bouwman, 2009; Berger, C. H. Bouwman, et al., 2016). Apart from bank characteristics, policy interventions could also affect bank liquidity creation. Monetary policy used to be regarded as an effective policy tool that could boost liquidity in the market during a recession. However, under the current circumstance (low- interest rate and QE may get diminishing returns), monetary policy may have its limitations. Specifically, the lower interest rate will reduce the bank profitability and decrease bank lending activities Borio and Gambacorta (2017). Additionally, Goodhart and Ashworth (2012) claims that QE is unable to boost credit and monetary growth, and it may have diminishing returns due to gilt rates is low.

Meanwhile, Berger and Sedunov (2017) found that monetary policy has significant but minor effects on liquidity creation, and the result is even weaker during the crisis period. Therefore, to maintain the liquidity of the market, it is vital to consider other practical tools.

Conventionally, theoretical works regard fiscal policy as crowding out private-sector spending and investment, so it is considered as a counterproductive policy tool (Auerbach, Gorodnichenko, and D. Murphy, 2020). However, a growing number of empirical results show that government spending could release the credit market. For example, Auerbach, Gorodnichenko, and D. Murphy (2020) shows that government spending shock could lower the cost of credit by reducing the risk premia. Additionally, Miranda-Pinto et al. (2019) claims government spending could transfer income to the savers which finally releases the credit market. Those findings conclude that government spending could redistribute the resources to the public which offsets the tightening effect proposed in the theoretical models (D. Murphy and Walsh, 2020).

Based on the previous research, in this chapter, we first examined the connection between government spending and bank liquidity creation. We follow Berger and C. H. Bouwman (2009) to divide liquidity creation into five categories, which are aggregate bank liquidity creation, on-balance sheet liquidity creation, asset side liquidity creation, liability side liquidity creation, and off-balance sheet liquidity creation. We use military spending to represent government spending, which is the third-largest subset of aggregate government spending data (Auerbach, Gorodnichenko, and D. Murphy, 2020; Demyanyk, Loutskina, and D. Murphy, 2019). Moreover, we also control bank size, bank competition, city-level population, and local income (Berger and C. H. Bouwman, 2009; Auerbach, Gorodnichenko, and D. Murphy, 2020).

We test three hypotheses in this chapter. Firstly, based on previous findings in the literature, we assume that government spending (military spending) may boost bank liquidity creation by lowering interest rates. Secondly, since we use military spending data, it

might be affected by political interventions. Also, a strand of literature has shown that political uncertainty such as geopolitical risk, and economic policy uncertainty are significant influencing factors. Thus, we examine the effect of a group of political uncertainty factors on bank liquidity creation through military spending. We start with the presidential election cycle, including 5 years, which could be divided into election dates, the first half-term of the sitting president (1-2 years post-election), and the second half-term of the sitting president (3-4 years post-election). Then, we explore the consequence of the partisan effect on bank liquidity creation. We test whether the Republican or Democratic president could benefit the bank liquidity creation. Also, we explore the effect when the state governor is the same party as the sitting president. By examining this, we could identify whether the high-tier politician would transfer government spending to low-tier politicians and finally result in bank liquidity creation. Finally, we examine the effect of Geopolitical Risk, Economic Policy Uncertainty, and World Uncertainty. Our results suggest that the presidential election cycle and World Uncertainty economically and significantly affect bank liquidity creation through military spending. Finally, based on the previous finding, we could conclude that bank liquidity creation is affected by political interventions through military spending. Auerbach, Gorodnichenko, and D. Murphy (2020) also claim that there would be a downward bias if the effect of government spending on wealth transfer and new production is mixed. Thus, we use the Bartik instrument as the instrumental variable to military spending. The empirical result is consistent with previous findings that military spending positively affects liquidity creation, and the Bartik instrument also show that it could remove the downward bias.

Section 2 is a literature review; section 3 illustrates data and methodology; section 4 is the empirical results; section 5 is the results with the Bartik instrument, section 6 is the conclusion.

3.2 Literature Review

In this section, first, we group the relevant literature about bank liquidity and bank liquidity creation. Then, we conclude the literature which explores the relationship between government spending and the credit market. Finally, we introduce the effect of political uncertainty which contains the presidential election cycle, geopolitical risk, etc.

3.2.1 Bank liquidity and bank liquidity creation

Bank liquidity shows the case, cost, and time for a bank to take to meet the liquidity requirements of its customers (Berger and C. Bouwman, 2015). It is significant for a bank to hold enough bank liquidity against the liquidity risk. Thus, accurate bank liquidity measurement becomes essential to banks. Prior studies have shown many theories and measurements of bank liquidity. V. V. Acharya and Mora (2015) use the deposit growth rate to examine the impact of bank liquidity shocks during the crisis period. Many researchers apply the ratio of cash and liquid assets to total assets to explore a sort of problem. For example, Kashyap, Rajan, and Stein (2002) use this ratio to explore the synergies between lending and deposits. Allen, Hryckiewicz, et al. (2014) use this ratio to show the transmissions of liquidity shocks from bank holding companies (BHCs) to banks. Also, the same measurement could also be applied by Schandlbauer (2017) to examine the bank taxes on bank capital structure. Moreover, there are other researchers who use the ratio of securities to total assets, the ratio of cash to deposits as the measurement of bank liquidity to examine the effects of monetary policy and the effects of the Troubled Asset Relief Program (TARP) (Kashyap and Stein, 2000; L. Li, 2013; Duchin and Sosyura, 2014; Berger and Roman, 2015). Besides single indicators, Basel III provides two measurements for liquidity requirements under stressful scenarios. One is the Liquidity Coverage Ratio (LCR) which means that banks should hold sufficient high-quality liquid assets to survive for up to 30 days. Another one is Net Stable Funding Ratio (NSFR) which indicates

banks need to prepare enough stable funding over one year. Additionally, the liquidity mismatch index (LMI) shows the liquidity measurements from a different perspective. The previous indicators focus on the liquidity within the individual financial institutions while LMI shows the liquidity provided by the Fed and liquidity shortage in the financial system. Those measurements indicate the liquidity situation of banks, but they do not show the exact amount of liquidity created by banks. Bank liquidity creation, which differs from bank liquidity, indicates the amount of liquidity that banks create for the public. Liquidity comes from two main perspectives: on-balance sheet liquidity creation means that banks transfer illiquid assets into liquid liabilities, and off-balance sheet liquidity creation mainly comes from loan commitments (Berger and C. Bouwman, 2015).
Bank liquidity creation is a significant tool for banks to inject liquidity into the market during the crisis period. Thus, it is essential to figure out its impact.

3.2.2 The impact and determinants of bank liquidity creation

Many studies have explored the effect and determinants of bank liquidity creation. Bank liquidity creation could benefit both economies and financial institutions. By using the U.S. data, Berger and Sedunov (2017) show that bank liquidity creation has a positive relationship with real economic output (GDP). Their results show that bank liquidity creation could boost real economic output, and liquidity creation by small banks makes more contribution to economic growth than large banks. Horváth, Seidler, and Weill (2014) also draw the same conclusion with the data from Russia. Davydov, Fungáčová, and Weill (2018) find that bank liquidity creation is pro-cyclical and it could amplify business cycle fluctuations. Bank liquidity creation could also predict the trend of the economy. Chatterjee (2018) show that decreased on-balance sheet liquidity creation could predict recessions four quarters in the future, and large banks' liquidity creation provides more information about the future than small banks. Similarly, Berger and Sedunov (2017) claims that bank liquidity creation could predict future crises. Apart from its effect on

the economy, a group of literature examines the effect on financial institutions and the financial system. Duan and Niu (2020) examine the nexus between liquidity creation and bank profitability with the U.S. panel data. They find that liability-side and off-balance sheet liquidity creation will benefit bank profitability while asset-side liquidity creation impairs the profitability. Davydov, Vähämaa, and Yasar (2021) conclude that bank liquidity creation alleviates systemic risk in the U.S. individual bank-level data. However, the opposite opinion has been found by X. Zhang et al. (2021). Their conclusion shows that bank liquidity creation is detrimental to systemic risk in China. And they also claim that excessive liquidity creation has a "U-shaped" relationship with systemic risk due to the distinct effect of internal and external liquidity creation.

The above literature discusses the significant effects of bank liquidity creation. Some other literature investigates the effect of influencing factors such as size, capital, and competition on bank liquidity creation. Yeddou and Pourroy (2020) show that a concentrated ownership bank tends to create more liquidity than dispersed banks. Diaz, Gonzalez, and Jafarinejad (2022) find that bank liquidity creation and institutional ownership are positively and significantly related. Jiang, Levine, and C. Lin (2019) shows that regulated-induced competition reduces bank liquidity creation, especially to less risk-absorb capacity banks. This conclusion has also been found by (Ali et al., 2022; Horvath, Seidler, and Weill, 2016; Toh, Gan, and Z. Li, 2020). Bank capital has two contrasting effects on bank liquidity creation. On the one side, some studies hold the "financial fragility-crowding out" hypothesis, which means high-capitalized banks create less liquidity because higher capital may crowd out deposits or it may reduce banks' monitoring ability. Other studies claim the " risk absorption " hypothesis. This opinion shows that banks with higher capital could create more liquidity, given they could absorb more risk Berger and C. H. Bouwman (2009). Bank size also shows a significant effect on bank liquidity creation. It is found that bank size has a positive relationship with asset-side liquidity creation while a negative relationship with liability-side liquidity creation Niu (2023). Apart from

bank characteristics, some studies show the interplay between bank liquidity creation and various regulations and policies. Díaz and Y. Huang (2017) find that large well-governed bank-holding companies create more bank liquidity. However, the regulatory intervention [1] from the authorities may reduce liquidity creation (Berger, C. H. Bouwman, et al., 2016). Berger, Guedhami, et al. (2017) demonstrate that economic policy uncertainty causes a large decrease in asset and off-balance sheet-side liquidity creation while a slight increase in liability-side liquidity creation. Berger and Sedunov (2017) examines the effect of monetary policy on bank liquidity creation. Their results show that monetary policy has a significant but slight effect on liquidity creation, and this slight effect holds even during the financial crisis period. Dang et al. (2021) further expands Beger and Bouwman's work to emerging markets by using the data from Vietnam. Their results conclude that smaller banks with high liquidity positions will contribute to liquidity creation under the expansionary monetary policy. Meanwhile, Pham, Le, and L. Q. T. Nguyen (2021) also points out that the effect of monetary policy is more pronounced for small banks while negligible for large banks. However, under the low-interest environment, the effect of monetary policy is diminishing. Thus, it is crucial to find another effective policy tool. Government spending is regarded as a counterproductive tool theoretically, but now a growing number of empirical evidence shows its positive effect on releasing the credit market (Auerbach, Gorodnichenko, and D. Murphy, 2019; Auerbach, Gorodnichenko, and D. Murphy, 2020; Demyanyk, Loutskina, and D. Murphy, 2019; Miranda-Pinto et al., 2023; Yan et al., 2021). Among all the above literature, to our best knowledge, there is no current research focusing on the effect of fiscal policy, especially the effect of government spending on liquidity creation. Some literature shows the effect of government spending shock on the credit market. These studies support our research to some extent, so we organize the relevant papers in the following section.

Hypothesis: Government spending could affect bank liquidity creation.

[1] Regulatory interventions: restrictions and prohibitions of deposit taking, restrictions and prohibitions of lending activities, restructuring of business activities, etc

3.2.3 Government spending and credit market

Auerbach, Gorodnichenko, and D. Murphy (2019) use the U.S. data to examine the effect of fiscal stimulus on local credit markets. They conclude that an expansionary government spending shock leads to lower interest rates and finally increases consumer loans. Meanwhile, D. Murphy and Walsh (2022) also find government spending shock would increase loan supply (bond demand) and decrease long-term interest rates. Demyanyk, Loutskina, and D. Murphy (2019) highlight that government spending would increase consumption of households with high debt-to-income ratios. They also find that government spending will not crowd out the private sector which in turn promotes higher government-spending multipliers. Similarly, Hebous and Zimmermann (2021) point out that unanticipated federal spending shocks increase capital investment, especially for those financially constrained firms. The above cases are based on the U.S. financial market. Other literature focus on the global financial market. Miranda-Pinto et al. (2023) conclude the effects of government spending on credit markets across OECD countries. Their results show that interest rates respond negatively to government spending shocks in half countries, and this effect is more pronounced in higher inequality countries. The same result has also been found in Italy (Cipollini and Frangiamore, 2023). Yan et al. (2021) find increasing government spending would reduce bank credit through bank liquidity channels while raising bank credit through external financing premium channels and collateral channels.

Hypothesis: Based on the previous finding, we assume that government spending would have a positive shock on bank liquidity creation.

3.2.4 Political inferences and bank activities

Both bank activities and government spending could be enormously affected by the political environment, so we organize a strand of relevant research as follows.

Political election cycle

Political uncertainty refers to the instability of political life, and it includes elections, wars, governmental processes, etc (Cioffi-Revilla, 1998). A growing number of influential studies have paid attention to political risk. Their findings show that political uncertainty becomes a major concern of financial institutions (Janbaz et al., 2022; Saffar, Y. Wang, and K. Wei, 2019). Central banks such as ECB and FED also indicate that geopolitical uncertainties and major US political events are key concerns for banks.

Political cycle lending is a significant influencing factor. It contains two sub-indicators. The first is the presidential election dates. According to the presidential election theory, the U.S. stock market is affected by a turnover in the presidential election. Micco, Panizza, and Yanez (2007) shows that bank lending increases during the election years, which is mainly due to the loan supply by state-owned banks. Kwabi et al. (2023) use the panel data of 42 countries over 19 years to examine the effect of political uncertainty on the variation in liquidity, stock market size, and transaction cost. Their results show that political uncertainty decreases liquidity, and stock market size, and raises the cost of transactions. Jahn and Stricker (2022) concludes that reinvested earnings fall during the election quarter only in high-income countries while in lower-middle and low-income countries, equity investment drops due to electoral uncertainty. Cox and Griffith (2018) shows the Brexit referendum and the 2016 U.S. presidential election will decrease the market liquidity. Similar negative effects have also been found as political uncertainty raises costs on loan contract (Francis, Hasan, and Y. Zhu, 2014), national elections intensify the stock market volatility (Białkowski, Gottschalk, and Wisniewski, 2008), and firm-level uncertainty will induce higher cost bank loans (Saffar, Y. Wang, and K. Wei, 2019).

We set the second half of the presidential term as a dummy variable. During this period, bank liquidity creation may increase, given the sitting president would like to stimulate the economy to get re-elected.

Hypothesis: Bank liquidity creation may decrease during the presidential election dates and in the second half term, bank liquidity creation may increase due to the re-election pressure.

Partisan effect

Apart from the presidential election cycle, we are going to test the partisan effect. The first indicator is the "presidential puzzle", which claims that stock return is higher under a Democratic president. Pástor and Veronesi (2020) observes a higher stock return and economic growth under a Democratic president. Also, Santa-Clara and Valkanov (2003) show that the stock market gains better return under the Democratic than Republican. Belo, Gala, and J. Li (2013) show that firms affected more by government spending have more cash flows and stock returns during the Democratic presidencies. However, other researchers find that monthly stock return does not depend on which party wins the recent election (Jones and Banning, 2009). To figure out the mixed effect, we set a dummy variable, which equals 1 when the sitting president is Democratic, to examine the relationship. The second explores whether state political parties grant more credit when it aligns with the president's party, which is the "co-partisan effect". By setting this dummy variable, we intend to explore whether the politician at the higher tier of government would benefit the lower-tier politician who is in the same party. Pickard (2021) investigates the characteristics of the politician, and the result shows investment in a state is more potent if the political color is the same as the president. Koetter and Popov (2021) study the German bank lending to the government over the political cycles. Their results show that state-level party turnover raises home-state government lending while crowding out private lending. Gropper, Jahera Jr, and J. C. Park (2013) show that a powerful political connection has a positive relationship with bank stock return. Their conclusion indicates that bank committee chairs would benefit those banks headquartered in their home state. By using the data from 47 countries, Faccio (2010) find that strong politically connected

firms will gain more market share and higher leverage. The same conclusion could also be found by (Civilize, Wongchoti, and M. Young, 2015; Faraji et al., 2020; W. Wu, C. Wu, and Rui, 2012). The political data comes from OPENICPSR.[2]

Geopolitical risk

Furthermore, we also introduce geopolitical risk. Corporate investment has been negatively influenced by geopolitical risk. Alam, Houston, and Farjana (2023) show that Geopolitical risk (GPR) has a negative relationship with corporate investments while this negative effect could be mitigated by political connection. Rumokoy, Omura, and Roca (2023) investigate this relationship by using the data from metals and mining companies in Australia. Their results indicate that US's geopolitical risk decreases investment while China's GPR has no significant effect. Alsagr (2020) find that geopolitical risk could impede the bank sector's profitability. T. C. Nguyen and Thuy (2023) show that geopolitical risk increases the cost of bank loans. Especially, geopolitical acts have a much stronger effect than geopolitical threats. Y. Zhang et al. (2023) find that geopolitical risk increases stock market volatility.

Economic policy uncertainty

Economics policy uncertainty (EPU) is also a significant influencing factor. Berger, Guedhami, et al. (2022) shows that economic policy uncertainty increases bank liquidity hoarding and this effect is more obvious with fewer liquidity banks, more peer-banks spillover effects,. Ashraf and Shen (2019) show that economic policy uncertainty could increase the average interest rates on bank gross loans. S. Hu and Gong (2019) show that there is a negative effect between EPU and loan growth, especially for those large and riskier banks. Additionally, by using the data from 24 countries, C.-W. Wang, C.-C. Lee, and

[2]Kaplan, Jacob. United States Governors 1775-2020. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2021-01-16. https://doi.org/10.3886/E102000V3

M.-C. Chen (2022) examine the effect of EPU and government governance on bank liquidity creation. Their conclusion shows that EPU decreases asset-side liquidity creation while increasing liability-side liquidity creation.

Hypothesis: Bank liquidity creation might be sensitive to political uncertainty.

3.2.5 Political inferences and government spending

From the previous section, we conclude that political interventions could affect bank activities. However, the previous findings barely show the influencing channel. We also find some researches show the effect of political inferences on government spending.

Brender and Drazen (2013) show the strong linkage between election and government spending composition. By using the data from Brazil, Brollo and Nannicini (2012) find that mayors who are in the same political party as the president could receive around one-third larger discretionary transfer. Baskaran and Hessami (2017) also show that being affiliated with the state government could gain more transfer for the local government in German. Additionally, Bilgin, Gozgor, and Karabulut (2020) show that geopolitical risk has a positive relationship with government investment. R. Li and N. Wei (2022) indicates that economic policy uncertainty (EPU) has a negative relationship with government spending multipliers.

The above two sections show the effect of political interventions on bank activities and government spending. In this chapter, we are going to examine the role of government spending on how political intervention affects bank liquidity creation.

Hypothesis: Political intervention and government spending could jointly affect bank liquidity creation.

3.3 Data and Methodology

In this section, we examine the nexus between bank liquidity creation and government spending by using two-stage least square, and we also cluster the state-fixed effects.

$$\text{BLC}_{it} = \beta_0 + \beta_1 \text{GS}_{it}{}^{3} + \beta_2 \text{SIZE}_{it} + \beta_3 \text{BCI}_{it} + \beta_4 \text{POP}_{lt} + \beta_5 \text{INCOME}_{lt} + \epsilon_{i,t} \tag{3.1}$$

In the above equation, BLC is bank liquidity creation, which is denoted as $Log(BLC_{it}) - Log(BLC_{it-4})$, GS is government spending, which is shown $\frac{G_{lt}-G_{lt-4}}{Y_{lt-4}}$, Y means local income, which is $\frac{Y_{lt}-Y_{l,t-4}}{Y_{l,t-4}}$, SIZE means bank size, which is calculated by log of gross total assets. BCI is bank competition index, POP represents the city-level population. Italian indices i and l denote banks and cities, and time t ranges from 2001q1 to 2016q4.

Compared to monetary policy, fiscal policy may take more time to react. Thus, to capture the dynamic relationship between government spending and bank liquidity creation, these variables are in growth rate with a 4-quarter lag, and this could also remove seasonality. The data of bank liquidity creation are from Berger and C. H. Bouwman (2009)[4]. The authors, unlike the previous theories only focused on asset side or liability side liquidity creation, they construct indicators by mixing changes on both sides and off-balance sheet. Based on this, the bank liquidity creation here is divided into five categories: aggregate/catfat (on-and-off balance sheet), catnonfat (on-balance sheet), LC-A (asset side liquidity creation), LC-L (liability side liquidity creation), OBS (off-balance sheet liquidity creation).

For government spending (GS), we use the military spending database as the proxy following Auerbach, Gorodnichenko, and D. Murphy (2020). There are several advantages to adopting this database. Firstly, according to statistics, military spending is the third-largest government spending (18%), which is secondary to Security (25%) and Medicare

[3]We use military spending data to represent government spending.

[4]Data Source: http://web.mit.edu/cbouwman/www/data.html

(24%)[5]. Unlike Security and Medicare, its effect is barely been investigated. Secondly, military spending is less affected by the local economic condition compared to other government spending, which could relieve the endogeneity problem (Auerbach, Gorodnichenko, and D. Murphy, 2019).

Besides, we also control for bank characteristics and the local demographic variables. A series of literature has shown that small banks significantly affect the on-balance sheet activities while large banks focus more on off-balance sheet activities. Thus, we add bank size to control the heterogeneity. Meanwhile, following Berger and C. H. Bouwman (2009), local market bank competition is a significant influencing factor. To construct the index, we use the deposits' proportion of each city as the weight, then calculate the weighted average across the city.

We also use city-level population and income growth rate to take into consideration the local demographic effect (Auerbach, Gorodnichenko, and D. Murphy, 2020). A large population means a vast and stable source of bank funding so that more population may benefit bank liquidity creation. Similarly, the income growth rate may also have a positive relationship with bank liquidity creation.

3.3.1 Summary Statistics

This table 3.1 reports summary statistics of the main variables of our analysis, which includes systemic risk, five indicators of liquidity creation and other control variables. We take log of five liquidity creation indicators. For liquidity creation, catfat (on and off-balance sheet liquidity creation) has the maximum value at 5.604. The on-balance sheet liquidity creation ranges from -5.587 to 7.598 while the off-balance sheet ranges from -7.939 to 8.589. Liability and asset side liquidity creation have the minimum value at -8.907,-4.957, and the maximum value at 6.330, 5.466 respectively. Government spending which represents by military spending ranges from -0.565 to 0.704. Most of the political

[5]The statistics data comes from Demyanyk, Loutskina, and D. Murphy (2019)

factors such as election are dummy variables. We also have four control variables. Bank size ranges from 10.128 to 21.495. Bank competition index has the minimum value 0.060 and maximum value 1. A higher value means the bank is more competitive.

Table 3.1: Summary Statistics

	Obs	Mean	Sd	Min	Max
Bank Liquidity Creation (Dependent variables)					
Catfat	51374	0.091	0.311	-5.204	5.604
Catnonfat	51182	0.096	0.346	-5.587	7.598
LC_A	48433	0.085	0.665	-7.939	8.589
LC_L	51496	0.096	0.293	-8.907	6.330
LC_OBS	51684	0.067	0.381	-4.957	5.466
Government Spending (Independent variables)					
Military Spending	53061	0.001	0.025	-0.565	0.704
Policy Interventions					
Election	58582	0.246	0.430	0.000	1.000
Post-election (3-4 yrs)	58712	0.257	0.437	0.000	1.000
Post-election (1-2 yrs)	58712	0.252	0.434	0.000	1.000
Presidential party	58712	0.458	0.498	0.000	1.000
Co-partisanship	58712	0.275	0.447	0.000	1.000
Foreign Intervention	58712	0.348	0.476	0.000	1.000
World Uncertainty Index (WUI)	58582	9.783	0.343	9.016	10.565
Economic Policy Uncertainty (EPU)	58582	4.502	0.392	3.771	5.259
Geopolitical Risk (GPR)	58582	4.633	0.325	3.999	5.863
Geopolitical Risk Actions (GPRA)	58582	4.710	0.433	3.848	6.366
Geopolitical Risk Threats (GPRT)	58582	4.549	0.273	4.117	5.709
Control variables					
Size	58582	12.679	1.271	10.128	21.495
Bank competition index (BCI)	58582	0.482	0.276	0.060	1.000
Population (POP)	58582	11.601	1.110	9.473	14.704
Income (INC)	54822	0.033	0.052	-0.427	2.217

3.4 Empirical Results

3.4.1 Preliminary result

The preliminary results (see table 3.2) show military spending has a positive and significant effect on aggregate bank liquidity creation, especially on on-balance sheet liquidity creation. One unit increase in military spending will cause around 8% and 12.6% increase in aggregate liquidity creation and on-balance sheet liquidity creation. This finding is in line with the existing literature that military spending could release the credit market by lowering interest rates and reducing individual risk premia (Auerbach, Gorodnichenko, and D. Murphy, 2020; D. Murphy and Walsh, 2020; D. P. Murphy, 2015). The effect holds positive on the asset side and liability side liquidity creation while negative on the off-balance sheet liquidity creation, but all the results are insignificant.

Bank size mostly shows a slight and weak negative effect on aggregate liquidity creation and off-balance sheet liquidity creation. One unit increase on bank size will reduce aggregate liquidity creation and off-balance sheet liquidity creation by 4.5% and 4.9% respectively. The local population also shows a weak negative effect on liability side liquidity creation. However, local income has a significant and positive effect on bank liquidity creation except for asset side liquidity creation. Income has greatest effect on off-balance sheet liquidity creation, where one unit increase in income will increase aggregate liquidity creation around 49%. Similar results could also be found in (Auerbach and Gorodnichenko, 2017; Miranda-Pinto et al., 2019; D. Murphy and Walsh, 2022), where the researchers find that government spending could reallocate income and transfer sources, which finally raises savings.

Although the results are consistent with the previous findings, the endogeneity problem of military spending might need to be considered. Many works of literature claim military spending may not be affected by economic factors, but political factors could have a significant effect (Demyanyk, Loutskina, and D. Murphy, 2019; Auerbach, Gorodnichenko, and

D. Murphy, 2019). Thus, we are going to test the potential effect of political influencing factors.

Table 3.2: The Effect of Military Spending on Bank Liquidity Creation (BLC)

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.0841*	0.126**	0.00826	0.0481	-0.0137
	(0.0450)	(0.0508)	(0.148)	(0.0499)	(0.0604)
Size	-0.0450*	-0.0269	0.00842	0.0109	-0.0494*
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
BCI	0.175	0.185	-0.0404	0.186	-0.265
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
POP	0.0499	0.0499	-0.0462*	0.0361	-0.0264
	(0.0389)	(0.0384)	(0.0209)	(0.0348)	(0.0431)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0598)	(0.0673)	(0.108)	(0.0574)	(0.0936)
_cons	0.111	-0.112	0.663	-0.391	1.217
	(0.576)	(0.546)	(0.469)	(0.445)	(0.732)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525
R^2	0.049	0.038	0.022	0.038	0.061

Note: GS means government spending (military spending), Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***, **, and * show 1%, 5%, 10% significance level.

3.4.2 Political Interventions

In this section, we are going to explore the effect of a series of political interventions such as presidential election cycles, and geopolitical risk together with government spending on bank liquidity creation. Thus, we add an interaction term in the regression model.

$$\begin{aligned} Log(BLC_{it}) - Log(BLC_{it-4}) &= \beta_1 GS_{it} * PU + \beta_2 SIZE_{it} \\ &= +\beta_3 BCI_{it} + \beta_4 POP_{l,t} + \beta_5 INCOME_{lt} + \epsilon_{i,t} \end{aligned} \tag{3.2}$$

PU means political uncertainty [6]. We list the specific indicators as follows:

We start with the political election cycle, which includes the election year and presidential term. Election year, our sample ranges from 2001-2016, and the year 2004, 2008, 2012, and 2016 are election years. We set the dummy equal to 1 when this year is an election year. Then, we are going to test the presidential term. We split the four-year presidential term into two parts: the first two years are 1-2 years post-election term, and the second half is 3-4 years post-election. Besides, we also test the partisan effect. During the sample period, the two presidents come from different parties: Democratic and Republican respectively. Thus, we set the dummy variable equal to 1 when the sitting president is Democratic to test whether government spending shock would create more bank liquidity during the Democratic presidential period. Also, we set the co-partisanship dummy, where equals 1 when the party of the state's governor is the same as the sitting president. Moreover, we focus on geopolitical risk. First, we set a dummy variable oversea intervention, which equals 1 when the U.S. has an oversea intervention. Second, we use the World Uncertainty index (WUI) following Ahir, Bloom, and Furceri (2022). The index measures the global economic and political related uncertainty and spikes in events such as the Gulf War, the Euro debt crisis and the Brexit vote. Third, we also use the geopolitical risk index (GPR) including geopolitical threats (GPRT) and geopolitical acts (GPRA). These indices measure geopolitical risks and spikes around the two world wars, at the beginning of the

[6] Data source: https://www.policyuncertainty.com/

Korean War, during the Cuban Missile Crisis, and after 9/11. Finally, we also test the effect of Economic policy uncertainty (EPU). We follow the EPU index constructed by Baker, Bloom, and Davis (2016), which combines many influencing factors into one index and is widely used in many literatures.

Presidential election cycle

Firstly, we start with the presidential election dates. It could be found that presidential election dates do not have a significant effect on bank liquidity creation except asset side liquidity creation (See table 3.3). One unit increase in government spending during the election year will reduce asset side liquidity creation by around 90%. This finding is in line with the previous finding that political uncertainty would restrict market liquidity such as lower corporate investment until the uncertainty has been solved (Julio and Yook, 2012). Alternatively, it is also consistent that the stock market performs poorly during the first half of the presidential term.

Then, we follow the presidential election cycle which indicates that the stock market is affected by the quadrennial presidential election cycle, especially the sitting president might boost the market in the second half of a presidential term to get re-elected. However, similar phenomena could not be found in bank liquidity creation. From table 3.4, we could find that government spending in the second half of the presidential term has a positive effect but insignificant on bank liquidity creation. Furthermore, we also examine the first half of a presidential term. From table 3.5, we found that government spending (1-2 years after the election) could increase around 10.4% on-balance sheet liquidity creation.

The previous findings conclude that the first half presidential term includes wars, recessions, and bear markets while prosperous times and bull markets in the latter half-term (J. A. Hirsch and Y. Hirsch, 2011). Most of the researchers focus on the stock market while our results indicate that bank liquidity creation does not meet the previous findings.

Table 3.3: The Effect of Military Spending affected by Election on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.0923*	0.113**	0.159	0.0496	-0.00930
	(0.0500)	(0.0472)	(0.153)	(0.0589)	(0.0589)
Election	-0.118***	-0.130***	-0.0991*	-0.223***	-0.0679**
	(0.0218)	(0.0260)	(0.0497)	(0.0135)	(0.0288)
GS*E	-0.0406	0.0662	-0.796***	-0.00758	-0.0217
	(0.113)	(0.112)	(0.219)	(0.0888)	(0.151)
Size	-0.0449*	-0.0270	0.00881	0.0109	-0.0494*
	(0.0224)	(0.0225)	(0.0243)	(0.0141)	(0.0258)
BCI	0.176	0.184	-0.0326	0.186	-0.265
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
POP	0.0500	0.0497	-0.0438**	0.0362	-0.0264
	(0.0390)	(0.0385)	(0.0215)	(0.0347)	(0.0431)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0599)	(0.0672)	(0.108)	(0.0574)	(0.0936)
_cons	0.110	-0.109	0.626	-0.391	1.216
	(0.577)	(0.549)	(0.466)	(0.444)	(0.732)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, Election is a dummy variable, which equals 1 in the election year otherwise 0. GS means government spending, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level.

Table 3.4: The effect of Post-election (3-4 yrs) government spending on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.0410	0.0868	0.0258	0.0449	-0.0195
	(0.0443)	(0.0623)	(0.173)	(0.0495)	(0.0812)
Post E	-0.177***	-0.0576*	-0.237***	-0.0868***	-0.0493*
	(0.0208)	(0.0276)	(0.0438)	(0.0173)	(0.0201)
Post E*GS	0.170	0.156	-0.0724	0.0127	0.0229
	(0.123)	(0.134)	(0.328)	(0.0720)	(0.175)
Size	-0.0449	-0.0269	0.00840	0.0109	-0.0494
	(0.0224)	(0.0225)	(0.0244)	(0.0141)	(0.0258)
BCI	0.175	0.185	-0.0403	0.186	-0.265
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
POP	0.0495	0.0495	-0.0460*	0.0361	-0.0265
	(0.0393)	(0.0387)	(0.0213)	(0.0348)	(0.0429)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0598)	(0.0672)	(0.108)	(0.0574)	(0.0936)
_cons	0.116	-0.107	0.660	-0.390	1.218
	(0.578)	(0.548)	(0.468)	(0.445)	(0.730)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, Post E show the post-election period: the second half term of the first presidential period, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level.

Table 3.5: The effect of Post-election (1-2 yrs) government spending on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.120*	0.180***	-0.0565	0.0718	-0.00266
	(0.0554)	(0.0498)	(0.148)	(0.0602)	(0.0827)
POST E	0.118***	0.130***	0.127**	0.197***	0.0647**
	(0.0218)	(0.0260)	(0.0373)	(0.0154)	(0.0255)
POST E*GS	-0.140	-0.206*	0.238	-0.0909	-0.0424
	(0.114)	(0.118)	(0.284)	(0.119)	(0.165)
Size	-0.0450*	-0.0270	0.00849	0.0108	-0.0494
	(0.0224)	(0.0225)	(0.0243)	(0.0141)	(0.0258)
BCI	0.176	0.185	-0.0411	0.186	-0.265
	(0.145)	(0.155)	(0.121)	(0.177)	(0.273)
POP	0.0502	0.0503	-0.0468**	0.0363	-0.0263
	(0.0390)	(0.0385)	(0.0206)	(0.0347)	(0.0430)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0598)	(0.0672)	(0.108)	(0.0574)	(0.0936)
_cons	-0.00944	-0.245	0.542	-0.589	1.151
	(0.584)	(0.551)	(0.477)	(0.444)	(0.743)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, Post E show the post-election period: the first half term of the first presidential period, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level.

Partisan Effect

We use two indicators to examine the partisan effect on bank liquidity creation. Table 3.6 shows the amount of liquidity creation under the different partisans. During our sample period, there are two presidents: George W. Bush who is a Republican, and Barack Obama who is a Democratic. The presidential puzzle indicates that the excess return is higher under the Democratic compared to under the Republican (Santa-Clara and Valkanov, 2003; Wong and McAleer, 2009; Pástor and Veronesi, 2020; Belo, Gala, and J. Li, 2013). To test this puzzle, we set the dummy variable equal to 1 when the sitting president is a Democratic. Although table 3.6 show that government spending under the Democratic president has negative effect on bank liquidity creation, the results are insignificant. The final results imply that, unlike the stock return, the presidential party has no effect on how government spending shock affects bank liquidity creation.

The second indicator is political alignment or co-partisanship which means the party of the state's governor is the same as the sitting president. We aim at testing whether politicians would favor co-partisans through government reallocation and finally affect bank liquidity creation. From table 3.7, we could find that co-partisanship has positive but insignificant results on bank liquidity creation, which means our results do not support the assumption that politicians will favor co-partisians through government reallocation.

Table 3.6: The Effect of Military Spending affected by Partisan on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.0662	0.0539	-0.371	0.143	0.0991
	(0.166)	(0.257)	(0.519)	(0.197)	(0.236)
PA	-0.131***	-0.132***	-0.244***	-0.0102	-0.119***
	(0.0226)	(0.0195)	(0.0370)	(0.0162)	(0.0201)
PA*GS	-0.125	-0.0471	0.472	-0.176	-0.561
	(0.179)	(0.272)	(0.402)	(0.195)	(0.225)
Size	0.0187	0.0258	0.0826*	0.00321	0.00512
	(0.0382)	(0.0249)	(0.0402)	(0.0395)	(0.0364)
BCI	-0.0478	-0.0506	-0.0331	0.0459	0.0210
	(0.0658)	(0.0455)	(0.0715)	(0.0392)	(0.0376)
POP	6.76e-08	2.49e-08	2.20e-09	4.28e-08	4.68e-08
	(4.18e-08)	(3.40e-08)	(7.72e-08)	(3.00e-08)	(4.90e-08)
INC	0.121	0.0944	-0.179	0.0469	0.289
	(0.0879)	(0.0927)	(0.206)	(0.0747)	(0.190)
_cons	-0.0944	-0.167	-0.922	0.0422	0.0397
	(0.526)	(0.344)	(0.554)	(0.555)	(0.505)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	5077	5068	4803	5083	5099

Note: BLC is bank liquidity creation, PA means the sitting president's partisan, CP means co-partisanship, Size is the log of total asset, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level.

Table 3.7: The Effect of Military Spending affected by Co-partisanship on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.0771	0.0942	0.0119	-0.00172	-0.0698
	(0.0595)	(0.0612)	(0.165)	(0.0609)	(0.0722)
CP	-0.00966	-0.00918	0.0174	-0.0104	-0.00298
	(0.0131)	(0.0125)	(0.0261)	(0.0111)	(0.0156)
CP*GS	0.0291	0.120	-0.0187	0.187	0.207
	(0.122)	(0.105)	(0.385)	(0.128)	(0.225)
Size	-0.0451*	-0.0271	0.00865	0.0107	-0.0495
	(0.0222)	(0.0222)	(0.0242)	(0.0140)	(0.0257)
POP	0.0499	0.0495	-0.0465*	0.0355	-0.0273
	(0.0388)	(0.0384)	(0.0210)	(0.0347)	(0.0429)
INC	0.247***	0.240**	0.140	0.338***	0.490***
	(0.0605)	(0.0685)	(0.110)	(0.0576)	(0.0929)
BCI	0.174	0.182	-0.0396	0.183	-0.268
	(0.144)	(0.155)	(0.120)	(0.178)	(0.273)
_cons	0.119	-0.0987	0.652	-0.373	1.232
	(0.573)	(0.547)	(0.453)	(0.447)	(0.732)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, CP means co-partisanship, Size is the log of total asset, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

Geopolitical risk

Geopolitical risks may also influence military spending and bank liquidity creation. Many economic models show that geopolitical risk could damage macroeconomic outcomes through loss of human life, destruction of capital stock, higher military spending, and increased precautionary behavior (Caldara and Iacoviello, 2022). Thus, to examine the relationship, we use the specific geopolitical risk data constructed by Caldara and Iacoviello (2022). The geopolitical risk data has eight categories: War Threats (Category 1), Peace Threats (Category 2), Military Buildups (Category 3), Nuclear Threats (Category 4), Terror Threats (Category 5), Beginning of War (Category 6), Escalation of War (Category 7), Terror Acts (Category 8). The author regards the former five as geopolitical threats (GPRT), and the latter three as Geopolitical Acts (GPRA). Thus, we test the effect of combined geopolitical risk data first. Then, we examine the separated data. The results show that these three indicators do not have any effect on bank liquidity creation (see table 3.10 table 3.11 table 3.12).

Besides, we use World Uncertainty Index. This indicator is computed by the percentage of word "uncertainty". This indicator spikes around risks such as the 9/11 attacks, the SARS outbreak, Gulf War II, and the Euro debt crisis. From table 3.9, we could find that one unit increase in military spending under the uncertainty will increase aggregate bank liquidity creation by 26.36% and on-balance sheet liquidity creation by 31.11%. Furthermore, we construct the dummy variable oversea U.S. intervention which equals 1 when there is oversea intervention, otherwise equals 0. Table 3.8 also shows that U.S. oversea intervention has a significant and positive effect on aggregate liquidity creation and on-balance sheet liquidity creation. One unit increase on military spending will increase aggregate liquidity creation and on-balance sheet liquidity creation by 17.3% and 15.4% respectively. Our results indicate that oversea military intervention could affect bank liquidity creation through military spending.

Table 3.8: The Effect of Military Spending affected by U.S Foreign Intervention on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	-0.00591	0.0392	-0.105	0.00329	-0.0360
	(0.0514)	(0.0744)	(0.186)	(0.0419)	(0.0731)
FI	-0.112***	-0.122***	-0.123*	-0.197***	-0.0696**
	(0.0220)	(0.0260)	(0.0538)	(0.0154)	(0.0263)
FI*GS	0.285**	0.276*	0.369	0.142	0.0709
	(0.131)	(0.151)	(0.261)	(0.101)	(0.123)
BCI	0.178	0.187	-0.0378	0.187	-0.264
	(0.145)	(0.155)	(0.121)	(0.177)	(0.273)
Size	-0.0448*	-0.0268	0.00857	0.0109	-0.0494*
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
POP	0.0500	0.0501	-0.0462**	0.0362	-0.0264
	(0.0390)	(0.0385)	(0.0206)	(0.0348)	(0.0432)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0597)	(0.0670)	(0.108)	(0.0574)	(0.0936)
_cons	0.107	-0.116	0.660	-0.393	1.216
	(0.576)	(0.546)	(0.465)	(0.445)	(0.733)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: FI is a dummy variable: If the U.S. has foreign intervention this year, it equals to 1; otherwise, it is 0. BLC is bank liquidity creation, GS means government spending, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

Table 3.9: The Effect of Military Spending affected by World Uncertainty Index on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	-1.799	-1.989*	-2.262	-0.310	-3.032
	(1.039)	(1.171)	(4.749)	(1.102)	(2.263)
WUI	0.0706***	0.0941***	0.0543	0.214***	0.0276
	(0.0172)	(0.0192)	(0.0383)	(0.0207)	(0.0199)
GS*WUI	0.193*	0.217*	0.232	0.0367	0.309
	(0.106)	(0.119)	(0.481)	(0.114)	(0.230)
POP	0.0501	0.0501	-0.0460*	0.0362	-0.0261
	(0.0390)	(0.0385)	(0.0212)	(0.0348)	(0.0430)
BCI	0.176	0.186	-0.0396	0.186	-0.264
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
Size	-0.0450**	-0.0270	0.00841	0.0109	-0.0494*
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0598)	(0.0672)	(0.108)	(0.0574)	(0.0935)
_cons	-0.598	-1.058	0.115	-2.533***	0.936
	(0.594)	(0.543)	(0.614)	(0.506)	(0.764)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, WUI is world uncertainty index, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

Table 3.10: The Effect of Military Spending affected by Geopolitical Risk on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	-0.522	0.815	2.452	-0.146	-1.885
	(0.998)	(1.409)	(3.185)	(0.902)	(1.403)
GPR	0.170***	0.169***	0.234***	0.289***	0.0720
	(0.0271)	(0.0318)	(0.0524)	(0.0190)	(0.0450)
GS*GPR	0.133	-0.151	-0.535	0.0424	0.409
	(0.218)	(0.306)	(0.707)	(0.197)	(0.308)
POP	0.0499	0.0499	-0.0461*	0.0361	-0.0264
	(0.0389)	(0.0385)	(0.0212)	(0.0347)	(0.0432)
BCI	0.176	0.185	-0.0411	0.186	-0.264
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
Size	-0.0450	-0.0270	0.00836	0.0109	-0.0494
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0598)	(0.0672)	(0.108)	(0.0574)	(0.0936)
_cons	-0.747	-0.965	-0.518	-1.849***	0.852
	(0.610)	(0.553)	(0.590)	(0.466)	(0.796)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, WUI is world uncertainty index, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

Table 3.11: The Effect of Military Spending affected by Geopolitical Risk on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	-0.183	0.663	3.024	0.0155	-1.232
	(0.711)	(1.010)	(2.568)	(0.659)	(1.039)
GPRA	0.102***	0.101***	0.141***	0.174***	0.0433
	(0.0163)	(0.0191)	(0.0314)	(0.0114)	(0.0271)
GS*GPRA	0.0577	-0.116	-0.652	0.00705	0.263
	(0.153)	(0.215)	(0.561)	(0.143)	(0.225)
POP	0.0499	0.0500	-0.0459*	0.0361	-0.0265
	(0.0389)	(0.0384)	(0.0214)	(0.0347)	(0.0431)
INC	0.249***	0.242***	0.136	0.340***	0.491***
	(0.0598)	(0.0672)	(0.108)	(0.0574)	(0.0936)
BCI	0.175	0.185	-0.0406	0.186	-0.265
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
Size	-0.0450	-0.0270	0.00834	0.0109	-0.0494
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
_cons	-0.444	-0.665	-0.105	-1.335**	0.982
	(0.594)	(0.545)	(0.537)	(0.456)	(0.766)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, WUI is world uncertainty index, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

Table 3.12: The Effect of Military Spending affected by Geopolitical Risk on BLC

	L4catfat	L4catnonfat	L4LC_A	L4LC_L	L4LC_OBS
GS	-0.713	0.439	0.122	-0.380	-1.619
	(0.979)	(1.382)	(2.533)	(1.045)	(1.363)
GPRT	-0.0589**	-0.0517*	-0.0422	-0.0794***	-0.0463*
	(0.0174)	(0.0250)	(0.0388)	(0.0157)	(0.0190)
GS*GPRT	0.177	-0.0696	-0.0252	0.0950	0.357
	(0.217)	(0.306)	(0.575)	(0.230)	(0.304)
POP	0.0499	0.0499	-0.0462*	0.0362	-0.0264
	(0.0389)	(0.0385)	(0.0210)	(0.0348)	(0.0432)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0599)	(0.0673)	(0.108)	(0.0574)	(0.0936)
BCI	0.176	0.185	-0.0405	0.186	-0.264
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
Size	-0.0450	-0.0269	0.00842	0.0109	-0.0494
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
_cons	0.383	0.127	0.857	-0.0250	1.429
	(0.584)	(0.569)	(0.485)	(0.455)	(0.739)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, WUI is world uncertainty index, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

Economic policy uncertainty

Finally, apart from the geopolitical risks, the Bank of England claims that geopolitical risk, economic and policy uncertainty are regarded as the "uncertainty trinity" (*Mark Carney: Uncertainty, the economy and policy* 2016). Also, many papers point out the significant and economic effect of economic policy uncertainty. For example, Berger, Guedhami, et al. (2022) show that economic policy uncertainty increases bank liquidity hoarding which includes asset, liability, and off-balance sheet activities. Kang, K. Lee, and Ratti (2014) show that economic policy uncertainty together with firm-level uncertainty reduces firms' investments. Based on the previous finding, our test is going to examine how bank liquidity creation is in response to economic policy uncertainty in interaction with government spending shock.

Table 3.13 shows that unlike firm investments or stock market return, bank liquidity creation does not affect by the joint impact of military spending and economic policy uncertainty.

Based on the above results, we have examined how political interventions and military spending jointly affect bank liquidity creation. The result shows that world uncertainty has a significant effect on bank liquidity creation through military spending. Thus, we use the Bartik instrument to filter out the effect of military spending on liquidity creation.

Table 3.13: The Effect of Military Spending affected by EPU on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.422	0.209	-1.273	0.481	0.153
	(0.515)	(0.526)	(1.735)	(0.372)	(0.942)
EPU	0.124***	0.143***	0.207*	0.289***	0.136***
	(0.0192)	(0.0252)	(0.0900)	(0.0181)	(0.0374)
GS*EPU	-0.0753	-0.0186	0.285	-0.0963	-0.0371
	(0.117)	(0.121)	(0.381)	(0.0874)	(0.205)
POP	0.0499	0.0499	-0.0464*	0.0362	-0.0264
	(0.0389)	(0.0384)	(0.0210)	(0.0347)	(0.0431)
BCI	0.175	0.185	-0.0404	0.186	-0.265
	(0.145)	(0.155)	(0.122)	(0.177)	(0.273)
INC	0.249***	0.242***	0.136	0.340***	0.490***
	(0.0598)	(0.0673)	(0.108)	(0.0574)	(0.0936)
Size	-0.0450	-0.0269	0.00841	0.0109	-0.0494
	(0.0224)	(0.0224)	(0.0244)	(0.0141)	(0.0258)
_cons	-0.469	-0.778	-0.301	-1.741***	0.583
	(0.594)	(0.548)	(0.747)	(0.459)	(0.772)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, EPU is economic uncertainty index, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

3.5 Bartik Instrument

Due to the concern about the endogeneity problem, we use an instrument to solve the regression bias follows Auerbach, Gorodnichenko, and D. Murphy (2019). Bartik instrument aims to instrument variables related to policy issues. We construct the instrument as follows:

$$\frac{S_l * (G_{t+h} - G_{t-1})}{Y_{l,t-1}} \tag{3.3}$$

In the above equation, G_t is aggregate military spending, S_l is the average share of aggregate military spending over a relevant time period, $Y_{l,t-1}$ is income in city l.
Firstly, military spending may cause both wealth transfer and new production to the local economy, but the Bartik instrument could separate the mixed effects.

$$\Delta G_{l,t} = G_{l,t} - G_{l,t-1} = \Delta G^W_{l,t} + \Delta G^P_{l,t} \tag{3.4}$$

$\Delta G^W_{l,t}$ "wealth transfer", $\Delta G^P_{l,t}$ introduces new production. if these two effects are mixed, there would cause a downward bias of government spending shock. Bartik instrument could filter out the wealth transfer and show the effects only related to new production. Secondly, military spending variation is highly driven by geopolitical events. Although military spending has been recognized as less endogenous, it is still affected by political events. Thus, we use the Bartik instrument to address the endogeneity problem.
Table 3.14 shows the effect of government spending by using the Bartik instrument on bank liquidity creation. The effect of government spending has an upward spiral, consisting of the conjecture that there could be a downward bias if government spending for wealth transfer and new production is mixed. One unit increase in military spending could increase the on-balance sheet liquidity creation, especially the asset side liquidity creation around 90.2% and 179.5%, both at 10% significance level.

Table 3.14: The Effect of Military Spending (Bartik Instrument) on BLC

	Catfat	Catnonfat	LC_A	LC_L	LC_OBS
GS	0.694	0.902*	1.795*	-0.129	0.271
	(0.469)	(0.473)	(0.969)	(0.332)	(0.435)
Size	-0.0100**	-0.0086**	-0.0038	-0.0070*	-0.0055
	(0.00373)	(0.00368)	(0.00309)	(0.00291)	(0.00317)
BCI	0.0507***	0.0533***	0.0377**	0.0332**	0.0307*
	(0.0133)	(0.0145)	(0.0187)	(0.0115)	(0.0149)
POP	0.0222***	0.0236***	0.0230***	0.0175***	0.0119**
	(0.00456)	(0.00458)	(0.00552)	(0.00388)	(0.00432)
INC	0.389***	0.310***	0.413***	0.101 ***	0.858***
	(0.0621)	(0.0657)	(0.125)	(0.0598)	(0.126)
_cons	-0.0777	-0.105*	-0.168**	-0.0366	-0.0443
	(0.0443)	(0.0438)	(0.0720)	(0.0367)	(0.0437)
Bank fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	51214	51022	48300	51336	51525

Note: BLC is bank liquidity creation, GS means government spending, Size is the log of total assets, BCI means bank competition index, POP means local population, and INC means local income. Standard errors in parentheses, ***,**, and * show 1%, 5%,10% significance level. N is observations.

3.6 Conclusion

This chapter examines the effect of military spending shock on bank liquidity creation. We focus on the U.S. economy and use a panel data set over the period 2001q1 to 2016q4. We use military spending which is a subset of aggregate government spending data, and unlike security and medicare data, the effect of military spending is rarely being explored. Additionally, we also examine how political interventions affect bank liquidity creation through military spending. Finally, to deal with the endogenous problem of military spending, we adopt the Bartik instrument to identify the military spending shock.

The finding shows that military spending could boost bank liquidity creation, especially the on-balance sheet liquidity creation. This result exists when military spending is affected by World Uncertainty, and the effect is greater when we use the Bartik instrument to remove the bias. Our results are consistent with the previous findings that the shock of government spending could release the credit market (Auerbach, Gorodnichenko, and D. Murphy, 2020; Demyanyk, Loutskina, and D. Murphy, 2019). Our findings contribute to the current literature by introducing a new mechanism that fiscal policy could release the credit market through the positive effect of military spending on bank liquidity creation. Moreover, we also examine the partisan effect, presidential turnover, economic policy uncertainty, and geopolitical risk will not have any effect on bank liquidity creation through military spending.

Our results imply that except for monetary spending, expansionary fiscal policy (increase military spending) could also be a practical tool to boost the credit market through bank liquidity creation. The limitation is that we only use the U.S. data, to obtain a general view of the effect of military spending, data from more countries should be examined to enrich the conclusion. Additionally, we should explore more subsets of government spending data rather than only using military data. Moreover, we only concentrate on bank-level data, future work could also explore the regional or country-level data.

3.6.1 Appendix

Table 3.15: U.S. President during the year 2001-2016

President	Year	Election Years	Post-election (1-2years)	Post-election (3-4 years)	Partisan
George W. Bush	2001		YES		Republican
George W. Bush	2002		YES		Republican
George W. Bush	2003			YES	Republican
George W. Bush	2004	YES		YES	Republican
George W. Bush	2005		YES		Republican
George W. Bush	2006		YES		Republican
George W. Bush	2007				Republican
George W. Bush	2008	YES			Republican
Bush/Obama	2009		YES		Republican\Democratic
Barack Obama	2010		YES		Democratic
Barack Obama	2011			YES	Democratic
Barack Obama	2012	YES		YES	Democratic
Barack Obama	2013		YES		Democratic
Barack Obama	2014		YES		Democratic
Barack Obama	2015				Democratic
Barack Obama	2016	YES			Democratic

Chapter 4

Bank liquidity creation and systemic risk

4.1 Introduction

The Covid-19 pandemic outbreak has sparked the worst liquidity crisis since the Global Financial Crisis (OECD, 2020). To address the liquidity shortage in the public, a range of policies should be implemented. Liquidity creation, one of the prominent roles of banks, could make banks inject liquidity into the financial system to maintain a sound economic environment (Berger and C. H. Bouwman, 2009; X. Zhang et al., 2021; Davydov, Vähämaa, and Yasar, 2021).

Bank liquidity creation is an essential bank service. Liquidity comes from two perspectives: on-balance sheet liquidity creation shows that banks transfer illiquid assets into liquid liabilities, and off-balance-sheet liquidity creation mainly comes from loan commitments (Berger and C. H. Bouwman, 2009). Prior literature has extensively studied the determinants of bank liquidity creation. For instance, bank size is shown as a significant influencing factor (M. L. Laeven, M. L. Ratnovski, and M. H. Tong, 2014; Pais and Stork, 2013; Varotto and Zhao, 2018). Their results highlight that large banks could generate more idiosyncratic and systemic risk than small ones. The effect of bank capital on bank liquidity creation is inconclusive. It has two opposite hypotheses: the "financial fragility-crowding out" hypothesis shows that high-level capital may decrease liquidity creation because of the "crowds out" effect on bank deposits. However, another "risk absorption" hypothesis indicates that high capital could enhance the ability of liquidity creation. Jiang, Levine, and C. Lin (2019) find that regulatory-induced competition reduces liquidity creation.

There are other researches show the effect of bank liquidity creation. They conclude that bank liquidity creation could promote economic growth, predict the financial crisis and it could improve bank performance such as profitability (Berger and Sedunov, 2017; T. C. Silva, M. A. d. Silva, and Tabak, 2017; Duan and Niu, 2020). Additionally, bank liquidity creation is positively related to economic output and the business cycle (Berger and Sedunov, 2017; Fidrmuc, Fungáčová, and Weill, 2015; Davydov, Fungáčová, and Weill,

2018). Although bank liquidity creation could inject liquidity for the public and release the public from a liquidity crunch, it may also plant seeds of a crisis. [1] For instance, high liquidity creation could cause asset price bubbles and finally result in financial instability (V. Acharya and Naqvi, 2012; Reinhart and Rogoff, 2009). Also, researchers highlight that excessive liquidity creation makes banks lack sufficient liquid assets to meet the liquidity requirements of their clients, which leads to bank run (X. Zhang et al., 2021; Davydov, Vähämaa, and Yasar, 2021). What is worse, these potential individual risks may have ripple effects and increase systemic risk (Berger and C. Bouwman, 2015).

A few of the findings provide the basic framework for our research. Fungáčová, Turk-Ariss, and Weill (2013) show that excessive liquidity creation greatly enhanced the likelihood of bank failure during the time period 2002-2007 by using the Russia data. X. Zhang et al. (2021), Davydov, Vähämaa, and Yasar (2021) examine the relationship between bank liquidity creation and systemic risk by using the data from China and the U.S. Their results conclude, that bank liquidity creation worsens the systemic risk in China while it reduces the systemic risk in the U.S. To figure out this ambiguous relationship, in this chapter, we contribute to the current literature by using a new systemic risk measurement to examine the nexus between bank liquidity creation and systemic risk with the U.S. data. Moreover, based on the previous finding, we find that systemic risk increases as the bank size grows. This is probably because large banks are more likely to be involved in risky activities and their funding source is mainly short-term debt[2] Also, the too-big-to-fail subsidies and deposit insurance make large BHCs engaged in moral hazard problems compared to small banks. Thus, We only collect quarterly data from 32 large U.S. bank holding companies (BHCs). These 32 systemic important BHCs occupy most of the U.S. banking assets and their failure will induce instability to the whole financial system. We use the bank liquidity creation data constructed by (Berger and C. H. Bouwman, 2009), which includes

[1] This is also known as volatility paradox, which means a stable environment breeds systemic risk (Berger and C. H. Bouwman, 2009; Brunnermeier and Sannikov, 2014)

[2] This is known as unstable banking hypothesis

five different indicators: aggregate liquidity creation, on-balance sheet liquidity creation, asset side liquidity creation, liability side liquidity creation, off-balance sheet liquidity creation. We start the regression test with the aggregate level bank liquidity creation. The previous evidence shows that large banks are more likely to associate with off-balance sheet liquidity creation, and approximately half of the liquidity creation is created on the off-balance sheet in the U.S. (Berger and C. Bouwman, 2015). Thus, we examine this relationship with disaggregated level liquidity creation. We first use off-balance sheet liquidity creation, and then split the on-balance-sheet liquidity creation into asset side and liability side liquidity creation. Our results show that, except for liability side liquidity creation, other bank liquidity creation indicators would deepen the systemic risk. However, liability side liquidity creation could stabilize the financial system.

The systemic risk goes beyond individual bank runs. It strengthens the risk raised by the connections or interdependencies in the financial system, where the failure of an individual entity could spread to the entire financial system (Berger and C. Bouwman, 2015). Meanwhile, since the 2008 great financial crisis, financial networks have been found to play a significant role in propagating individual risk in systemic risk (J. W. Lee and Nobi, 2018; X. Zhang et al., 2021; Jackson and Pernoud, 2021). One strand of previous findings shows networks could help the financial system diversify the risk. They claim that too connected to fail, which means a highly interconnected multi-hub-based system could prohibit risk transmission (Markose, Giansante, and Shaghaghi, 2012). The researchers also show that the density of bank connections under a certain point could mitigate systemic risk, while beyond this point, it might worsen risk (Acemoglu, Ozdaglar, and Tahbaz-Salehi, 2015). However, another viewpoint highlights bank network impairs financial stability. X. Zhang et al. (2021) show that bank networks could damage systemic stability, and they could also deepen the damage brought by bank liquidity creation. Battiston, Caldarelli, et al. (2016) also points out that complicated financial networks increase the probability of systemic risk. Then, we contribute to the literature by figuring out the risk transmission

channel between the bank's idiosyncratic risk and systemic risk. We are going to test how bank network affects the relationship between bank liquidity creation and systemic risk in the U.S. We capture stock return data of 32 large U.S. bank holding companies (BHCs) to construct the network among banks by using principle component analysis (PCA) proposed by Billio, Getmansky, Gray, et al. (2013). Our empirical results show that bank network has a certain reduction in the threat brought by bank liquidity creation, but in total, bank liquidity creation still has a positive and significant relationship with systemic risk.

Furthermore, X. Zhang et al. (2021) points out that low-level bank liquidity creation may benefit the financial system while excessive liquidity creation may create instability. In their findings, using data from China's banks, they conclude there is a "U" shaped relationship between liquidity creation and systemic risk. Thus, we also examine the non-linear relationship between bank liquidity creation and systemic risk. Our results clearly show the "U" shaped relationship does not hold among the 32 large U.S. bank holding companies. Meanwhile, prior researches also claim that network and systemic risk might have a non-monotonic effect (Elliott, Golub, and Jackson, 2014). Therefore, we explore the nonlinear relationship between network and systemic risk using the same method as we examine the "U" shaped relationship before. The result illustrates the nonlinear relationship between network and systemic risk does not exist.

The remainder of the paper is organized as follows. Section 2 shows the literature review. Section 3 introduces data and methodology. Section 4 presents the main results. Section 5 shows the extension of the results. Section 6 is the conclusion.

4.2 Literature Review

4.2.1 Bank liquidity creation

Bank liquidity creation is one of the main roles of banks (Berger and C. H. Bouwman, 2009). It transfers liquidity to the whole economy especially during the crisis period. Many literatures have explored the determinants and the effects of liquidity creation. Bank capital is a significant influencing factor to bank liquidity creation. A part of the literature examines the relationship between bank liquidity creation and bank capital. Using the US quarterly data from 1993 to 2003, Berger and C. H. Bouwman (2009) conclude that there is a trade-off between bank capital and liquidity creation, which means more capital reduces a bank's ability to create liquidity. Their findings also point out that the negative relationship only exists among small banks. Similar findings have also been found by Distinguin, Roulet, and Tarazi (2013), Fu, Y. Lin, and Molyneux (2016) using the data from European and Asia-Pacific countries. Apart from the bank capital, many researches examine the effect of bank governance on liquidity creation. Díaz and Y. Huang (2017) point out that large U.S. bank holding companies with well-governance would create more liquidity. The similar result has also been shown by S.-C. Huang, W.-D. Chen, and Y. Chen (2018), which claims that optimistic CEO may overestimate the benefits of bank liquidity creation and provide more risky loans to the market. Using the U.S. data, Bertrand, Klein, and Soula (2021) find a positive relationship between people's trust and liquidity creation. They demonstrate that people's high trust level in banks would stabilise bank deposits which could finally increase bank liquidity creation. Other researchers also find that asset market liquidity may foster bank liquidity creation while economic policy uncertainty would reduce liquidity creation (Chatterjee, 2015; Berger and Sedunov, 2017). Regulatory-induced competition could reduce the liquidity creation (Jiang, Levine, and C. Lin, 2019). Berger, C. H. Bouwman, et al. (2016) use the German data to show that regulatory intervention reduces liquidity creation while capital support statistically

insignificantly affects bank liquidity creation. A strand of the literature elaborates on the vital role of liquidity creation. Berger and Sedunov (2017) finds bank liquidity creation shows a significant and positive effect on GDP growth. Hsieh and C.-C. Lee (2020) use the data from Asia, and they draw the same conclusion that bank liquidity creation could significantly increase real economic output. Jiang, Levine, and C. Lin (2019), additionally, show bank liquidity creation could improve banks' performance such as profitability. Using the data from the Middle East and North Africa (MENA) region, Mdaghri (2021) claims that bank liquidity creation reduces non-performing loans. Moreover, liquidity creation contributes to predicting of financial crises (Berger and Sedunov, 2017). Liquidity creation is procyclical, and the amount of liquidity creation fluctuations, especially on-balance sheet liquidity creation, could be a warning of future recessions (Chatterjee, 2018; Niu, 2022). In turn, it could also exacerbate the fluctuations in the business cycle (Niu, 2022). Apart from these profits, the process of liquidity creation (transferring non-risk deposits to support risky commercial loans) may bury the seed of crisis. More liquidity creation makes banks exposed to unknown risky losses. For example, Fidrmuc, Fungáčová, and Weill (2015) claim that higher liquidity creation may cause banks to lack liquidity, which is more likely to cause bank failure. V. V. Acharya and Thakor (2016) shows that excessive financial leverage will speed up contagion among banks in the crisis period. Excessive bank liquidity creation will cause the bank itself to lack liquidity, which would finally raise the fragility of the whole financial system. X. Zhang et al. (2021) shows that bank liquidity creation will increases the systemic risk by using the data from China while Davydov, Vähämaa, and Yasar (2021) indicates an opposite relationship by using the U.S. data. The effect is inconclusive given the different data samples. Here, we choose only systemic important banks (SIBs) in the U.S., by using their liquidity creation, we examine the effect of liquidity creation on systemic risk.

Hypothesis 1: Based on the above discussion, the first hypothesis is that bank liquidity creation increases the systemic risk, and there is a "U" shaped relationship between bank

liquidity creation and systemic risk.

4.2.2 Bank network and systemic risk

Systemic risk refers to linkage or interdependencies among the financial institutions, where individual failure may have a domino effect and propagate to the whole financial system. The connectivity among financial institutions has attracted much attention, given the imperative role of financial architecture in creating systemic risk. A growing number of researches have focused on this field, proposing two contrasting opinions. One view shows how the connections between financial institutions could diversify the risk, which means that financial networks could contribute to safer systems. Proponents of this view highlight the reduction effect from two perspectives: firstly, some views demonstrate that the network structure determines the propagation among financial institutions. Markose, Giansante, and Shaghaghi (2012) examine how topology fragility affects systemic risk by using US CDS data. Their conclusion shows that a small clustered network could limit the risk transmission among the institutions, and compared to unstructured random graphs, highly interconnected multi-hub-based systems are more stable during the financial crisis. Allen, Babus, and Carletti (2010) also show that an individual's behaviour differs between clustered network groups and unclustered ones. Financial institutions with clustered networks are more likely to default jointly, while the unclustered networks are more likely to default individually. Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015) demonstrate that a more diversified structure would disperse risk, given the potential threat could be distributed to more institutions. As a result, each institution could suffer from less risk, preventing greater losses. Secondly, other studies suggest that the financial resources and the magnitude of negative shocks could be the reason to reduce systemic risk. Nier et al. (2007) explore the nexus between systemic risk and network based on the level of capital. Their conclusion shows that a system with less capitalisation would aggregate the risk contagion while a more capitalised system would reduce the propagation. Acemoglu,

Ozdaglar, and Tahbaz-Salehi (2015) show weak bank connections ensure the creditors with more senior status bear most of the losses, preventing cascading defaults throughout the system. Additionally, the small shock could also be absorbed by the network, which would not damage financial system stability. Allen, Babus, and Carletti (2010) declare that long-term financed financial institutions are less likely to trigger systemic risk than those with show-term finance, given there is no rollover risk associated with long-term finance.

Another side of researches find that network damages the financial system's stability. Elliott, Golub, and Jackson (2014) find two conditions necessary for propagation in the financial system. They argue that each institution should hold significant assets whose failure would cause an unstable financial system. Additionally, there should be a network among financial institutions, ensuring the propagation within the financial system. T. C. Silva, M. A. d. Silva, and Tabak (2017) examine the role of networks on bank lending and systemic risk by using the Brazil data bank level loan data. They claim that the network plays a significant role in propagation among the financial system, and high-level networks would amplify risk. With the similar Brazil data set, T. C. Silva, Guerra, et al. (2016) show more details of the network effect on bank efficiency and systemic risk. They point out that core-periphery network reduce bank efficiency and this type of network would increase systemic risk. S. H. Lee (2013) investigates the relationship between systemic liquidity shortage and interbank network structures, and their findings show that inter-bank structure mismatch will aggregate the vulnerability of the financial system. Fan and Pan (2020) uses heterogeneous data such as text data from different sources to detect the relationship. And they have the similar conclusion that excessive connections increase the systemic risk. Cifuentes, Ferrucci, and Shin (2005) claims that systemic stability may have a non-linear relationship with bank networks. Thus, over a certain point, dense bank networks could dampen financial system resilience. Battiston, Gatti, et al. (2012) also points out the similar view that there might be a U-shaped relationship between network

and stability. Risk diversification only exists with low-level connection while it disappears with more robust connectivity. X. Zhang et al. (2021)investigate the relationship between bank liquidity creation, network, and systemic risk using Chinese bank data. Their conclusion shows that the network damages the stability of individual banks, and even worse, it amplifies the risk raised by bank liquidity creation to the financial system.

Besides the effect of bank networks on systemic risk, much attention has been paid to the role of bank networks. Some researchers imply a mechanism linking individual risk to systemic risk, which is that networks appear to contribute to the transmission of individual financial institution risk. Many findings show that the network might amplify the effect raised by other bank activities, which is the connection between banks might be the channel to propagate the effect of bank liquidity creation. Glasserman and H. P. Young (2015) finds that a financial institution with a greater connection would raise a deeper cascade among the financial institutions. And the effect is worse by introducing bankruptcy costs and mark-to-market reductions in credit quality. X. Zhang et al. (2021) uses the data from china's bank, and their results show that bank interconnectedness will enhance the positive effect of bank liquidity creation on systemic risk. Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015) claims that excessive liquidity creation aggregates the systemic risk over the connection among banks.

Based on the previous findings, it reminds the problem that whether the intense connection among the large banks reduces or increases the systemic risk. Moreover, we assume that interconnection among financial institutions could be the potential channel for risk proliferation. Therefore, we propose the following hypothesis:

Hypothesis 2: The intensification of the bank network affects systemic risk, and their relationship is non-linear.

Hypothesis 3: The effect of liquidity creation on systemic risk is diversified or intensified by the bank connection.

4.3 Data and Methodology

In this section, we will introduce the construction of the main variables and econometric methodology to test our key hypothesis.

4.3.1 Bank-level systemic risk

The dependent variable measures the systemic risk raised by the failure of individual bank holding companies. The idiosyncratic risk may eventually develop into systemic risk since a crisis at one particular bank would spread panic throughout the whole financial system. Based on this, we measure the systemic risk by applying the technique developed by Adrian and Brunnermeier (2016). They claim that the traditional measurement VaR assess a bank's risk in isolation while their method CoVaR captures bank's contribution to the systemic risk.

The value at risk (VaR) measures the expected loss at a given confidence level over a certain time interval. VaR_q^i is defined as the percentage R^i of asset value that bank i may lose with $q\%$ probability over time horizon:

$$P(R^i \leq VaR_q^i) = q \tag{4.1}$$

Conditional-value-at-risk (CoVaR) refers to VaR of financial institution j conditional on crisis of financial institution i over time period t, which is the q quantile of conditional probability distribution:

$$Pr(X_{j,t}|C(X_{i,t}) \leq CoVaR_{j|C(X_{i,t},t,q)}) = q \tag{4.2}$$

Adrian and Brunnermeier (2016) use linear quantile regression to estimate the VaR and set the distress level at 5%, Then $\text{VaR}_{q,t}$ can be calculated from the predicted value from

the below regression:

$$X_{i,t} = \alpha_i + \gamma_i M_{t-1} + \epsilon_{i,t} \tag{4.3}$$

$$\hat{VaR}^{i}_{q,t} = \hat{\alpha}^{i}_{q} + \hat{\gamma}^{system|i}_{q} M_{t-1} \tag{4.4}$$

We apply the VaR into the following equation to calculate CoVaR:

$$X^{system|i}_{t} = \alpha^{system|i}_{q} + \gamma^{system|i}_{q} M_{t-1} + \beta^{system|i}_{q} X^{i}_{t} + \epsilon^{system|i}_{q,t} \tag{4.5}$$

$$\hat{CoVaR}^{i}_{q,t} = \hat{\alpha}^{system|i}_{q} + \hat{\gamma}^{system|i}_{q} M_{t-1} + \hat{\beta}^{system|i}_{q} VaR^{i}_{q,t} \tag{4.6}$$

ΔCoVaR$^{s|i}$ is the difference of the value-at-risk of the system's return conditional on the distress level (5%) and median state (50%) of bank i.

$$\begin{aligned} \Delta CoVaR &= CoVaR_q - CoVaR_{50\%} \\ &= \hat{\beta}^{system|i}_{q} (VaR^{i}_{q,t} - VaR^{i}_{50,t}) \end{aligned} \tag{4.7}$$

ΔCoVaR measure financial system performance based on the left tail of the distribution of bank return, and it is more likely to capture contagion risk (M. L. Laeven, M. L. Ratnovski, and M. H. Tong, 2014). To calculate ΔCoVaR, we use daily equity return with the quantile regression. M is the macro state controls which are: the change in the three-month yield, i.e. change in the three-month Treasury bill rate; the change in the slope of the yield curve as measured by the spread between the composite long-term bond yield and the three-month bill rate; a short term "TED spread", i.e. difference between the three month LIBOR rate and three-month secondary market treasury bill rate; the change in the credit, i.e. spread between Moody's Baa-rated bonds and the ten year Treasury rate; the weekly market return; the weekly real estate sector return; equity volatility which is calculated as the 22-day rolling standard deviation of the daily equity market return. We followed Adrian and Brunnermeier (2016) to choose these control

variables, and data sources include FRED, S&P capital and Yahoo Finance.

4.3.2 Bank liquidity creation

We collect the bank liquidity creation from the Berger and C. H. Bouwman (2009) database. We choose the category-based liquidity creation data, which only classify loans based on category. The authors use a three-step procedure to calculate bank liquidity creation: in the first step, all banks activities have been categorised into illiquid, semi-liquid, and liquid based on the speed at which the banks meet the liquidity demand of clients. In the second step, those three categories are assigned different weights: positive (+1/2) to liquidity liabilities and illiquid assets, negative (-1/2) to illiquid liabilities and equity capital and liquid assets, and zero (0) to semi-liquid assets. In the third step, they construct four measures of liquidity based on the previous classification. The calculation formula is shown as follows:

$$\text{Aggregate\_lc} = \underbrace{\text{asset side\_lc} + \text{liability side\_lc}}_{\text{on-balance sheet lc}} + \text{off-balance sheet lc} \tag{4.8a}$$

where

$$\text{Asset side\_lc} = 0.5 \times \text{illiquid assets} + 0 \times \text{semi-liquid assets} - 0.5 \times \text{liquid assets} \tag{4.8b}$$

$$\text{Liability side\_lc} = 0.5 \times \text{liquid liability} + 0 \times \text{semi-liquid liability} - 0.5 \times \text{illiquid liability} \tag{4.8c}$$

$$\text{Off-balance sheet lc} = 0.5 \times \text{Illiquid off\_balance} + 0 \times \text{semi-liquid off\_balance} - 0.5 \times \text{liquid off\_balance} \tag{4.8d}$$

Compared to the previous literature, this database show more details about liquidity creation. They construct five different liquidity creation indicators, which are catfat (aggregate liquidity creation), lc_a (asset side liquidity creation), lc_l (liability side liquidity creation), catnonfat (on-balance sheet liquidity creation) and lc_obs (off-balance sheet liquidity creation). "Cat" means classify the bank activities based on category rather

than maturity. "Fat" means off-balance sheet activities and "nonfat" means without off-balance sheet activities. Some researchers normalised the liquidity creation data by the bank's gross total assets to make different sizes of banks comparable. However, since we all use large BHCs here, we use the original data without normalization.

Figure 4.1 shows the amount of liquidity creation generated from large bank holding companies, which includes the five indicators that we described above. The liquidity creation data is published by Berger and C. H. Bouwman (2009)[3]. The time period used ranges from 2002:Q1-2016:Q4. Over the 60 quarters, the amount of four liquidity creation (catfat, catnonfat, lc_l, lc_obs) has increased continuously during the past 60 quarters, with the exception of a decline around 2008. This is probably because the banks choose to hold more capital in response to the global financial crisis. Apart from those four liquidity creation, asset side liquidity creation has a slight decrease over 2008-2014 before increasing later. Since the large bank liquidity creation keeps increasing, so it is significant to figure out the effect of the liquidity creation.

[3]Data source: https://sites.google.com/a/tamu.edu/bouwman/data

4.3.3 Bank network connectedness

Exploring bank interconnectedness could prevent contagion between banks (Cifuentes, Ferrucci, and Shin, 2005; S. Li, 2011; Billio, Getmansky, Gray, et al., 2013)because banks do not only operate independently but also have peer dependence (Allen and Carletti, 2015). As a consequence, it is imperative to explore the linkages between banks.

We use principle component analysis proposed by (Billio, Getmansky, Lo, et al., 2012) with the stock return from 32 large BHCs to measure the interconnectedness among the banks. PCA yields the decomposition of variance-covariance matrix of the standardisation returns of N banks into the orthonormal matrix and diagonal matrix of eigenvalues. We define the stock return of individual bank i as R^i, and system's aggregate return as $R^S = \sum_i R^i$. Let $E[R^i] = \mu_i$ and $\text{Var}[R^i] = \sigma_i^2$. Then, the variance of the system could be defined as:

$$\sigma_s^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_i \sigma_j E(r_i r_j) \tag{4.9}$$

We define the covariance matrix as $M = cov(r_i, r_j)$. We decompose M to get the eigenvalues series $\lambda_1, ..., \lambda_N$ and eigenvector matrix $L = (L)_{ij}$. Then, we will get:

$$E(r_i r_j) = \sum_{k=1}^{N} L_{ik} L_{jk} \lambda_k \tag{4.10}$$

$$\sigma_s^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} \sum_{k=1}^{N} L_{ik} L_{jk} \lambda_k \sigma_i \sigma_j \tag{4.11}$$

When using PCA, we normally take results of the first few eigenvalues which explains more to system variation. This subset shows the majority of returns that tend to be moved together, which often links to the crisis period Billio, Getmansky, Lo, et al. (2012). We use the n eigenvalues in this subset to calculate each banks' connectedness with other banks in the system.

$$PCAS_{i,n} = \frac{1}{2}\frac{\sigma_i^2}{\sigma_s^2}\frac{\partial \sigma_s^2}{\partial \sigma_i^2}|_{h_n > H} = \sum_k^n \frac{\sigma_i^2}{\sigma_s^2} L_{ik}^2 \lambda_k |_{h_n > H} \tag{4.12}$$

$PCAS_{i,n}$ means the variance contribution of individual bank i to the entire systemic risk, and it could also be regarded as the risk of a individual bank i when it exposes to the whole financial system risk. $h_n = \frac{\sum_{k=1}^{n} \lambda_k}{\sum_{k=1}^{N} \lambda_k}$. H equals to 0.33, which is the threshold value following Billio, Getmansky, Lo, et al. (2012). The high PCAS value illustrate a close connection of bank i to the system. Thus, we would expect network connection is positive in the calculation, given banks could contribute more risk to the system when they are close to the system.

4.3.4 Bank characteristics and Covariates

Bank-specific characteristics such as bank size, profitability, deposits to assets, non-interest income, non-performing loans, and capital ratio also have significant effect on systemic risk. (Anginer, Demirguc-Kunt, and M. Zhu, 2014; L. Laeven, L. Ratnovski, and H. Tong, 2016; Davydov, Vähämaa, and Yasar, 2021; X. Zhang et al., 2021). Size is measured as log of total assets, capital ratio is the ratio of equity capital to total assets, profitability is calculated as the ratio of net income to total assets, deposits to assets is calculated as total deposits divided by total assets, which is used as a control for funding structure, non-interest income is calculated as the ratio of non-interest income to interest income, which is used as a proxy for income structure and business model, non-performing loans defined as the ratio of non-performing loans to total loans, which controls for the quality and riskiness of banks' loan portfolios.

The conventional view shows that large banks introduce more risk to the financial system, given the fragility brought by its high association with lower capital, less-stable funding, more complicated organization system, and more market-based activities (M. L. Laeven, M. L. Ratnovski, and M. H. Tong, 2014). This hypothesis has also been supported by other studies: for example, Pais and Stork (2013) uses EU data and concludes that large banks have significantly contributed to systemic risk while it has a limited effect on individual banks' risk(measured by VaR). Varotto and Zhao (2018) also highlight that firm size plays a significant role in systemic risk by using the data from EU and US. A strand of literature supports the "risk absorption" hypothesis of bank capital, which indicates that higher bank capital enhances banks' capacity to handle risk by both absorbing risk and expanding their capacity to bear risk Berger and C. H. Bouwman (2009). Similar opinions have also been found by (Anginer and Asli Demirgüç-Kunt, 2014; Anginer, Asli Demirgüç-Kunt, and Mare, 2018). More specifically, they point out that this effect is more pronounced in large banks rather than in small banks. However, Berger and C. H. Bouwman (2009) also claim that holding capital creates a cost to banks, which may trigger

instability. Brunnermeier, Dong, and Palia (2020) finds that banks' non-interest income has a positive effect on systemic risk by using the US data. More specially, they claim that this positive effect significantly holds on bank tail risk, bank interconnectedness risk but it loses significance on bank exposure risk. This positive effect has also been found in other studies (Williams, 2016; X. Zhang et al., 2021; Köhler, 2014). The previous empirical evidence has shown that bank non-performing loans have positive effect on systemic risk (Davydov, Vähämaa, and Yasar, 2021; Halili, Fenech, and Contessi, 2021; Bottazzi, De Sanctis, and Vanni, 2020), and also deposit to asset ratio could dampen financial system when the crisis happens (L. Laeven, L. Ratnovski, and H. Tong, 2016). Bank profitability, measured by ROA, has been found negatively correlated with systemic risk, which indicates higher bank profits would introduces more instability to the financial system(Xu, K. Hu, and Das, 2019). The results has been found by Davydov, Vähämaa, and Yasar (2021),Xu, K. Hu, and Das (2019).

This table 4.7 shows the 32 large U.S. BHCs which occupy over 75% of all U.S. assets. We draw the list from Federal Reserve Statistical Release[4].

This table 4.1 reports summary statistics of the main variables of our analysis, which includes systemic risk, five indicators of liquidity creation and other control variables. We take log of five liquidity creation indicators. For liquidity creation, catfat (on and off-balance sheet liquidity creation) has the minimum value at 8.696 and the maximum value at 20.707. The on-balance sheet liquidity creation ranges from 6.789 to 19.965 while the off-balance sheet ranges from 8.550 to 20.704. Liability and asset side liquidity creation have the minimum value at 7.848,7.609, and the maximum value at 20.098, 19.965 respectively. Network ranges from 0 to 1.125, and the higher value demonstrates a closer connection of individual banks to the whole financial system. Systemic risk ranges from -5.272% to 7.533%.

Table 4.2 refers to the correlations between the variables. As the table shows, liquidity

[4]The list of large commercial banks source: https://www.federalreserve.gov/releases/lbr/current/

creation indicators and network are negatively correlated with systemic risk. Deposit to asset ratio, bank profitability have positive relationship with systemic risk.

Table 4.1: Descriptive Statistics

	Obs	Mean	Std.Dev	Min	Max	Sum
Dependent variable						
Systemic risk	1,856	1.048	1.862	-5.272	7.533	1,944.767
Key independent variables						
Catfat	1,569	16.489	2.339	8.969	20.707	25,872.022
Catnonfat	1,525	15.931	2.079	6.789	19.965	24,294.294
Lc_a	1,116	14.886	2.022	7.609	18.432	16,612.718
Lc_l	1,682	15.746	2.147	7.848	20.098	26,484.369
Lc_obs	1,685	15.316	2.725	8.550	20.704	25,808.083
Network	1,888	0.064	0.094	0.000	1.125	120.565
Control variables						
Capitalratio	1,515	0.161	0.331	0.003	2.369	244.199
Profitability	1,632	0.035	0.187	-0.323	3.364	57.864
DtoA	1,685	0.740	0.081	0.248	0.944	1,247.274
NI	1,745	0.582	0.613	-2.238	4.766	1,015.338
Size	1,685	17.446	2.169	10.362	21.495	29,396.521
NPLF	1,816	1.388	1.644	0.011	16.315	2,521.505

Note: The table reports descriptive statistics for 32 bank holding companies over the period 2002q1-2016q4. Systemic risk is ΔCoVaR from Adrian and Brunnermeier (2016). Profitability is return to asset (ROA), size is log of total asset, DtoA is deposit to asset ratio. NI is non-interest income, NPLF is non-performing loans.

Table 4.2: Correlation Matrix

	Systemic risk	Catfat	Catnonfat	Lc_a	Lc_l	Lc_obs	Network	Capitalratio	Profitability	DtoA	NI	Size	NPLF
Systemic risk	1.000												
Catfat	-0.286***	1.000											
Catnonfat	-0.206***	0.970***	1.000										
Lc_a	-0.106***	0.919***	0.932***	1.000									
Lc_l	-0.308***	0.968***	0.952***	0.875***	1.000								
Lc_obs	-0.349***	0.984***	0.938***	0.885***	0.952***	1.000							
Network	-0.087***	0.007	0.001	-0.011	0.018	0.020	1.000						
Capitalratio_new	0.042	-0.206***	-0.189***	-0.182***	-0.257***	-0.233***	-0.036	1.000					
Profitability	0.064*	-0.137***	-0.125***	-0.116***	-0.163***	-0.150***	-0.018	0.345***	1.000				
DtoA	0.143***	-0.180***	-0.046	0.080**	-0.106***	-0.228***	0.034	0.137***	-0.052*	1.000			
NI	-0.229***	0.358***	0.407***	0.291***	0.252***	0.287***	0.067**	0.034	0.033	0.043	1.000		
Size	-0.336***	0.979***	0.943***	0.885***	0.974***	0.978***	0.020	-0.253***	-0.164***	-0.185***	0.329***	1.000	
NPLF	-0.294***	0.027	0.022	-0.057	0.024	0.018	0.237***	0.005	-0.071**	0.022	-0.043	0.025	1.000

Note: The table shows bi-variate correlations between the variables in the regression.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.3.5 Methodology

To investigate the impact of bank liquidity creation on systemic risk, we use the feasible generalized least squares method(i.e. FGLS) following X. Zhang et al., 2021. In our analysis, we examine the relationship between systemic risk and bank liquidity creation using aggregate level bank liquidity creation constructed by Berger and C. H. Bouwman (2009) firstly. Then, we rerun the regression with disaggregate level liquidity creation. We use the following regression specification in our key analyses:

$$Risk_{it} = \beta LC_{it-1} + \theta M_{it-1} + \alpha_i + t + \epsilon_{it} \tag{4.13}$$

Where Risk_{it} is the systemic risk of the bank i's failure at time t. LC represents five liquidity creation indicators: catfat, catnonfat, liability side liquidity creation, asset side liquidity creation, and off-balance sheet liquidity creation. M captures bank characteristics such as deposit to asset ratio, bank size, capital ratio, non-interest income, non-performing loans and bank profit as control variables. α_i is bank-specific fixed effect, t is time trend. Based on the previous evidence, bank liquidity creation could reduce the systemic risk while beyond a certain level, excessive liquidity creation may cause bank failure or asset bubble burst, and finally leads to systemic risk. Therefore, there might be a nonlinear relationship between liquidity creation and systemic risk. Moreover, X. Zhang et al. (2021) concludes that there is a "U" shape relationship between liquidity creation and systemic risk. Thus, using their method, we could also examine whether bank creates liquidity at an appropriate level:

$$Risk_{it} = \beta_1 \text{LC}_{it-1} + \beta_2 \text{LC}_{it-1} \times \text{LC}_{it-1} + \theta M_{it-1} + \alpha_i + t + \epsilon_{it} \tag{4.14}$$

This panel data set contains 32 large bank holding companies (N) and with the time period from 2002:Q1-2016:Q4 (T). To solve auto-correlation and heteroscedasticity, we

use the feasible generalized least squares method (i.e. FGLS) following (X. Zhang et al., 2021). We also control bank fixed effect and time trend.

4.4 Main results

4.4.1 The effect of bank liquidity creation

Table 4.3 shows the nexus between liquidity creation and systemic risk ($\Delta CoVaR^{s|i}\%$). Model (1) shows aggregate level liquidity creation has a significant and positive relationship with systemic risk, which clearly indicates that a one percent increase in bank liquidity creation would cause systemic risk raises around 0.013 units. Then, we use the disaggregate levels of liquidity creation such as on-balance sheet liquidity creation and off-balance sheet liquidity creation to check our results. Off-balance-sheet liquidity creation has a significant and positive effect on systemic risk, with a slight magnitude of 0.006 units. However, although on-balance sheet liquidity creation also has a positive effect on systemic risk, it does not statistically significant. To investigate the detailed effect of on-balance sheet liquidity creation, we apply the data from Berger and C. H. Bouwman (2009) by splitting the on-balance sheet into asset side and liability side liquidity creation. With the same methodology, we conclude that asset-side liquidity creation increases systemic risk at 5% significance level while a 1% increase in liability-side liquidity creation reduces 0.005 units on systemic risk, given 10% significance level.

Bank liability side liquidity creation refers to transfer bank activities such as deposits and equity into commercial loans. Since those businesses could quickly transfer into loans, they could inject liquidity into the whole financial system immediately when the liquidity crisis occurs. Although it may cause a bank run, its quick and high level of capital injection into the system may release the risk at a certain point. Similar results have also been found in (Davydov, Vähämaa, and Yasar, 2021). Their finding shows that banks with higher liquidity creation generate less systemic risk. Additionally, off-balance sheet liquidity creation includes the transformation of bank business such as interest derivatives and unused commitments, etc. Its positive and significant effect on systemic risk is consistent with the previous finding (X. Zhang et al., 2021). The off-balance sheet bank

activities contain higher risk and this transformation may finally introduce more risk to the financial system.

Bank capital ratio has a positive effect on systemic risk, approximately with the range from 0.00365 to 0.008 units, which indicates a higher capital level would increase systemic risk. Bank profitability, as well as the deposit-to-asset ratio,non-interest income, and non-performing loans, have a negative effect on systemic risk. Bank profitability is normally negatively correlated with problem loan ratio, which means higher bank profitability is associated with a lower problem loan ratio, which finally reduces the potential instability. Bank size in model (4) causes a positive effect on systemic risk, given large banks normally generate more liquidity. However, in model(1), bank size has a negative effect on systemic risk.

As we discussed before, there are two opposite opinions regarding the effect of liquidity creation on systemic risk, and our results above are consistent with the prior literature: except for liability side liquidity creation, other liquidity creation could deepen the systemic risk. However, the analysis does not consider the role of networks in these relationships. Given the imperative role of the network, it is essential to explore its effect on systemic risk in response to bank liquidity creation.

Table 4.3: Regression table of Liquidity Creation on Systemic risk

ΔCoVaR	(1)	(2)	(3)	(4)	(5)
Catfat	1.267***				
	(0.205)				
Catnonfat		0.103			
		(0.136)			
Lc_a			0.212**		
			(0.091)		
Lc_l				-0.518*	
				(0.239)	
Lc_obs					0.647**
					(0.233)
Capitalratio	0.366**	0.550	0.870	0.849*	0.681
	(0.133)	(0.458)	(0.458)	(0.383)	(0.406)
Profitability	-0.719*	-0.662	-0.430	-0.523	-0.703
	(0.400)	(0.419)	(0.418)	(0.397)	(0.406)
DtoA	-1.814 *	-2.654**	-2.326 *	-0.766	-1.463
	(0.935)	(1.198)	(1.329)	(1.110)	(1.124)
NI	-0.587***	-0.474**	-0.362	-0.494**	-0.441*
	(0.195)	(0.208)	(0.235)	(0.175)	(0.171)
Size	-1.221***	0.020	0.171	0.747	-0.498
	(0.267)	(0.265)	(0.269)	(0.284)**	(0.323)
NPLF	-0.279***	-0.292***	-0.239***	-0.336***	-0.288***
	(0.043)	(0.045)	(0.042)	(0.043)	(0.045)
Constant	3.178	1.503	-2.853	-2.334	1.483
	(2.837)	(4.176)	(4.496)	(3.590)	(3.836)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Observations	1323	1283	915	1370	1373

Note: Capital ratio is the ratio of equity is the ratio of equity capital to total assets. Profitability is return on assets. DtoA is the ratio of total deposits to total assets. NI is non-interest income divided by interest income. Non-performing loans is the ratio of non-performing loans to total loans. Standard errors are in parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

4.4.2 Nonlinear relationship of bank liquidity creation

Previous findings indicate that the effect of bank liquidity creation has a threshold. Within a certain liquidity creation level, it may have a positive effect on systemic risk while beyond this level, the effect may turn negative. To testify this relationship, in this section, we test the possibility of nonlinear relationship between bank liquidity creation and systemic risk following (X. Zhang et al., 2021). Their results suggested a "U" shaped relationship with systemic risk. They claim that under a certain level, bank liquidity creation could reduce systemic risk, given its vast profits prevent bank failure. However, beyond this level, liquidity creation may cause bank runs. Our results (columns 1-5) show this relationship does not exist in our sample. The potential reason might be that banks within the same BHCs could be regarded as an internal capital market (Jiang, Levine, and C. Lin, 2019). Thus, it could provide large liquidity, especially during the financial crisis period (Jiang, Levine, and C. Lin, 2019; Berger and C. H. Bouwman, 2009), which is closely associated with systemic risk.

Table 4.4: Nonlinear relationship of liquidity creation

ΔCoVaR	(1)	(2)	(3)	(4)	(5)
Catfat	1.059				
	(0.867)				
$Catfat^2$	0.007				
	(0.028)				
Catnonfat		0.816			
		(0.987)			
$Catnonfat^2$		-0.022			
		(0.031)			
Lc_a			0.152		
			(0.475)		
Lc_a^2			0.002		
			(0.017)		
Lc_l				-0.293	
				(0.912)	
Lc_l^2				-0.007	
				(0.027)	
Lc_obs					0.183
					(0.873)
Lc_obs^2					0.014
					(0.026)
Control variables	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes
Observations	1323	1283	915	1370	1373

Note: We show non-linear relationship of bank liquidity creation and network on systemic risk. The details of control variables are omitted here, but it could been found in the appendix table 4.8. Network is the connection among 32 large U.S. BHCs constructed by PCA. Catfat, catnonfat,lc_a, lc_l, lc_obs are five liquidity creation indicators. Standard errors are in the parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

4.5 The effect of network

Excessive liquidity creation will cause illiquidity concerns for individual banks. However, the linkage between idiosyncratic risk and systemic risk is still under-explored. Bank network plays a significant role in risk contagion, but their effect is ambiguous. Some research shows bank networks cause financial instability by amplifying the risk while others indicate that network diversifies risk. Compared to the previous research, our analysis focuses on the connection among large BHCs. Those systemic important banks are in a central position in the financial system, and the intensification of connections among large banks may stabilize the financial system. And this refers to the "too connected to fail" assumption. We use the following regression to examine the role of bank networks. First, we examine the effect of the network on systemic risk as follows:

$$Risk_{it} = \beta \text{network}_{it-1} + \theta M_{it-1} + \alpha_i + t + \epsilon_{it} \tag{4.15}$$

4.5.1 Nonlinear relationship of network

Similar to the effect of bank liquidity creation, the previous researches also indicate the possibility of "U-shaped" relationship between bank network and systemic risk. If the connection among financial institutions is beyond a certain point, it would damage systemic risk. Thus, we also examine whether there is a non-monotonic relationship between network and systemic risk as follows:

$$Risk_{it} = \beta_1 \text{network}_{it-1} + \beta_2 \text{network}_{it-1} \times \text{network}_{it-1} + \theta M_{it-1} + \alpha_i + t + \epsilon_{it} \tag{4.16}$$

The following table 4.5 shows that the network has a negative but insignificant relationship with systemic risk, which illustrates that the connection between large bank holding companies does not affect the whole financial system stability.

As we could find from column (2), the result shows that the non-monotonic relationship

does not hold. From the results, we could see that the magnitude of the network is small, which also indicates the connection among banks is weak. Thus, we may conclude that bank connections are not dense and under the critical point, so it does not significantly affect systemic risk.

4.5.2 The transmission role of network

Additionally, as the previous evidence indicates that bank networks could be the transmission channel of risk contagion. In this section, we explore the contagion of the risk associated with bank liquidity creation by adding an interaction term as follows:

$$Risk_{it} = \beta_1 \mathrm{LC}_{it-1} + \beta_2 network_{it-1} + \beta_3 \mathrm{LC}_{it-1} \times network_{it-1} + \theta M_{it-1} + \alpha_i + t + \epsilon_{it} \quad (4.17)$$

As we could see from table 4.6, in the first column, we find that bank network and on and off-balance sheet liquidity creation have a positive and significant effect on systemic risk, with 5% and 1% significance levels, respectively. However, the interaction term, bank liquidity creation with network, has a negative and significant relationship with systemic risk, which indicates network diversifies the potential risk raised by liquidity creation. In total, the whole financial systemic risk would increase by 0.0567 units when on and off-balance sheet liquidity creation increases by one unit. This result is consistent with the previous finding from the last section. Additionally, bank capital ratio increases systemic risk while profitability, non-interest income, bank size, deposit-to-asset ratio and bank non-performing loans cause a negative effect on systemic risk. These effects also barely change compared to the previous finding.

Next, we move to column two, and it could be found that bank network has a positive but slight significant effect on systemic risk. Although on-balance sheet liquidity creation has a positive effect, it lost its significance. The interaction term still decreases the systemic risk when banks provide on-balance sheet liquidity creation. The control variable, except bank size loses its significance, and other variables still hold their effects.

Then, the third column shows how asset side liquidity creation affects systemic risk. Both network and asset-side liquidity creation show a positive effect while the interaction term shows a negative effect. From this result, it is concluded that banks provide one more unit of asset side liquidity creation could lead to 0.0675 unit increase in systemic risk.

Capital ratio, deposit-to-asset ratio and non-performing loans still have a significant effect on systemic risk while others controls lose their significance.

After that, column four shows the results of liability side bank liquidity creation. Bank network holds a positive and significant effect. However, liability side liquidity creation reduces systemic risk, and more specifically, it shows a unit increases in liability creation reduces systemic risk by 0.0052 units. In this regression results, the interaction term still highlights the risk diversification function of the network on liquidity creation. Bank profitability and deposit-to-asset ratio lose their significance. Bank size has a positive effect here, and other controls do not have any significant change.

Finally, the last column shows the effect of off-balance sheet liquidity creation. Off-balance sheet liquidity creation and the network would dampen the stability of the financial system. One unit increase on these two variables would cause 3.797 and 0.00648 unit increase in systemic risk, with 5% and 1% significance level,respectively. The interaction term shows the negative effect on systemic risk at 5% level. Other controls hold similar results as before except bank capital ratio, bank size and deposit to asset ratio lose their significance.

Table 4.5: Regression table of Bank Network on Systemic Risk

ΔCoVaR	(1)	(2)
Network	-0.286	-0.355
	(0.317)	(0.526)
Network^2		0.149
		(0.879)
Capitalratio	0.634	0.636
	(0.394)	(0.393)
Profitability	-0.555	-0.557
	(0.400)	(0.400)
NI	-0.462**	-0.463**
	(0.172)	(0.172)
Size	0.173	0.172
	(0.211)	(0.211)
DtoA	-1.700	-1.700
	(1.115)	(1.114)
NPLF	-0.319 ***	-0.319 ***
	(0.044)	(0.044)
Constant	0.071	0.081
	(3.740)	(3.735)
Bank fixed effects	Yes	Yes
Time trend	Yes	Yes
N	1373	1373

Note: Network is the connection among 32 large U.S. BHCs constructed by PCA. Capital ratio is the ratio of equity is the ratio of equity capital to total assets. Profitability is return on assets. DtoA is the ratio of total deposits to total assets. NI is non-interest income divided by interest income. Non-performing loans is the ratio of non-performing loans to total loans. Standard errors are in the parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table 4.6: Regression table of Interaction term on Systemic risk

ΔCoVaR	(1)	(2)	(3)	(4)	(5)
Catfat	1.273***				
	(0.205)				
Network × Catfat	-0.294**				
	(0.135)				
Catnonfat		0.129			
		(0.135)			
Network × Catnonfat		-0.285*			
		(0.156)			
Lc_a			0.258**		
			(0.093)		
Network × Lc_a			-0.490**		
			(0.227)		
Lc_l				-0.522**	
				(0.238)	
Network × Lc_l				-0.267*	
				(0.144)	
Lc_obs					0.648**
					(0.232)
Network × Lc_obs					-0.255**
					(0.114)
Network	4.692**	4.414*	6.976**	4.127*	3.797**
	(2.319)	(2.560)	(3.404)	(2.372)	(1.852)
Capitalratio	0.341	0.531	0.819	0.808*	0.663
	(0.132)**	(0.454)	(0.458)	(0.381)	(0.402)
Profitability	-0.712	-0.657	-0.436	-0.519	-0.684*
	(0.399)	(0.417)	(0.417)	(0.396)	(0.406)
DtoA	-1.819*	-2.664**	-2.292*	-0.782	-1.474
	(0.927)	(1.194)	(1.326)	(1.107)	(1.120)
NI	-0.576	-0.481**	-0.354	-0.500**	-0.435**
	(0.195)	(0.208)	(0.235)	(0.175)	(0.171)
Size	-1.222***	0.001	0.130	0.747	-0.491
	(0.266)	(0.263)	(0.269)	(0.283)	(0.322)
NPLF	-0.283***	-0.295***	-0.242***	-0.341***	-0.294***
	(0.043)	(0.045)	(0.042)	(0.043)	(0.045)
Constant	3.100	1.435	-2.843	-2.260	1.373
	(2.815)	(4.149)	(4.491)	(3.567)	(3.816)
Observations	1323	1283	915	1370	1373

Note: Network is the connection among 32 large U.S. BHCs constructed by PCA. Capital ratio is the ratio of equity is the ratio of equity capital to total assets. Profitability is return on assets. DtoA is the ratio of total deposits to total assets. NI is non-interest income divided by interest income. Non-performing loans is the ratio of non-performing loans to total loans. Standard errors are in the parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

4.6 Discussion of the results

From the above analysis, we could find within the five liquidity creation indicators, four of them: aggregate liquidity creation (catfat), asset side liquidity creation (lc_a), and off-balance-sheet liquidity creation (lc_obs) would increase systemic risk. However, bank liability side liquidity creation (lc_l) lowers the systemic risk. These results are consistent with the prior finding (X. Zhang et al., 2021; Davydov, Vähämaa, and Yasar, 2021). Bank liquidity creation shows an increasing trend during the 15 years, a possible explanation is that banks create excessive liquidity. As a result, excessive bank liquidity creation cause a negative effect of on systemic risk. Moreover, large banks rely more on off-balance sheet liquidity creation, so they might not have excessive liability side liquidity creation. Thus, the limited liability side liquidity creation could stabilize financial system.

Non-performing loans (NPLs) have a negative relationship with systemic risk, which indicates that non-performing loans could stabilize the financial system. Most of the literature shows a negative relationship between NPLs and systemic risk while our results show a reverse pattern. However, when we add the quadratic term of NPLs into our regression, the result show that NPLs have a positive relationship with systemic risk. This indicates that NPLs of large banks have a U-shaped relationship with systemic risk (see table 4.9 and table 4.10 in the appendix).

From the interaction term, we find that the network between large banks reduces the systemic risk raised by bank liquidity creation. These results are in a line with the previous conclusion (Markose, Giansante, and Shaghaghi, 2012; Acemoglu, Ozdaglar, and Tahbaz-Salehi, 2015). The potential reason behind this could be: firstly, the magnitude of the risk brought by liquidity creation is relatively slight, which could be diversified by the network Allen, Babus, and Carletti (2010). Secondly, connections between those large banks are weak. Weak connection with senior banks could absorb more risk Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015). Lastly, we only use 32 large BHCs, which is a small clustered community, and this small clustered network could prohibit risk transmission

(Markose, Giansante, and Shaghaghi, 2012). The bank network may make banks collude in the market for liquidity creation, which finally causes risk sharing. As a result, we might assume that large banks are more resilient due to its well connection with other systemic important banks.

Overall, it is concluded that bank liquidity creation would increase the systemic risk. Although this systemic risk could be slightly diversified by the network, it deepens systemic risk in total.

4.7 Conclusion

In this chapter, we examine the nexus between bank liquidity creation and systemic risk by using data from 32 large U.S. BHCs. We find that catfat (aggregate liquidity creation), catnonfat (on-balance-sheet liquidity creation), lc_a (asset side liquidity creation), lc_obs (off-balance-sheet liquidity creation) could deepen the systemic risk while lc_l (liability side liquidity creation) reduce the instability. Moreover, our results also show the "U" shaped relationship does not exist between liquidity creation and systemic risk. Our results enhance that "too-big-to-fail" would lead to moral hazard problems, which finally increases systemic risk. Also, large U.S. banks might create liquidity that mismatches or exceeds the demand of the public, and this excessive liquidity raises the instability of the financial system. Thus, it might underscore the prudential management of liquidity.

We also explore the role of bank networks. First, we examine the relationship between bank networks and systemic risk. The results show that the connection between large banks does not affect systemic risk. Additionally, bank networks do not hold a non-monotonic linkage with systemic risk. Further, we examine the effect of liquidity creation on systemic risk over the bank networks. The results show that the connection among BHCs could diversify risk brought by bank liquidity creation to a certain extent, though bank liquidity creation increases systemic risk in total. "Too-connected-to-fail" as an adjunct to "too-big-to-fail" raises a certain concern. However, our results indicate that intense connection among the banks may strengthen the financial system by diversifying risks rather than introducing new risky moral hazard problems

Our results contribute to the current literature by shedding light on the systemic risk associated with liquidity creation from large U.S. BHCs, and we show the role of bank networks in this relationship. Our findings suggest that more supervisory tools such as micro- and macro-prudential regulations should be taken to avoid the risk raised by bank liquidity creation. Additionally, our results show excessive liquidity creation by large banks increases systemic risk, which indicates that "too-big-to-fail" subsidies may need

to be reduced and the optimal size of banks is required to be considered.

Our sample only focuses on 32 large U.S. BHCs, so to have a better understanding of this relationship, it might be more vital to contain extra samples in the analysis. For example, medium and small banks should be taken into consideration, given the "too-many-to-fail" hypothesis. What is more, the range of large banks' activities and the structural of large bank liquidity creation might need to be reconsidered. Moreover, an increase of literature concentrates on the network structure among financial institutions, so it may be worthwhile to explore the effect of network structure on the relationship between bank liquidity creation and systemic risk.

4.8 Appendix

This table 4.7 lists 32 large U.S. bank holding companies, and they are publicly traded on the New York stock exchange (NYSE). We selected these banks based on the large commercial banks' list on Federal Reserve Statistical Release[5]. We drop come of them due to the data unavailable. Table 4.8 is the supplement material to table 4.4, and it shows the results of control variables. Figure 4.1 shows five bank liquidity creation indicators. Table 4.9 and table 4.10 show the "U-shaped" relationship of the non-performing loans and systemic risk.

[5]Website: https://www.federalreserve.gov/releases/lbr/current/

Table 4.7: List of 32 large U.S. bank holding companies

Banks	Ticker
Associated Banc-Corp (NYSE:ASB)	ASB
Bank of America Corporation (NYSE:BAC)	BAC
Bar Harbor Bankshares (NYSEAM:BHB)	BHB
Berkshire Hills Bancorp, Inc. (NYSE:BHLB)	BHLB
The Bank of New York Mellon Corporation (NYSE:BK)	BK
Bank of Hawaii Corporation (NYSE:BOH)	BOH
Citigroup Inc. (NYSE:C)	C
Cadence Bank (NYSE:CADE)	CADE
Community Bank System, Inc. (NYSE:CBU)	CBU
Cullen/Frost Bankers, Inc. (NYSE:CFR)	CFR
Comerica Incorporated (NYSE:CMA)	CMA
Capital One Financial Corporation (NYSE:COF)	COF
Central Pacific Financial Corp. (NYSE:CPF)	CPF
Flagstar Bancorp, Inc. (NYSE:FBC)	FBC
First Commonwealth Financial Corporation (NYSE:FCF)	FCF
First Horizon Corporation (NYSE:FHN)	FHN
F.N.B. Corporation (NYSE:FNB)	FNB

Banks	Ticker
JPMorgan Chase & Co. (NYSE:JPM)	JPM
KeyCorp (NYSE:KEY)	KEY
M&T Bank Corporation (NYSE:MTB)	MTB
New York Community Bancorp, Inc. (NYSE:NYCB)	NYCB
Prosperity Bancshares, Inc. (NYSE:PB)	PB
The PNC Financial Services Group, Inc. (NYSE:PNC)	PNC
Park .tio.l Corporation (NYSEAM:PRK)	PRK
Regions Financial Corporation (NYSE:RF)	RF
Synovus Financial Corporation (NYSE:SNV)	SNV
Sterling Bancorp, Inc.	STL
State Street Corporation (NYSE:STT)	STT
Truist Financial Corporation (NYSE:TFC)	TFC
Tompkins Financial Corporation (NYSEAM:TMP)	TMP
U.S. Bancorp (NYSE:USB)	USB
Webster Financial Corporation (NYSE:WBS)	WBS
Wells Fargo & Company (NYSE:WFC)	WFC

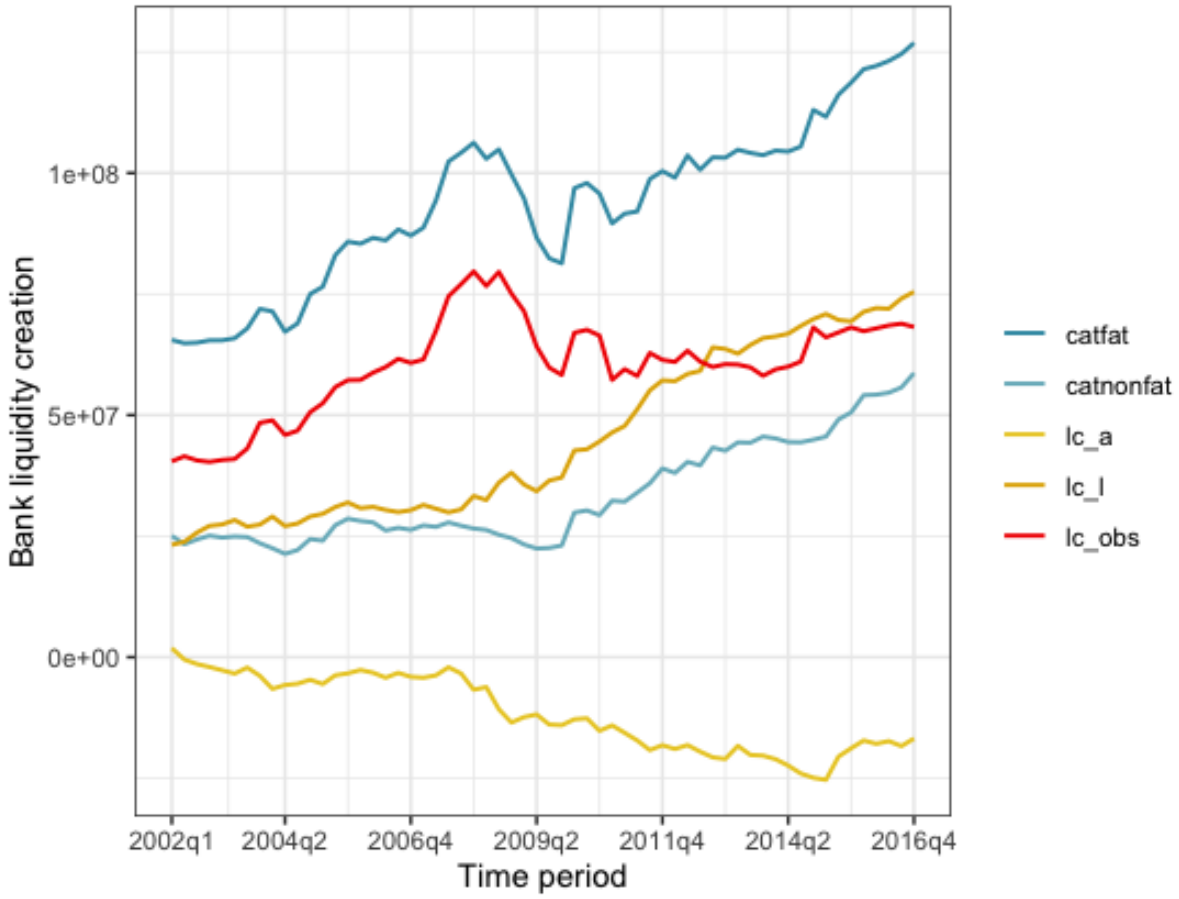


Figure 4.1: Bank Liquidity Creation

Table 4.8: Nonlinear relationship

ΔCoVaR	(1)	(2)	(3)	(4)	(5)	(6)
Catfat	1.059					
	(0.867)					
$Catfat^2$	0.007					
	(0.028)					
Catnonfat		0.816				
		(0.987)				
$Catnonfat^2$		-0.022				
		(0.031)				
Lc_a			0.152			
			(0.475)			
Lc_a^2			0.002			
			(0.017)			
Lc_l				-0.293		
				(0.912)		
Lc_l^2				-0.007		
				(0.027)		
Lc_obs					0.183	
					(0.873)	
Lc_obs^2					0.014	
					(0.026)	
Network						-0.355
						(0.526)
$Network^2$						0.149
						(0.879)
Capitalratio	0.364*	0.584	0.865	0.887*	0.635	0.636
	(0.133)	(0.461)	(0.458)	(0.403)	(0.415)	(0.393)
Profitability	-0.758	-0.513	-0.444	-0.448	-0.776	-0.557
	(0.433)	(0.454)	(0.425)	(0.478)	(0.432)	(0.400)
DtoA	-1.823	-2.545*	-2.321	-0.750	-1.534	-1.700
	(0.937)	(1.201)	(1.330)	(1.109)	(1.130)	(1.114)
NI	-0.589**	-0.468*	-0.363**	-0.494**	-0.441**	-0.463**
	(0.195)	(0.208)	(0.235)	(0.175)	(0.171)	(0.172)
Size	-1.231	-0.009	0.159	0.738*	-0.452	0.172
	(0.266)	(0.268)	(0.270)	(0.288)	(0.329)	(0.211)
NPLF	-0.279***	-0.291***	-0.238***	-0.336***	-0.292***	-0.319***
	(0.043)	(0.045)	(0.042)	(0.043)	(0.045)	(0.044)
Constant	4.891	-3.787	-2.282	-4.012	4.508	0.081
	(7.335)	(8.329)	(5.640)	(7.246)	(6.905)	(3.735)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1323	1283	915	1370	1373	1373

Table 4.9: Non-linear relationship of Non-performing Loans

ΔCoVaR	(1)	(2)	(3)	(4)	(5)
Catfat	1.112***				
	(0.208)				
Catnonfat		0.070			
		(0.128)			
Lc_a			0.208*		
			(0.088)		
Lc_l				-0.864***	
				(0.238)	
Lc_obs					0.538*
					(0.227)
Capitalratio	0.342**	0.669	1.066*	0.804*	0.760
	(0.115)	(0.442)	(0.441)	(0.356)	(0.390)
Profitability	-0.680	-0.614	-0.349	-0.563	-0.652
	(0.392)	(0.410)	(0.408)	(0.389)	(0.400)
NI	-0.581**	-0.479*	-0.404	-0.504**	-0.451 **
	(0.194)	(0.205)	(0.234)	(0.175)	(0.170)
Size	-0.999 ***	0.172	0.356	1.132***	-0.285
	(0.266)	(0.256)	(0.263)	(0.276)	(0.315)
DtoA	-1.707	-2.341*	-2.127	-0.269	-1.350
	(0.873)	(1.177)	(1.307)	(1.072)	(1.102)
NPLF	-0.646***	-0.687***	-0.676***	-0.765***	-0.664***
	(0.080)	(0.083)	(0.087)	(0.076)	(0.079)
$NPLF^2$	0.035***	0.037***	0.038***	0.042***	0.037***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Constant	2.262	-0.300	-5.537	-3.452	-0.134
	(2.728)	(4.058)	(4.383)	(3.383)	(3.717)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes
N	1323	1283	915	1370	1373

Table 4.10: Non-linear relationship of Non-performing Loans

ΔCoVaR	(1)	(2)	(3)	(4)	(5)
Catfat	1.119***				
	(0.208)				
Network×Catfat	-0.267*				
	(0.134)				
Catnonfat		0.093			
		(0.127)			
Network×Catnonfat		-0.252			
		(0.154)			
Lc_a			0.248**		
			(0.090)		
Network ×Lc_a			-0.475*		
			(0.218)		
Lc_l				-0.859***	
				(0.238)	
Network×Lc_l				-0.233	
				(0.142)	
Lc_obs					0.538*
					(0.226)
Network×Lc_obs					-0.234*
					(0.112)
Network	4.226	3.886	6.838*	3.581	3.451
	(2.294)	(2.527)	(3.254)	(2.338)	(1.816)
Capitalratio	0.319**	0.648	1.023*	0.776*	0.740
	(0.114)	(0.441)	(0.442)	(0.355)	(0.388)
Profitability	-0.675	-0.611	-0.351	-0.557	-0.635
	(0.392)	(0.410)	(0.408)	(0.388)	(0.400)
NI	-0.570**	-0.483*	-0.389	-0.508**	-0.444**
	(0.194)	(0.206)	(0.234)	(0.175)	(0.170)
Size	-1.001 ***	0.153	0.326	1.127***	-0.279
	(0.266)	(0.255)	(0.263)	(0.275)	(0.315)
DtoA	-1.714*	-2.356*	-2.129	-0.283	-1.365
	(0.867)	(1.175)	(1.304)	(1.070)	(1.100)
NPLF	-0.645***	-0.686***	-0.671***	-0.766***	-0.666***
	(0.080)	(0.083)	(0.086)	(0.076)	(0.079)
$NPLF^2$	0.035***	0.036***	0.037***	0.042***	0.036***
	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)
Constant	2.189	-0.332	-5.625	-3.431	-0.220
	(2.719)	(4.047)	(4.385)	(3.374)	(3.709)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes
N	1323	1283	915	1370	1373

Chapter 5

Conclusion

5.1 Conclusion

This thesis focuses on financial stability. Specifically, the major research investigates the determinants of financial inclusion and bank liquidity creation, as well as their impact on financial stability.

Our measurements of financial stability include single indicators and conditional value-at-risk (CoVaR). In Chapter 1 and Chapter 3, We examine the impact of financial inclusion and bank liquidity creation on financial stability with different measurements separately. For single financial stability indicators, our results in Chapter 1 conclude that financial inclusion might benefit financial stability through its reduction on the NPLs in upper-middle and high-income countries, but it causes instability in low and low-middle-income countries, given it increases the NPLs. Furthermore, financial inclusion decreases bank liquid assets. However, it shows a positive effect on bank liquid assets (LA) in upper-middle-income countries, which indicates financial inclusion has a synergy with financial stability in upper-middle- income countries. Finally, financial inclusion causes a negative but insignificant effect on bank capital (BCTA) and provisions to non-performing loans (PNPLs). Apart from single indicators, we apply CoVaR as a proxy for systemic risk. Chapter 3 finds that, except for liability side liquidity creation, aggregate liquidity creation, on-balance sheet liquidity creation, asset side liquidity creation, and off-balance sheet liquidity creation could deepen the systemic risk. Moreover, we also find that although the bank network does not affect systemic risk, it could reduce the risk raised by bank liquidity creation.

In this thesis, we also investigate the influencing factors such as fiscal policy (proxied by military spending) on bank liquidity creation which could stabilize the economy during the crisis period. Our findings show fiscal policy could boost bank liquidity creation, especially on-balance sheet liquidity creation. The result exists when military spending is affected by the World Uncertainty Index, and the effect is greater when we use the Bartik instrument to remove the bias.

5.1.1 Policy Implication

In Chapter 1, our results imply that the government could build more regulations to provide available services to financially excluded people. Additionally, those financial institutions could build more financial infrastructures, especially digital finance systems and mobile payment. Besides, it is also vital to promote financial education and improve financial literacy, which are more likely to improve the quality of financial inclusion. Finally, cooperation between different departments could be useful for the financial inclusion process. Government and financial institutions should intense collaboration to improve the financial inclusion level. Also, it might be important to promote regional or country-level cooperation, which could benefit financially excluded people globally.

In Chapter 2, our results imply that except for monetary spending, expansionary fiscal policy (increase military spending) could also be a practical tool to boost the credit market through bank liquidity creation. Additionally, policymakers may need to consider the financial crisis risk when formulating fiscal policies. Besides, the regulators should be aware of the potential risks stemming from geopolitical conflicts and transfers to financial institutions.

In Chapter 3, our findings suggest that more supervisory tools such as micro- and macro-prudential regulations should be taken to avoid the risk raised by bank liquidity creation. Additionally, our results show excessive liquidity creation by large banks increases systemic risk, which indicates that "too-big-to-fail" subsidies may need to be reduced. Finally, the authorities may also need to consider the optimal size of banks and financial systems.

5.1.2 Future Work

In Chapter 1, the financial inclusion index only includes access and usage dimensions. Quality dimensional indicators such as financial literacy might be taken into consideration. Besides, we only use single indicators to measure financial stability. Future work

may use indices such as z-score to measure comprehensive financial stability. Finally, we only use the country-level data. Disaggregated level data such as regional level and bank-level should also be investigated.

In Chapter 2, we only use military spending data to represent government spending. To achieve more accurate results, we may also use Security data or Medicare data to proxy government spending.

In this chapter, we only investigate the relationship in the U.S. It might be worthwhile to investigate the relationship in other countries. The results might be different between advanced economies and emerging market economies. Moreover, although we have tested the effect of political interventions, other political indicators may affect bank liquidity creation through military spending.

In Chapter 3, we are inspired by the "too-big-to-fail" conjecture. Thus, we only focus on large U.S. banks. However, it may also be significant to consider the small and medium banks, given the "too-many-to-fail" hypothesis. Besides, although we construct the network among the large banks, we do not show the details of the network. Different network structures may generate different spillover effects. Thus, future work could explore the structure of the banks, given the "too-central-to-fail" or "too-complex-to-fail" hypothesis. Then, we choose CoVaR as the measurement for systemic risk. The future work may use other measurements such as SRISK. Finally, we only use data from large U.S. banks. Other studies could use the data across countries to investigate whether there is a significant difference between the countries.

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