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Bachelor thesis

2020 **Jiayan Zhang**

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Risk management in commercial banks: housing mortgage loans after the subprime crisis

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Abstract

The subprime crisis in 2008 was a financial tsunami that affected the whole world. The primary source of the financial crisis was the increase in mortgage defaults, caused by the burst of the housing bubble. Prior to the crisis, the policies for housing mortgages within commercial banks were more relaxed. In the United States, before the subprime crisis, house prices were rising, and the market boomed, with people readily getting loans from commercial banks, without having to provide adequate guarantees. Inadequate risk management of mortgages was a major factor in causing financial disaster.

Following the subprime crisis, commercial banks around the world realised the importance of risk management in personal housing loans. In this thesis, I plan to study the risk management system of the American mortgage business, the causes of the crisis and summarise the American subprime crisis. Moreover, I will introduce how commercial banks around the world China the emerging market and the U.S. as the original of the subprime crisis, The Europe which was affected by the subprime crisis. And maily discuss the comparision between the U.S. and China.This thesis will focus on the risks of housing mortgages, look at the related theories, and summarise the latest research achievements in associated fields, divided into the different markets. It will also discuss lessons learned from the crisis, particularly in the risk management of housing mortgages.

The final goal of this thesis is to oversee mortgage risk management from a horizontal perspective in different markets including U.S., Europe and other emerging counties especially China, since the financial crisis and to build a global mortgage risk management framework. It will focus on risk management in emerging markets after

the disaster. It is more crucial to understand the characteristics of current global market risk management and some forward-looking experiences for future risk management.

Abstrakt

Krize rizikových hypoték v roce 2008 byla vlnou tsunami, která postihla celý svět. Primárním zdrojem této krize bylo zvýšení počtu nesplácených hypoték, způsobený prasknutím bubliny na trhu s nemovitostmi. Ve Spojených státech amerických před krizí rizikových hypoték rostly ceny nemovitostí, kdy lidé rychle získávali půjčky od komerčních bank, aniž by museli poskytovat dostatečné záruky. Hlavním faktorem způsobujícím finanční katastrofu bylo nedostatečné řízení rizik hypoték.

V této práci se chystám studovat systém regulace rizik amerického hypotečního podnikání, příčiny krize a shrnout americké hypotéky, jako takové.

Tato práce se dále zaměří na regulaci komerčních bank, rizika hypoték na bydlení a shrnutí nejnovějších výsledků výzkumu v souvisejících oborech, rozdělených dle různých trhů. Budu v této práci také diskutovat ponaučení z krize v podobě regulace hypoték na bydlení.

Konečným cílem této práce je porovnat řízení hypotečního rizika z horizontální perspektivy na několika trzích, včetně USA, Evropy a dalších rozvíjejících se oblastí, zejména Číny. Kromě toho se zaměří na pochopení charakteristik současného řízení globálního tržního rizika a některé výhledové přístupy pro budoucí řízení rizik.

Klíčová slova

Hypotéky na bydlení Sub-prime hypotéka Krize Řízení rizik

Keywords

housing mortgage loans subprime crisis Risk management

Range of thesis: 86 668

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague 06.05.2020 **Jiayan Zhang**

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Research question and motivation

The research direction of this paper focuses on risk management in commercial bank housing mortgage loans, in the context of the post subprime crisis of 2008.

The subprime crisis in 2008 was a financial tsunami that affected the whole world. The primary source of the financial crisis was the increase of mortgage defaults, caused by the burst of the housing bubble. Prior to the crisis, the policies for housing mortgages within commercial banks were relaxed. In the United States, before the subprime crisis, house prices were rising and the market exploded, with people readily getting loans from commercial banks, without having to provide guarantees. Inadequate risk management of mortgages was a major factor in causing the financial disaster.

Following the subprime crisis, commercial banks around the world realised the importance of risk management in personal housing loans. In my thesis, I plan to study the risk management system of the American mortgage business, the causes of the crisis, and summarise the American subprime crisis. Moreover, I will introduce how commercial banks around the world have managed the risk of housing mortgages since the financial disaster. This thesis will focus on the risks of housing mortgages, look at the related theories, and summarise the latest research achievements in associated fields, divided into the different markets. It will also discuss lessons learned from the crisis, particularly in the risk management of housing mortgages.

Contribution

Most existing literature focuses on the experience and lessons learned by the market in mortgage risk management after the financial crisis, and most are longitudinal alignment studies of a single market. The intention of my thesis is to create a horizontal comparison by examining three different markets according to the various impacts of the financial crisis: the United States, where the financial crisis started; Europe, where the financial crisis spread to; and China, where there are emerging markets. Comparing

different markets is better for establishing a simple global mortgage risk management framework; it also facilitates the understanding of various management options and policies between different markets.

Most of the research on mortgage risk management since the financial crisis has focused on lessons that have been learned from the United States; however, they often ignore the importance of emerging markets. Since the financial crisis, emerging markets have taken up a significant portion of global finance. Within the American source and cause of the subprime crisis, there were a series of problems, such as the risk management of mortgage loans. The research on mortgage risk management in the United States since the financial crisis is planned from the perspective of a financial system suffering from the trauma of the disaster . It is the reconstruction of the financial system after the crisis, and the volatility of the many emerging market such as China's, that are not so distinct; China has ushered in significant economic development since the crisis. Post-crisis risk management analysis for emerging markets, is an analysis from a third perspective, similar to learning from a case study and continuously improving through self-improvement. Therefore, mortgage risk management after the crisis, in the context of emerging markets, is one of the missing aspects in the current papers.

The final goal of this paper is to oversee mortgage risk management from a horizontal perspective in different markets since the financial crisis, and to build a global mortgage risk management framework. It will focus on risk management in emerging markets after the disaster.. It is more convenient to understand the characteristics of current global market risk management and some forward-looking experiences of future risk management.

Methodology

This thesis will study the US, European, and Chinese loan default rates (data from the People’s Bank of China [PBOC], the central bank), before and after the subprime mortgage crisis, and combine them with the changes in mortgage risk management in the different markets. The horizontal comparison will be carried out separately, according to mortgage management policies and norms introduced in different periods.

The literature research method will be employed to study the the implementation of the housing mortgage risk management policies in various markets after the financial crisis. Meanwhile, China is selected for conducting an in-depth study through the case study method to summarise the situation of housing mortgage risk management in emerging markets.

As the lenders of mortgages are commercial banks, the risk management of commercial banks in lending should balance the costs and benefits of the mortgage portfolios. Therefore, the assessment of mortgages using the model of credit risk will also be introduced (Smith, Sanchez, & Lawrence, 1996).

Outline

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2. Overview of risk management of housing mortgage loans in commercial banks
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Content

Introduction

Why my topic is interesting

The financial crisis caused by the U.S. subprime mortgage crisis has spread, increasingly spread from local to worldwide, moving from developed countries to emerging market countries and extending from the financial industry to the real economy.

Most existing literature focuses on the experience and lessons learned by the market in mortgage risk management after the financial crisis, and most are longitudinal alignment studies of a single market. My thesis intends to create a horizontal comparison by examining several different markets according to the various impacts of the financial crisis: the United States, where the financial crisis started; and especially China, as a representative of the most important emerging market. Comparing different markets is better for establishing a global mortgage risk management framework; it also facilitates the understanding of various management options and policies in different markets.

In my thesis, I test three hypothesis related to my topic:

H1: The subprime mortgage crisis in the U.S. from 2007 is due to the bank ’s relaxing risk management, which is the root cause of the subprime mortgage crisis.

H2: China did not break out the subprime mortgage crisis in 2007-mid 2010s because China did not have the preconditions.

H3: The risk management of China’s banks today is at an appropriate level.

Brief overview of existing knowledge

The subprime crisis from 2007 was a financial tsunami that affected the whole world. The origins of the subprime crisis can be traced back to 2001. The U.S. maintained low-interest rates from 2001 to 2004, the real estate market was robust, and the number of mortgage loans was rapid up yearly. Since June 2004, however, the United States has entered a cycle of interest rate hikes. Rising interest rates and declining economic growth caused changes to the real estate market. It contributed directly to problems in

paying out the subprime mortgage debtor and the collapse of operating the subprime mortgage companies, which in turn caused enormous losses for mortgage bond investors and market panic.

From mid-August 2007, the United States injected enormous sums of money into financial markets to alleviate the lack of liquidity in several ways. The U.S. government announced it was purchasing preferred stock in Citigroup on November 23, 2008, and purchased $20 billion in preferred Citigroup stock on December 31, 2008.[1] A move aimed at strengthening investor confidence and avoiding a credit crunch and an expanding crisis. Although these measures have temporarily eased the crisis, there have been seen slowing economic activity around the world, and the severe consequences of the subprime mortgage crisis were not fully apparent for quite some time.

Since 2007, the subprime mortgage crisis has rapidly spread from the field of subprime mortgages to the field of credit cards, from the banking system to the capital market. From the United States to Europe, it spread to the global economy. Just as "a small butterfly fluttered from South American Amazon its small wings but triggered a tornado in Texas, U.S.A.". There are many reasons why the subprime mortgage crisis has caused such a significant hazard, the bubble in the U.S. real estate market, the proliferation of financial derivative products, etc. No one can afford to grant a loan to someone who cannot afford it. Banks and mortgage companies are pursuing profits one by one, blindly relaxing loan management, subjectively reducing credit conditions, and issuing prepayments, and even zero-downpayment loans to borrowers with poor credit, low income, and undocumented records. The U.S. mortgage crises had devastating effects and put the global economy in trouble.

Contribution to the research

Most of the research on mortgage risk management since the financial crisis has focused on lessons that have been learned from the United States; however, they often ignore the importance of emerging markets. Since the financial crisis, emerging markets have taken up a significant portion of global finance. Within the American source and cause of the subprime crisis, there were a series of problems, such as the real estate bubbles. It is the reconstruction of the financial system after the crisis, and the volatility

1 Congressional Oversight Panel (December, 2009): *A review of Treasury's foreclosure prevention programs*. Washington: US G.P.O., p.18.

of the many emerging markets such as China's, that are not so distinct; China has ushered in significant economic development since the crisis. Post-crisis risk management analysis for emerging markets is an analysis from a third perspective, similar to learning from a case study and continuously improving through self-improvement. Therefore, mortgage risk management after the crisis, in the context of emerging markets, is one of the missing aspects in the current papers. This part will also be added to the thesis.

How the thesis is organised

This thesis plans to study the risk management system of the mortgage business, the causes of the crisis and summarise the subprime crisis. Moreover, I will introduce how commercial banks in the U.S., Europe, China, and other emerging have managed the risk of housing mortgages since the financial disaster. This thesis will focus on the risks of housing mortgages, look at the related theories and summarise the latest research achievements in associated fields, divided into different markets through studying in the different markets. The comparison will be carried out separately, according to mortgage management policies and norms introduced in different periods.

The literature research method will be employed to study the implementation of housing mortgage risk management policies in various markets after the financial crisis. Meanwhile, China is selected for conducting an in-depth study through the case study method to summarise the situation of housing mortgage risk management in emerging markets.

As the lenders of mortgages are commercial banks, the risk management of commercial banks in lending should balance the costs and benefits of the mortgage portfolios. Therefore, three housing mortgage risk management theories used in banks will also be introduced.

Finally, the thesis will also discuss lessons learned from the crisis, particularly in the risk management of housing mortgages.

Chapter 1

Overview of credit risk management

1.1. Overview of credit risk

The U.S. scholar A. H. Willet (1901) defined risk for the first time, pointing out that risk is an objective manifestation of the uncertainty about the occurrence of events that do not feel.[2]

In the article *Risk Uncertainty and Profit*, the U.S. economist F. H. Knight (1948) made an essential distinction between risk and uncertainty. He believed that risk was “measurable uncertainty”.[3]

Based on the universal understanding of financial theory circles and practical workers, the definitions of risk mainly include the following:

(1) Risk is the uncertainty (or change) of future results.

(2) Risk is the possibility of loss.

(3) Risk is the deviation of future results (such as the rate of return on investment) from expectations, that is, volatility.

The core words in all definitions of risk above are about the uncertain, combined with the "credit”. The credit risk should be the uncertainty in credit, which means there is the probability not to meet the engagement. The Basel Committee on Banking Supervision on September 2000 defines credit risk as "Credit risk is most simply defined as the potential that a bank borrower or counterparty will fail to meet its obligations in accordance with agreed terms."[4]. Credit risk refers to the risk caused by an individual's inability to perform all repayment obligations. This risk is often due to changes in a borrower's ability or willingness to repay. Repayment ability is the fundamental guarantee for the security of personal loan funds. Whether a borrower can repay the principal and interest of a loan on time and in full is mainly due to the income sources of the borrower and his family or other refinancing channels. Applies to less-

2 Willett, A. (1901): *The economic theory of risk and insurance*. New York: Columbia University Press.

3 Knight, F. (1948): *Risk, uncertainty and profit. Boston:* Houghton Mifflin.

4 Bis.org. (2020): *Principles for the management of credit risk* [Online] Available at <https://www.bis.org/publ/bcbs75.pdf> (Accessed 4 May 2020), p. 1.

developed emerging countries, since some borrowers do not file tax returns, banks are usually unable to use tax returns as evidence when investigating personal income status. Alternatively, some borrowers may use income certification that overstates the income get higher loans, which may be precisely the reason and source for future non-performing loans. On the other hand, in many countries, including developed countries, when borrowers file tax returns, the tax returns are rather understated to avoid the taxes.

The bank must manage credit risk when there is a non-performing loan that the debtor is not able to repay. On the other hand, for the non-performing loan that the debtor is not willing to repay. In developed countries, law enforcement is mature enough, and the legal system will show its power when it is a credit fraud that the debtor is not willing to repay. However, in some emerging markets, law enforcement is not mature enough. In some regions, some areas cannot be covered by law enforcement due to the underdevelopment of the legal environment. Sometimes even the court has a judgment under the law, but it cannot be executed completed. This causes some people to have weak credit concepts and poor awareness of active repayment by have not realised the law risk, making it difficult for commercial banks to control credit risk. The result is the credit risk control is weak in some emerging countries compared with developed countries. At the same time in the emerging market, for instance, China is still developing and the gap between rich and poor lead to the inability to circulate information between the cities or the region. According to the technology and cost problem, it is have not finished building the network of credit risk control for every citizen as it in developed countries.

1.2 Credit risk in housing mortgage loans

The credit risk of a housing mortgage loan is mainly due to default, which is the loss a lender suffers when a borrower fails to repay the principal and interest of a loan on time. The factors that affect the default risk of personal housing mortgage loans mainly include a borrower's income, age, occupation and credit status on the one hand and the loan management of commercial banks on the other. The default risk can be divided into two categories. The first is the willingness risk of a borrower's bad credit and the active default risk of termination of payment. The most critical measurement here is law enforcement, as mentioned before. Normally, developed countries have less willingness

risk. The second ability risk is a borrower's passive default risk due to insufficient payment capacity. At present, in most emerging countries with asymmetric information between the client and the bank, commercial banks cannot maintain continuous and effective monitoring of a borrower's financial situation. That is, commercial banks cannot accurately and timely predict and control the main factors that affect the default risk, which is precisely the credit risk management that commercial banks face.

1.3 The strategy of credit risk management in housing mortgage loans

The credit risk in a mortgage must first be identified, which is the pre-step in credit risk prevention. Moreover, there are two core steps in credit risk management.

1.3.1. Analysis and assessment of credit risk

A borrower's credit risk is mainly manifested as difficulty fulfilling the terms of a contract. The analysis in this regard is to determine a borrower's ability and willingness to repay the principal and interest of a loan, following the contract. The content of the analysis usually includes the following five aspects: character, capacity, capital, collateral and conditions. (Bajtelsmit, V. 2020)[5]. Character includes honesty and moral prestige and reflects a borrower's willingness to repay. Capacity means the ability to repay debts; occupation, income level, property status, etc. are all indicators that reflect solvency or the capacity to repay. Capital refers to a borrower's financial resources. Individuals can control and own property, such as cars, certificates of deposit or insurance policies. Collaterals are mainly houses financed by mortgage loans. Conditions refer to the impact of a borrower's background and changes in that background, especially for customers who are affected by the business cycle. Risk assessment is a process of quantifying risks and can also be understood as a method of risk analysis. Quantifying risks is the basis for managing and controlling risks, and it is also a vital link to preventing risks.

5 Bajtelsmit, V.(2020): *Personal finance,* 2nd edn. John Wiley & Sons. p. 9

1.3.2 Credit risk measurement

The second step in credit risk management is risk control based on risk identification. Risk control is the ongoing process of monitoring the effect of actions, which refers to a series of means and methods taken before or when a risk occurs to succeed in avoiding risks or reducing risk losses(Faltin, F.et al. 2012).[6]It should be a continuous process. In content, risk control includes risk selection, risk diversification and risk transfer.

Risk selection is the choice of the nature of risk; taking only acceptable risks prevents moral hazard. Furthermore, excluding unqualified borrowers is the first step towards avoiding risks when choosing borrowers.

Risk diversification is a measure used to diversify a risk portfolio and avoid or control the portfolio concentration. Under the condition that risk cannot entirely be avoided, the process of risk dispersion is used for mitigation. Risk diversification includes many areas; it may limit specific segments, borrower types, regions, currencies, interest rate settings or repayment structures.

Risk transfer is also called transfer of risk. It is a way for banks to pass on a loan risk to others via the sales of receivables and whole portfolios and securitisation. It is an essential way for banks to decrease credit risk. In some countries, where the risk transfer system is relatively developed and legally secured, the transfer objects usually include big institutional investors, investment companies, investment and pension funds and insurance companies. (Yuan, Z. 2016).[7]

6 Faltin, F., Kenett, R. and Ruggeri, F. (2012): *Statistical methods in healthcare*. Chichester, England: Wiley, chapter 6.3.2.

7 Yuan, Z. (2016): *New strategic research on China (Shanghai) pilot free trade zone*. WCPC. p. 211.

Chapter 2

Overview of risk management of housing mortgage loans

2.1. Definition and characteristics of housing mortgage loans

Housing mortgage loans, also known as housing loans, originated in Britain in the nineteenth century. Globally, such loans are a widely used personal financing tool. In the U.S., according to the mortgage process from Freddie Mac, a mortgage is a lien on a property (mainly house in housing mortgage loans) that secures a loan and is paid in instalments over a set period[8]. Mortgages are loans provided by financial institutions to a borrower's property, with the borrower or a third party as the property owner as collateral, when purchasing, constructing or renovating a house and applying to a lending institution for loans. Moreover, within a specified period, the borrower repays an agreed-upon amount of loan principal and interest on a regular basis. It is a borrowing behaviour occurring in the process of personal housing consumption and used in consumer credit for specific purposes, such as purchasing, repairing, modifying, building and constructing houses. Houses with specific loan targets are an essential part of the business of housing finance fund application.

Housing consumption credit is essentially a type of personal consumer credit. In the U.S., consumer credit is defined as "A consumer credit system allows consumers to borrow money or incur debt, and to defer repayment of that money over time. Having credit enables consumers to buy goods or assets without having to pay for them in cash at the time of purchase. ".[9] This definition includes almost all loans made by consumer credit providers to consumers. This is mainly because a mortgage loan is not only long term but also far exceeds the amount of medium-term and short-term consumer credit. Moreover, its market demand, competitive environment and legal requirements are different, and the loan procedures are much more complicated. However, in theory, housing mortgage loans should undoubtedly be included in consumer credit, due to they

8 Sf.freddiemac.com (2020): *Step by step mortgage guide* [Online] Available at <https://sf.freddiemac.com/content/_assets/resources/pdf/update/step_by_step_mortgage_guide_english.pdf> [Accessed 5 May 2020].

have the two most essential characteristics of consumer credit, which are also the differences between consumer credit and other credit[10]. First, consumer credit loans are made to individuals and families. In legal terms, the entities are “natural persons”, rather than “legal persons” which included different companies and organizations. Besides, from a loan usage standpoint, the proper of consumer credit is to purchase consumer goods for personal or family use, which is entirely different from the loan issued to enterprises for production and business operations. Within this definition, the housing mortgage loans are used for family or individual to consume real estate property(house).

However, there are differences between housing consumption credit and short-term and medium-term personal consumer credit. This is mainly because a mortgage loan is not only long term but also far exceeds the amount of medium-term and short-term consumer credit. Moreover, its market demand, competitive environment and legal requirements are different, and the loan procedures are much more complicated. Compared with medium-term and short-term consumer credit, housing mortgage loans has the following characteristics in addition to the characteristics of consumer credit.

The amount of personal housing mortgage loans is large, and the loan period is extended. Housing is a necessary consumption material for people; it has the characteristics of great value and continued use-value. Generally, it is the most valuable of all personal consumer goods. Therefore, in consumer loans, the balance of housing mortgage loans is much larger than the balance of short- and medium-term consumer credit, for example, in the U.S., before the subprime crisis, the housing debt account around 78%-79% in total debt balance, at the last quarter in 2007, the total housing debt was $12.37 trillion, and $9.75 trillion were housing debt. (Appendix 1)

Medium and short-term consumer term loans are generally within five to seven years, with the longest being ten years, while housing mortgage loans are usually more than ten years. Generally, the most extended maturity period for housing mortgage loans in

9 Ftc.gov (2020): *Consumer credit law & practice in the U.S.* [Online] Available at <https://www.ftc.gov/sites/default/files/attachments/training-materials/law_practice.pdf> [Accessed 5 May 2020].

10 Fdic.gov (2020): *FDIC law, regulations, related acts - Consumer protection* [Online] Available at <https://www.fdic.gov/regulations/laws/rules/6000-200.html> [Accessed 6 May 2020].

China can reach 20 to 30 years (Li, S. & Yi, Z. 2006)[11], while the loan maturity for housing mortgage loans in the U.S. is generally 15 to 30 years[12].

The social and economic significance of housing mortgage loans is considerable. The housing market and housing finance market has the participation of many institutions, such as real estate appraisal agencies, loan insurance guarantee agencies, accounting firms, law firms and rating agencies. From a personal viewpoint, the object of housing mortgage loans is essential to life. The purchase of a house is the most critical consumption decision in the life of many consumers. From the perspective of society, the housing problem is ensured to be resolved appropriately, affecting family stability and even the safety and stability of the entire society. Governments of various countries start with the right to individual survival and actively intervene in housing markets and housing finance to support economic development while improving people's standard of living.

Housing credit is a highly specialised financial service project. The operation of housing credit funds has distinctive characteristics. It is necessary to coordinate the contradiction between the diversification of funding sources and the concentration of funding. If this contradiction is not appropriately handled, the risks hidden behind housing credit will be revealed. Although housing finance is relatively safe, once its risks are formed, they will expand quickly. Thus, large-scale financial turmoil jeopardises the development of the entire financial market and the national economy.

2.2 Overview of risk management of housing mortagage loans in commercial banks

2.2.1. Definition of risks of commercial banks' housing mortgage loans

The risk of bank loans can be defined as the uncertainty of future gains or losses of loans. Generally speaking, the risk of a loan refers to the possibility of future loss of a loan; during the operation and management of a bank, due to various unpredictable

11 Li, S. and Yi, Z. (2006): *Financing home purchase in China. Hong Kong: The Centre for China Urban and Regional Studies*, Hong Kong Baptist Univ., p. 413.

12 LII / Legal Information Institute (2020): *15 U.S. Code § 1639C - Minimum standards for residential mortgage loans* [Online]. Available at: <https://www.law.cornell.edu/uscode/text/15/1639c> [Accessed 5 May 2020]

uncertainties, a loan cannot recover the principal and interest as expected, leading to the possibility of a bank suffering financial losses.

When the U.S. scholar George W. Gau(1978) studied the risk of personal property default in the U.S., the definition of default was either a voluntary transfer of property rights in the mortgage to the creditor or a borrower's loss of property rights and having to hand over collateral to the creditor due to default in repayment.[13] Under the definition, the most frequent default of mortgage loans is the default of subprime mortgage loans, which can show that subprime mortgage loans are the main risk of housing mortgage loans in commercial banks.

Generally, institutions avoid providing loans to customers with low credit records (scores) that mean high default risks. The high risks lead to higher loan losses. However, as lenders expand their risk selection criteria to attract enormous numbers of lower quality customers to earn a profit, the subprime mortgage loans increase. Compared with subprime loan customers, other customers are called 'prime'. Therefore, the definition of a 'subprime loan' is providing credit to borrowers with the following characteristics. That is, compared with traditional mortgage loan customers, a borrower's default risk is higher in subprime mortgage loans.[14] A borrower's default risk can be measured by traditional credit risk measures (repayment history, debt to income level, etc.) or alternative measures (credit score). Due to the higher risk of subprime mortgage loans, their interest rates and loan costs are higher than those offered to standard risk borrowers. As long as the price charged by the lender is sufficient for making up for the higher loan loss rate and indirect costs related to service and collection of loans, these loans can be profitable. Subprime mortgage lenders represent all kinds of debtors, from debtors with repayment problems due to adverse events, such as unemployment, to debtors with persistent mismanagement of financial and debt obligations. This kind of risk is directly related to the subprime crisis in the U.S.

2.2.2. Related theories of commercial banks' housing mortgage risk management

Renegotiation theory of personal mortgage risk management

13 Gau, G., (1978):'A taxonomic model for the risk-rating of residential mortgages'. *The Journal of Business*, **51(4),** pp. 687–706.

14 Fdic.gov. (2020): *FDIC Law, Regulations, Related Acts - Statements Of Policy*. [online] Available at: <https://www.fdic.gov/regulations/laws/rules/5000-5100.html> [Accessed 6 May 2020].

Terence M. Clauretie and Mel Jameson (1995)[15] believe that the collater disposal process due to breach of contract is a costly legal litigation fee and other fee payment process for the lender. If a lender recovers the arrears through this way, it may lead to significant losses for the borrower, the loss of collateral ownership causes a massive decline in credit rating as well as substantial property losses. In the case of non-moral risks that make it difficult for a borrower to temporary inability to repay, from the perspective of economic benefits, both a lender and a borrower reset the loan interest rate or loan maturity through renegotiation or loan restructuring. Both sides of the agreement give up something, but the credit relationship may continue and in the long-run both parties benefit. Through the renegotiation of personal mortgages, the expensive default costs for both parties are avoided, thus forming the renegotiation theory.

Personal housing insurance theory

Personal mortgage insurance is also an effective tool for managing risks. Therefore, from the perspective of diversifying and transferring the default risk of personal mortgage loans, an entity with an insurance agency as the main body must be established. The second part of the mortgage guarantee system is combining existing insurance varieties with personal mortgage business. Since personal mortgage insurance involves property insurance, personal insurance and guarantee insurance, comprehensive personal mortgage insurance should be established.

Five Cs theory of personal mortgages

In order to control risks, Chapter 1.3.1 above introduces the Five Cs principles of credit risk management, namely principles, capacity, capital, mortgage and conditions. Specific in housing mortgage loans, an analysis of the borrower ’s credit history, repayment ability, and financial status should also be considered. To decide whether to approve the loan application made by the borrower. Therefore, in the housing mortgage loan, the bank has the right to reject the application depend on the insufficient in five aspects or the credit history.[16]

15 Clauretie, T. M. and Jameson, M. (1995): “Residential loan renegotiation: Theory and evidence”, *Journal of Real Estate Research*, **(10), p**. 153−162.

Chapter 3

Risk management of housing mortgage loans in various markets

3.1. The background of the subprime crisis

The subprime crisis erupted in the first quarter of 2007. It rapidly extended from the local subprime mortgage business to the subprime mortgage-based securities business based on subprime products and spread from the financial sector to the real economy. The following summarises the main evolution stages since the subprime crisis, in chronological order and according to the impact characteristics of the crisis.

The first stage was from March to July 2007 – the first stage of the subprime crisis. Damages included mortgage-issuing companies being close to failure reformulate, a substantial decline in home sales, and fluctuating bond market prices. The landmark events were the New Century Financial Corporation bankruptcy, S & P downgrading its subordinated debt rating, and the Bear Stearns' hedge being on the verge of collapse.

The second stage was from August to December 2007 – the development stage of the subprime crisis. It was characterised by the central bank's continuous injection of liquidity through such as the discount window the injection of capital into the banking system to the nationalization of banks and the start of a rate cut cycle. Significant events were real estate trust and investment companies filing for bankruptcy protection and a crisis breaking out in the subprime mortgage market.

The third stage was from January to February 2008 – the deepening stage of the subprime crisis. It was characterised by huge losses by large commercial banks, investment banks and insurance companies because they purchased the subprime MBS and CDOs. Iconic events included Citigroup and Merrill Lynch reporting a loss of USD 9.83 billion in the fourth quarter and AIG offsetting the USD 15 billion in subprime debt losses.

The fourth stage was from March to July 2008 – the subprime crisis accelerated to the spread stage. It was characterised by enormous hedge fund losses, high-leverage

16(1988): Quarterly Information Statement. Federal Farm Credit Banks Funding Corporation (U.S.).

investment banks facing bankruptcy crises, and a sharp increase in short-selling market pressure. The iconic incident of the financial crisis was Bear Stearns being on the verge of bankruptcy and being acquired by JP Morgan Chase. Carlyle Capital was forced to liquidate.

The fifth stage was from August 2008 to June 2009 – the subprime crisis escalated into a financial tsunami. This period was characterised by the failure, acquisition, transformation or takeover of large Wall Street financial institutions, the inter-bank LIBOR soaring in three months, and the market liquidity suddenly freezing. Iconic events included Freddie Mac and Fannie Mae reporting a crisis and the Ministry of Finance spending USD 300 billion in the bailout and taking them over, the Lehman Brothers applying for bankruptcy protection, Merrill Lynch being acquired by Bank of America for USD 50 billion, and AIG being taken over. Goldman Sachs and Morgan Stanley were allowed to operate traditional banking business, and Washington Mutual Bank went bankrupt.

Overview of large financial institutions taken over or bankrupt (billions of US$)

Financial institutions	Asset	Debt	Highest market value in 52 weeks	Lowest market value in 52 weeks
Bear Stearns	398.10	387.10	32.07	0.68
Lehman Brothers	639.43	613.16	47.03	0.035
Merrill Lynch	966.21	931.43	119.09	24.85
AIG	1,049.88	960.54	938.13	16.72
Fannie Mae	885.92	844.53	367.44	1.88
Freddie Mac	879.04	865.96	211.81	0.81

Source: U.S. Federal Deposit Insurance Corporation (FDIC), 2007

The financial crisis caused by the subprime crisis intensified and rapidly spread. It led to an international financial crisis rare in history and a robust and wide range of impacts.

3.2 Risk management problems exposed by the subprime crisis

The reasons for the subprime mortgage crisis vary, and some suggest that it is mainly due to external reasons, such as the real estate market bubble, but because risk management can affect the default rate such as the credit risk management quality

directly influences the default rate of the portfolio. Here comes the first hypothesis. The hypothesis I want to study is:

H1: The subprime mortgage crisis in the U.S. from 2007 is due to the bank 's relax risk management, which is the root cause of the subprime mortgage crisis.

To analysis the hypothesis:

At the beginning of this century, the U.S. suffered a double blow from the burst of the high-tech stock bubble. To prevent economic downturn, the Federal Reserve (Fed) continuously cut interest rates sharply, especially from June 2003–June 2004, when the federal benchmark interest rate was maintained at a historical low of 1%; the lowest rate was 0.88%. (Goel, S. 2009). [17] The loose monetary environment created excess liquidity, pushed up housing prices and greatly stimulated the appetite of both supply and demand for mortgages. The U.S. subprime mortgage business began to develop rapidly.

Banks sold the mortgages to newly founded SPVs (special purpose vehicle companies), and these companies securitised these then packaged them into Mortgage-Backed Security (MBS) or mortgage debt certificates (e.g. Collateralized debt obligation, CDOs). Based on CDOs, investment banks used sophisticated financial instruments to design derivatives, such as credit default swap and subordinated bond price composite index.

In this process, the lender's default risk was widely dispersed among investors in the securities market. The serious problem is that credit transactions and derivative innovations magnify risk leverage. The first leverage comes from CDO-backed mortgage credit transactions. Hedge funds holding low-quality CDOs pledge to banks to obtain multiple times the mortgage amount; the credit line of the asset continues to purchase CDOs. The second leverage comes from the options trading tool based on the CDOs. Derivative products usually only need to pay a 5%–10% margin, so the transaction scale based on subprime mortgages has been enlarged 10–20 times; through leverage, the risk is sharply amplified. In the whole process, the risk of default for lenders is widely dispersed among investors in the securities market.

17 Goel, S. (2009): Crisis management. Global India Publications. p. 207.

This is the first strong evidence support. In the process of designing financial derivatives at that time, there was a lack of consideration for risk diffusion in internal risk management.

While innovating mortgage products, banks in the U.S. ignored significant risks, which promoted the growth of subprime mortgages. To attract more customers to apply for mortgage loans, banks in the U.S. carried out innovation in many aspects, such as borrower access, downpayment and repayment methods. Nevertheless, this was not so-called innovation, and it instead led to relaxing the risk management standards. From the perspective of borrower access, traditional commercial banks require borrowers to have a stable source of income recognised by the bank and customer scores above a specific score, and borrowers need to provide income certification materials and historical credit records. With the intensification of competition in the mortgage business, high-quality borrowers in the market became scarcer, and lenders began to explore the blue ocean of sub-borrowers. These people usually do not have a stable job or an excellent credit record and mainly include the unemployed, illegal immigrants, and other socially weaker vulnerable groups in society. To issue loans to borrowers not accepted by traditional commercial banks, American bankers had to make some loose changes to the terms of the loans. It caused an increasing level of non-performing loans. To enable subprime borrowers to purchase housing, low downpayment or zero-downpayments became an inevitable choice. In the beginning, banks in the U.S. did not seriously consider this risk. In the case of rising housing prices, the high amount of profit masks the risk. The U.S. subprime mortgage market was booming.

The saving rate of American residents is meagre, a large amount of consumption is financed by credit, and the ability to resist risks is fragile. The U.S. housing prices peaked in 2006, and this was also when mortgage delinquency rates began to rise. (Appendix 2)

Above is also one of the most important causes of the subprime mortgage crisis in the United States. The chaotic market order and profit-seeking businessmen and bankers have chosen to sacrifice part of the credit risks management in the risk management to gain profit. Therefore, risk management at that time was often chaotic and loose, far from perfect. Eventually, it broke out when the real estate index fell.

Conclusion: Confirmed.

Therefore, it can be concluded that the hypothesis can be confirmed. Which also can find in the chart (Appendix 3) to show the process of credit expansion and contraction in the U.S. subprime crisis, there was a problem with subprime mortgage loans at the bottom of the entire risk transmission link. The risk was quickly passed on towards upper levels and coupled with the magnification effect of leverage, However, the relaxing risk management has been chosen, which eventually evolved into the outbreak of the subprime mortgage crisis. The relaxed risk management in banks has led to the spread and increase of risks in every financial link after the real estate bubble burst. The relaxing risk management caused the non-performing loans to increase with the housing prices to decrease. The growth rate of delinquencies suddenly expands from 2007. Then in 2008, the delinquencies on all housing loans and leases rapidly jumped more than two times as 2007(Appendix 4). The subprime mortgage crisis fully erupts due to relaxing risk management.

3.3 Risk management of housing mortgage loans in the U.S.

After the subprime crisis, the U.S tried to figure out the risk in the commercial banks and then managed it. There are some measures in risk management in the bank in the U.S.

3.3.1 Perfect risk management organisation structure

Commercial banks in the U.S. generally adopt a three-dimensional risk management system in which the board of directors and senior management are independent of each other. The board of directors conducts comprehensive monitoring of the overall risk through its risk audit committee, especially oversight of the moral hazard risk of senior management. Bank senior management is in charge of risk management, which also has another set of risk detection framework to implement management of risks: the establishment of a management department that controls business risks and the establishment of a department that comprehensively controls various risks of business

and management departments - internal audit, which usually directly reports to the CEO.[18]

3.3.2. The effective internal control system

In the governance structure of commercial banks, For example, Citibank in the U.S. has set up audit centre in 90 locations worldwide, which are responsible for the bank's global business audit and internal management status audit. The audit department is directly accountable to the board of directors, which makes the bank's internal supervision and control institution more independent and authoritative. The internal audit system helps to avoid the risks within the institution that are developed due to financial innovations such as derivatives(Crarwan, M. 2020).[19]

These two measurements are used to improve internal risk management in commercial banks.

3.3.3. Advanced risk management tools

Scientific analysis and excellent expert judgement (experience) are the fundamental prerequisites for doing an excellent job in risk management. The analysis in commercial bank credit risk management must rely on specific management tools. The bank shall design a credit analysis tools and credit analysis system. The system shall provide an online credit file system that not only supports the management of customer credit files but also supports online approval of loans. There is also another business risk system which covers almost all commercial credit risk exposures, beyond the boundaries of different organisational units within the bank as well as different product areas.

To control external risk, commercial banks have also established a vast and sound database. Through the establishment of information data warehouses and credit management application systems, customer managers, credit analysts and approvers at all levels can easily query industry, region and customer information credit rating, etc. under different authorisations. Under the condition that a bank's operating environment is stable, the default probability and default loss rate of customers can be accurately

18 Corpgov.law.harvard.edu (2020) Risk management and the Board of Directors [Online]. Available at <https://corpgov.law.harvard.edu/2018/03/20/risk-management-and-the-board-of-directors-5/> [Accessed 5 May 2020].

19 Carawan, M. (2020): *A strong foundation: Citi internal audit undertook an ambitious project to transform its training and development, enhance consistency, and better meet stakeholder needs* [Online]. Available at:

estimated based on the data available. With the development of information technology and econometrics, banks have begun to use various quantitative models, such as credit scoring, risk-adjusted return on the capital model, or internal rating model.

There is currently a widely used system in the U.S. that should be mentioned. It called FICO made by Fair, Isaac and Company.The range of FICO points is between 300 and 850 points, and different score levels mean different probability of default. The FICO score is made up by the following five categories: 35% of payment history, 30% of amounts owed, 15% of the length of credit history, 10% of new credit and 10% of credit mix.[20] The data based on the credit reports from three national credit bureaus: Equifax, Experian and TransUnion.

In the Federal Deposit Insurance Corporation (FDIC) list, a credit bureau risk score (FICO) of 660 or below will be considered as the subprime mortgage borrowers.[21] In the Federal Housing Administration(FHA), FICO above 580 can get the right with 3.5% downpayment. On the other hand, if FICO score is between 500 and 579, which means 10% downpayment. [22] Moreover, a borrower with a high FICO score will be given a lower interest rate. All based on the high FICO score means well credit performance with lower risks, and low FICO score means high risks. FICO can be used in over 90% of U.S. lending decisions nowadays.[23]

3.4 Risk management of housing mortgage loans in Europe

From the comparison chart below, the increase in European housing prices from 2000 to 2008 was obviously higher than that of the United States. Although the growth rate of housing prices in Europe was higher, the default rate has not increased. This can be due to stricter risk management in Europe compared with the United States. At the same time, it can also refute some views that think the direct cause of the U.S. subprime mortgage crisis is the rapid growth of housing prices and real estate bubbles.

<https://go.gale.com/ps/anonymous?id=GALE%7CA434320761&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=00205745&p=AONE&sw=w> [Accessed 5 May 2020].

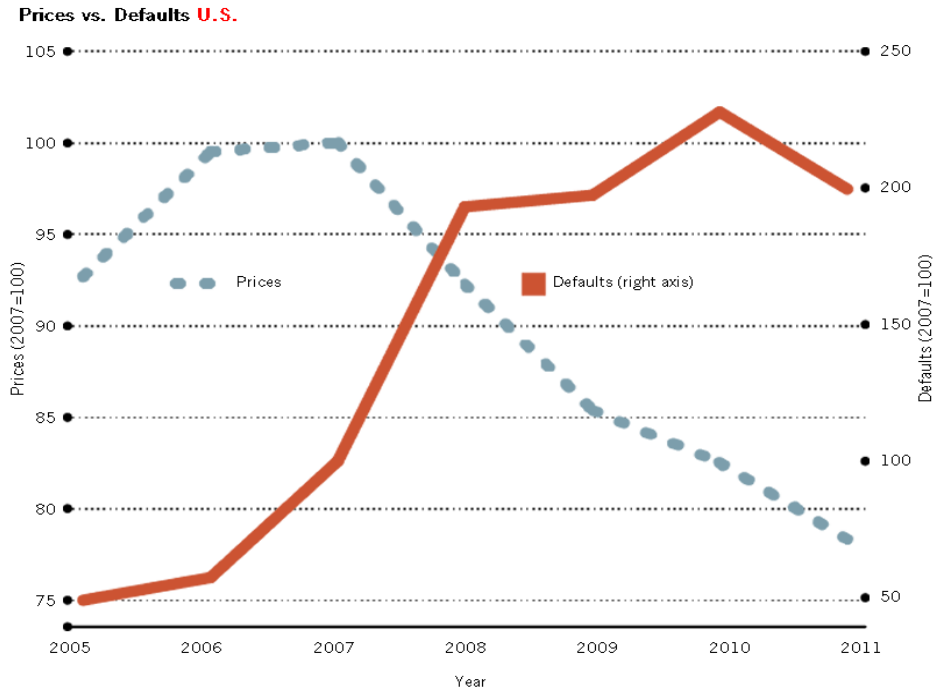
20 Myfico.com (2020): *What is a FICO score and why is it important?* [Online]. Available at <https://www.myfico.com/credit-education/what-is-a-fico-score> [Accessed 5 May 2020].

21 Fdic.gov (2020): *FDIC: Come-IN background definitions* [Online]. Available at <https://www.fdic.gov/about/comein/background.html> [Accessed 6 May 2020]

22 Fha.com (2020): *FHA loan requirements in 2020* [Online]. Available at <https://www.fha.com/fha_loan_requirements> [Accessed 6 May 2020].

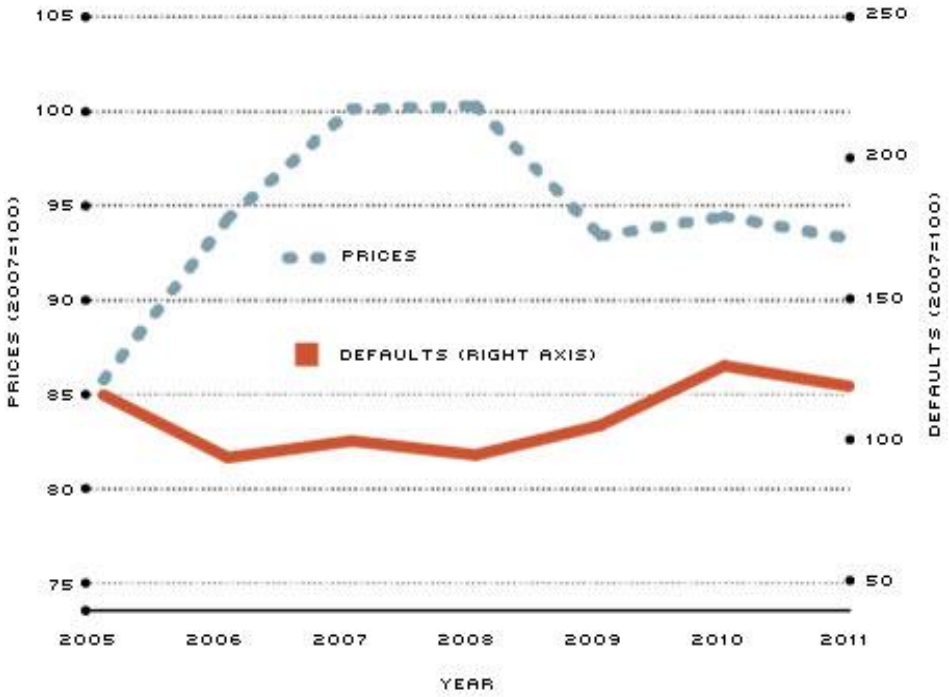
23 Ficoscore.com (2020): *About – FICO® score [Online]*. Available at <https://ficoscore.com/about/> [Accessed 6 May 2020].

Prices and defaults in the U.S. from 2005-2011



Source: Zillow Real Estate Research

Prices and defaults in Europe from 2005-2011



Source: Zillow Real Estate Research

Banks in europe are specialisation and fragmented. besides, each country has its different policies towards it, the level of circulation is not as high as that in the United States. The innovation of financial derivatives is not as excessive as that of the United States. The risks of housing mortgage loan in commercial banks are lower than in the U.S. thus, it did not lead to a breakout of another subprime mortgage crisis in the European area.

The Four-Eyes Principle is widely used by European commercial banks, especially the German banking system in their risk control. This controlling mechanism is made by a specific process[24]. For details, transactions and decisions are monitored by at least two persons at the same time. Apart from the requirement that two eyes(one person) approvals are from the market expansion system and the other two eyes (one person)are based on the risk controlling department. Such kind of simultaneous controlling mechanism greatly ensures the accuracy of the commercial banks' risk analysis and the comprehensiveness of the business decisions as well as increasing transparency between departments.

There are specialised credit-rating agencies and personnel responsible for the rigorous credit rating system within the risk controlling system of European commercial banks. It is required that every customer be rated by the European Commercial Bank before a decision of whether to grant credit or the continuation of activities with the customer can be made. Concerning its dynamic credit rating, it is adjusted every six months in general circumstances and can be flexible in case of an emergency.

In terms of the degree and direction of risk management, the United States and Europe are relatively close to each other since they are advanced economies. There can be significant differences from them to those of emerging countries. The risk management of housing mortgage loans in emerging countries will be introduced in the following section.

24 Manzanaares, A. and Schwartzlose, H. (2009): 'Risk Management for Central Banks and Other Public Investors'. Cambridge University Press.

3.5 Risk management of housing mortgage loans in Emerging Markets

Generally speaking, emerging markets refer to countries that have several characteristics of developed countries. Still, the per capita GDP or other indicators have not reached the level of developed countries yet. The typical examples of emerging markets are BRICS countries including Brazil, Russia, India, China and South Africa. Some international organizations are divided into emerging countries.

In these countries, Russia is the largest former Soviet Union member and a typical representative of the transition economy, and India has a very high population, in that case, these two countries' markets are chosen to be the representatives of emerging markets. China, as another typical representative of the emerging market, will be analyzed detailly in the next chapter.

Compared with the United States and Europe, the housing loans in the Russian Federation is a new-born phenomenon. In the Soviet period, Gosbank (the State Bank of the USSR) was the only bank until 1988. It was not functioning as a commercial bank, and almost no loans were provided for individuals (Zadonsky, G. 2013). [25]. In addition, housing was constructed and allocated by the authorities as ordinary citizens had no need to make a housing loan or purchase real estate. But after the collapse of the Soviet Union, along with the privatisation of the construction industry and housing, Russian banks also began to promote housing loans. The personal houisng mortgage loan business is one of the fastest-growing businesses of Russian banks. Before the subprime mortgage crisis, Russian housing loans continued to grow, and the loan conditions were gradually loosened. In 2008, the average weighted mortgage interest rate and maturity were 12.9% and 215.3 months, respectively. In comparison, the corresponding figures in 2005 were 14.9% and 174.6 months, respectively(Poroshina, A. 2014)[26] . Although Russia's housing loans have also been influenced by the subprime mortgage crisis, growth began again in 2010. In 2011, Russian banks issued mortgages for RUB 717 billion, achieving 90% annual growth. In 2012, mortgage borrowing had grown by another 40% to RUB 1.029 billion. (Khmelnitskaya, M. 2014).[27] However, compared to

25 Zadonsky, G. (2013): "Mortgage in the Russian Federation", *Russian Economic Developments,* **2**, p. 54.

26 Poroshina, A. (2014): "Credit risk modeling of residential mortgage lending in Russia", *SSRN Electronic Journal.*

27 Khmelnitskaya, M. (2014): "Russian housing finance policy: State-led institutional evolution", *Post-Communist Economies*, **26(2),** p.149–175.

developed markets, the Russian mortgage market is still developing, and the potential risks faced by banks are more visible. Compared with developed markets such as the United States, the risks faced by Russian banks are more regional. First of all, Russian banks have an available funds shortage. In order to choose better customers to resist credit risk, the interest rate of Russian housing mortgage loans is generally high, which results in only a few people who can afford mortgage loans. Secondly, there is a particular interest rate risk. Due to the instability of the ruble-dollar exchange rate, Russian mortgage loans denominated in rubles have always had an interest rate risk. Also, due to the fluctuation of the ruble-dollar exchange rate, the prepayment risk, which is caused by lost interest, is more severe than other economies.

To achieve better risk management, banks in Russia have also implemented several new methods, such as using a three-party (the lenders, the buyers-borrowers and the sellers) agreement contract when entering into a mortgage contract, using variable interest rates instead of fixed interest rates as the new mortgage interest rate, opening up a secondary mortgage loans market, vigorously promoting the securitisation of housing loans and so on.

The Russian government attaches great importance to the housing market and has repeatedly issued policies and legislation to allow more citizens to own housing, such as the national priority project ‘affordable and comfortable housing’ (Dostupnoe i komfortnoe zhil'e – grazhdanam Rossii) in 2006 (Khmelnitskaya, M. 2014) [28], The Russian version of Fannie Mae-AHML is also actively promoting the development of the secondary mortgage market.

India’s housing market is experiencing rapid growth. With the increase in urban population, the improvement of residents’ living standards and considering India’s population growth rate and urbanisation rate, India’s housing market will be an important industry in India for a long time. Therefore, after the subprime mortgage crisis, the credit risk of Indian housing mortgage loans gradually became serious, and many borrowers who received loans at low-interest rates became overdue, resulting in non-performing loans. To cope with the increase in the outstanding rate, the banks in India adopted a similar approach to the banks in Russia. On the one hand, it uses mortgage securitisation to diversify risks. On the other hand, it has accelerated the

implementation of tri-party contracts to increase the binding power of the contract. Banks in India also increased the potential customer population to better select qualified customers.

However, it also need be mentioned that there exist specific phenomenon as emerging countries - corruption and expansion of state power. Corruption may affect the ability of banks to evade risks and judgments on loans, allowing loans to be concentrated in the hands of personnel who may not need them. (Weill, L. 2011)[29]. Government's attention can effectively promote the development of the mortgage market, but it should also pay attention to the possibility of further corruption in the expansion.

28 Khmelnitskaya, M. (2014): "Russian housing finance policy: State-led institutional evolution", *Post-Communist Economies*, **26(2)**, p.149–175.

29 Weill, L. (2011): "How corruption affects bank lending in Russia", *Economic Systems*, **35(2)**, p. 230–243.

Chapter 4

Lessons from the subprime crisis about risk management for commercial banks

4.1. Lessons learned from developments in the United States

The U.S. subprime crisis was one of the most-watched events in the international economic and financial field from 2007. The subprime mortgage crisis has significantly impacted the global financial market and the global financial system, from which several enlightenments can be obtained.

First, financial institutions should strengthen their risk awareness. The sub-loan risk stems mainly from the relaxation of loan conditions by mortgage lenders, providing credit to high-risk customers who cannot repay; investment banks created a large number of high-risk derivative securities based on these loans. Financial institutions should strengthen their sense of sound operation and strike a balance between business innovation and risk prevention. A bank's mortgage innovation is far from achieving controllable risks. The following risks are not reflected and resolved within a commercial bank's risk management framework. First, the new moral hazard cannot be solved. On the one hand, the introduction of new mortgage loans has indeed brought convenience and benefits to borrowers. On the other hand, it has also allowed some people who do not yet have sufficient repayment ability to join the ranks of borrowers, which has brought the risk of adverse selection to banks. Once the income situation of this group of people deteriorates, the bank cannot recover the loan on time. Moreover, once housing prices fall, the problem of the default rate becomes more serious.

Second, the standard for the issuance of subprime mortgage loans decreases before subprime mortgage crisis because of the over-competitive. More and more customers with extremely low credit ratings become subprime customers. They do not need or provide less financial information, usually using floating-rate mortgages and they only need to pay less interest. Which accumulates risks.

Year	Shares of loans with only rate payment(%)	Shares of loans with no financial information provided(%)	Monthly payment/salary(%)
2002	2.3	38.6	40.1
2003	8.6	42.8	40.5
2004	27.2	45.2	41.2
2005	37.8	50.7	41.8
2006	22.8	50.8	42.4

Source: Author's work, data based on Freddie Mac

In order to control the over-competitive, to have a positive competitive banking industry is important .so that the government and central banks should partially play a role in that.

Third, financial supervision should keep up with the pace of financial innovation. It is necessary to strengthen the risk supervision of complex financial products, such as the supervision of credit derivatives. It is also necessary to strengthen the supervision responsibility of asset-backed securities institutions on a primary debtor's ability to pay their debts.

4.2. The current risks to China's commercial banks in housing mortgage loans

4.2.1 Credit risk

Current housing mortgage loans in China are not large amounts of subprime mortgage loans like in the U.S. during the subprime crisis. The default rate is temporarily low. Furthermore, to curb the excess liquidity in the market and prevent the economic development from overheating, the People's Bank of China has continuously required policy measures to commercial banks to have tight credit standards, to have raised interest rates several times and increased the deposit reserve ratio. But the increase in interest has made borrower have more pressure in repayment and had hidden dangers for the rise in the default rate. Moreover, China's mortgage securitisation is still in its infancy with a small scale and low liquidity. The risks of mortgage loans are

mainly concentrated in the banking system. It means in case the default rate rises, the impact on the commercial banking system cannot be underestimated.

In recent years, China's real estate market has developed rapidly, and commercial banks have adjusted the credit structure based on the market environment with overflowing liquidity and the quality of housing loan assets. They have taken personal housing loan business as the focus of business development and new business growth points, which has driven the expansion of the housing loan market. However, at present, the risk management and control measures of the Chinese commercial banks are not perfect. In this context, the following risks in the housing loan market need also to be considered.

China has not established a complete credit information system. Therefore, in the housing loan business of commercial banks, there is a general problem of asymmetry between personal information and the personal information held by commercial banks. Commercial banks usually have a few methods for investigating the creditworthiness of loan applicants. For customers who have not established a credit history yet, banks are quite blind, resulting in a moral hazard from borrowers, manifested mainly in the following situations. First, a loan applicant's income certification is overstated; loan applicants can issue corresponding income certificates at work units based on the housing they want to purchase. Even enterprises or institutions that are closing can issue corresponding income certificates for retired workers. Second, it is different as in developed countries, China has an issue with poor communication between banks, some borrowers have several income certificates, borrowing from different banks and buying houses in multiple places. Third, personal housing loans are medium-to-long-term loans with long repayment terms. During this period, uncertainties are possible, which are likely to become credit risks for commercial banks.

4.2.2. Macroeconomic risk

Due to the long repayment period of personal housing loans, the real estate industry has a close relationship with aggregate economic trends and changes in the macroeconomic cycle. At present, China's real estate market prices are rising rapidly and there are apparent irrational factors. The impact of the government's macro-control

policies on the economic outlook is uncertain, and the market risks facing commercial banks have increased significantly.

4.2.3 Operation risk

In recent years, with the development of housing credit in China, competition among commercial banks for the market share of housing loans has intensified. Some bank employees do not follow the rules and regulations to benefit themselves by simplifying the procedure; they do not strictly check the authenticity and legality of the data. Without in-depth investigation and verification of data with obvious doubts, it would be illegal to lend money, which causes hidden risks in housing loans. With the rapid increase in the amount of personal housing mortgage loans, the rigour of loan operations will be ignored to speed up the processing, resulting in the lack of relevant legal texts and procedures, such as contract elements being filled in incorrectly. Missing information or randomly amended contracts, affecting the contract's legal validity, cause disputes where the law is determined. A borrower's identity is not strictly checked in some undeveloped cities and regions due to China´s problem with the incomplete identification information system, resulting in the loan contract and related legal texts being signed or forged by others. It would result in an invalid contract which led to loan guarantees are impossible to implement.

4.2.4. Price risk

At present, China is in a period of economic upsurge, and the real estate market is overheating, so prices are rising step by step. (Appendix 5), it can be found that although currently influenced by COVID-19, the prices are still high compared to five years ago. However, since the situation of COVID-19 in the world worsened, prices may also fall. If the value of a house is lower than the total loan amount, that does not exclude some borrowers from choosing to default. In this case, even banks handling collateral cannot avoid vicious asset losses.

Chapter 5

Risk management of housing mortgage loans in China

In the subprime mortgage crisis, China was not the country that broke out, only was affected. When studying China's risk management, it can be found that China has not experienced a subprime mortgage crisis from 2007 until now.so figure out the reason then can help to comparably discuss the risk management in China. Here I want to study in the second hypothesis is :

H2: China did not break out the subprime mortgage crisis in 2007-mid 2010s because China did not have the preconditions.

To analysis the hypothesis:

First aspect: housing market

China's economy has been growing rapidly since 2007, and people's pursuit of material life has undergone fundamental changes, which has promoted the rapid development of the real estate industry. Some are using this to think that China's real estate bubble is about to burst. However, according to the real residential property price index (the gap of 12 years was selected, and the real index excludes from inflation and other factors.). China's real residential property price index from 2007-2019 is compared with the U.S.'s before the subprime crisis. The increase in the number of real residential property price index in the United States during the period 1994-2006 is much larger than that in China during 2006-2018. Moreover, the index increase is nearly doubling in the U.S. during 1994-2006, but real residential property price index increase in China is around 18.36% from Quarter Four of 2006 by 92.47 to 2018 by 109.45 (The year 2010 =100, Appendix 6)

Therefore, although China's real estate market has been increasing, compared with the United States before the subprime mortgage crisis, it is far from reaching its levels. Considered to the preconditions for the subprime mortgage crisis, which can be affirmed is that China does not have a big enough real estate growth to stimulate the subprime mortgage crisis.

However, there is the thing that needs to be noticed that Chian's real residential property price index is decline suddenly in 2015, which is approximately downward 5.24% annually(Appendix 7). The main reason is that the failure due to the government cut interest rates in 2014, which caused the exchange rate to plummet, and the overnight interest rates on the Shanghai interbank borrowing skyrocketed. The interest rate cut has caused capital to escape from the real estate sector. However, after 2015, because of the plummeting housing prices in 2015, the government's policy on housing loans has been relaxed. China's current housing price growth is speedy so that there are indeed unstable factors. The current housing market is still on the rise, so whether the real estate market bubble meets the preconditions of the subprime mortgage crisis and the crisis will maybe expose in years, which cannot be concluded based on the data after 2015. That is why the analysis of hypothesis 2 is based on the timeline from 2007 to 2015(the mid-2010s).

Second aspect: housing mortgage loans

China advocates the development of its related industries through the real estate industry and guides the consumption patterns of the general public to realize the transition from consumption to investment. According to statistics, by the end of 2014, China's real estate development loan balance reached as much as 5.6 trillion yuan, an increase of 22.6% year-on-year. The balance of personal housing mortgage loans was 11.5 trillion yuan, a year-on-year increase of 17.5%, and still maintained year-on-year growth.[30]

Although in the growing of housing mortgage loans in China, after analysis of the non-performing loan which related to the subprime mortgage crisis, the result shows that since 2008, the total amount of non-performing loans rate in China has not been high. Before 2015, the non-performing loan rates are all lower than the U.S (Appendix 8). That can be concluded that China's non-performing loan rate until 2015 is far from reaching the U.S. non-performing loan rate since the subprime mortgage crisis broke out. in the aspect of housing mortgage loans , the precondition also not exit.

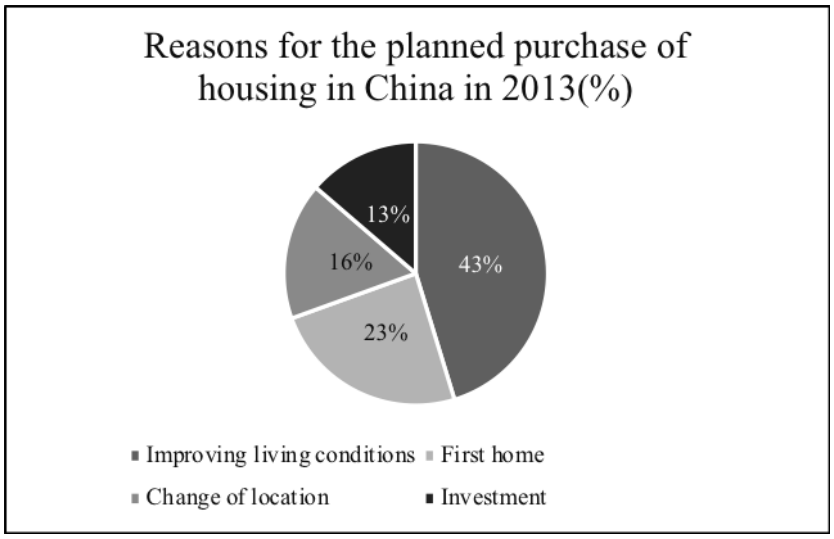
Third aspect: financial innovation

30 Pbc.gov.cn (2015). *Statistical report on loans invested by financial institutions in 2014* [Online]. Available at <http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/2810324/index.html> [Accessed 5 May 2020].

Although China's economic development trend is increasing, the total has not reached the level of the United States. It has not yet reached the level of the market developed. Therefore, China's finance and its derivatives are in the embryonic stage. Therefore, China can be said to follow American products in terms of financial innovation, rather than innovating on its own. However, one of the reasons why the subprime mortgage crisis is critical, as mentioned before, is the runaway and spread of risks due to financial innovation. So China also does not have this preconditions, there was a very limited amount of MBS or CDO in China.

Fourth aspect: culture and society

Cultural factors to some extent lead to China's acceptance of loans is not as high as that of the United States. While in China, the concept of credit payment has not developed very well. Chinese prefer to save money for consumption. Therefore, although it is developing, it cannot be compared with the United States.



Source: Author’s work, data based on Credit Suisse

At the same time, the common concept in China that houses have always been important, and most people are eager to buy their own property(home). Therefore, after the house price plummets, ordinary consumers will have the opportunity to enter. In this case, they began to buy houses. Demand led to another rise in house prices. In 2013, the proportion of demand factors for Chinese people to buy houses can be seen from the figure above. Investment still accounts for only a small part, and most of them are needed houses (improvement of living environment or purchase of the first apartment).

Therefore, demand always exists, meanwhile most people buy houses on the condition that they pay 30% or more of the downpayment. combine with the typical Chinese concept of saving money, China has less probability to break out the crisis due to non-exiting preconditions

Conclusion: Confirmed.

It can be concluded that China does not have the preconditions for the outbreak of the subprime mortgage crisis, as in the hypothesis, this can also be confirmed, because from 2007 to mid-2010s, China did not break out of the subprime mortgage crisis similar to the United States. Then to be more specify China's risk management, there are two aspects: government policy and the measures in commercial banks

5.1. Government policies

Policies at the macro-control level

Inspired by the U.S. subprime mortgage crisis, and also relative to the excessively rapid growth of China's housing loans in the last decade, the government has issued a series of policies to adjust the development model of the real estate market and strengthen the management of bank real estate loans since the second half of 2007. At the same time, the Central Economic Work Conference of China arranged a tight monetary policy. These timely macro policies countered speculation in the real estate market and accompanied the maintenance of a sound and sustainable development in China's housing loan market.

However, the breakout of COVID-19 and the disputes caused by the China-U.S. trade war make the current period unpredictable. Uncertainty regarding the U.S. economy is increasing; if it experiences large fluctuations, it will have a significant impact on global financial markets. Therefore, China's macro-control department pays close attention to the impact of fluctuations in the international financial market on China's housing loan market. China also closely monitors the development trend of its domestic real estate market and takes corresponding regulatory measures to address identified problems in time to avoid financial risks caused by price decline, prevent capital outflows and speculation, and maintain the stability of the real estate market.

Policies for financial regulatory authorities

Supervision is a guiding force and a powerful guarantee of financial development. Adequate supervision can promote sustained, healthy development of finance. In the context of the current development situation of China's commercial banks' housing loan market, to ensure its sustained and healthy development, financial regulatory authorities are accelerating the establishment of a comprehensive risk management system.

To gradually establish a sound credit management system, strengthening credit management, the People's Bank of China issued guidance for improving the credit system, strengthening pre-loan reviews and effectively preventing housing mortgage loan risks, requiring lenders to verify a borrower's necessary information such as financial information, credit information and credit status. Recently, a credit system called Zhima Credit has started to be widely used in China. This is the credit system made through cooperation between government, the People's Bank of China and the Fintech company Ant Financial. It based on employing the commercial bank's information system combined with the use of machine learning technology to analyse the database then summarized as a simple score. It can be used for applying for a credit card, renting a car, and obtaining a credit report when applying for a travel visa. Unfortunately, it is not valid for mortgage loans, and it is not as popular as FICO. Zhima Credit requires a smartphone to download its app, but the smartphone ownership rate in emerging countries is lower than that in developed countries.

Hence, the government still regards the establishment of a sound credit management system as a major project at present, uniting financial institutions, political and legal departments, industrial and commercial departments, judicial institutions, personnel units, household registration, social-medical institutions, taxation departments, public utility units and property companies. Relevant enterprises and institutions collaborate to improve and perfect the credit system so that information users can make a comprehensive assessment of the assets, credit, health, as well as other repayment capabilities, and risk tolerance of the person being queried. This would gradually establish a complete real estate credit information management system for the whole of society.

Establishing a restriction mechanism for real estate companies, intermediary companies, and evaluation agencies would raise the requirements for evaluation companies. Meanwhile, an evaluation agency is designated by a bank, not introduced by

a second-hand housing brokerage company, and there should be requirements for its qualification. Banks need to sign a responsibility contract with an appraisal agency, which should bear a corresponding responsibility for the bank's asset risk caused by the high house prices they assess. If necessary, they can also be required to open a margin account.

The banking system should actively develop mortgage securitisation and find ways to solve the current problems regarding the liquidity of mortgage loans. Banks need to solve the problem of offsetting, spreading the mortgage risk to the greatest possible extent, and striving to minimise the losses caused by the potential bursting of the real estate bubble.

5.2. Main measures in commercial banks

Given the hidden risks in China's housing loans, necessary measures in commercial banks should be taken to prevent the emergence of a subprime mortgage crisis similar to that in the U.S.

One risk prevention measure is the establishment of a comprehensive risk management system. Implementing comprehensive risk management is not only about the need for commercial banks to control risks themselves; it is also the highest requirement for financial supervision today. Commercial banking is a risk management industry, and the creation of commercial banks must be achieved through effective risk management. Every business undertaken by a commercial bank has certain risks. Any change in the banking business, whether it is launching a new business or improving an existing business, causes changes in related business processes, which may lead to a series of risk management problems.

A method of establishing comprehensive risk management is the establishment of internal rating systems and internal rating models before, commercial banks' credit management mainly focused on the risk of a single borrower. The credit risk management of modern commercial banks should not only include the management of a single borrower's risk; more importantly, it should adopt the optimal allocation of risk capital and the allocation of credit asset portfolios as risk management models. Therefore, although nowadays many commercial banks have already developed and established an internal rating system for their overall credit business, the whole

circumstances still requires improvement. This internal rating method should be used to comprehensively understand the risk situation of housing mortgage loans, as well as rationally and accurately predict future overall risks. On this basis, a borrower's data and historical credit information should be thoroughly considered. A scientific solvency and credit evaluation model needs to be established to gradually improve the single borrower's credit rating system and segment the borrower's market, which should then be used as an important reference tool for business development.

The second precautionary measure against risks is the building of an early warning mechanism for crises by the commercial banks, e.g. stress test. This mechanism entails a system that analyses and predicts the severity of events that may occur during the banks' operation, leading to their bankruptcy and failure. The system also provides countermeasures and recommendations for commercial banks to prevent and resolve crises. The mechanism includes an index system that reflects the crisis events of commercial banks, a monitoring system for these index systems, an analysis system based on the index, and a management system that makes decision suggestions based on the analysis data. An early warning system for commercial banks is a prerequisite for the active management of crises, and is also the primary means of preventing and resolving them. It fully embodies the concept that crisis prevention is more critical than crisis resolution. Most commercial banks in China set up a scientific and reasonable early warning mechanism after the subprime crisis in the U.S., following the changing market environment and the crisis management characteristics of different positions in different periods.

The last risk prevention measure is improving a bank's internal credit management mechanism to minimise management and operational risks. Commercial banks are required to formulate a set of strict, detailed and highly operational rules and regulations, and gradually improve their level of credit management. First, they must formulate loan risk capital allocation and credit portfolio plans, based on the relevant data of the housing mortgage loan internal rating model, and determine the business development direction, proportion, development pace and progress in order to avoid losses due to loan policy mismanagement. Second, they must strengthen the management of the whole loan process; analyse related risk points from the pre-loan investigation, loan approval and post-loan inspection; implement management responsibilities; and standardise operational procedures, as well as ensure business personnel consciously

abide by various rules and regulations to strengthen accountability for losses. Third, in the organisational structure, banks must implement a separation of loan review and risk supervision to ensure the independence of loan approval and risk control, and establish a particular review and approval centre to implement intensive operations. Fourth, they must strengthen the collection and analysis of lender information to provide an objective basis for better prevention of credit risk and increased control of credit risk evaluation.

Chapater 6

Comparasion

6.1. Horizontal comparison of results in various markets

This thesis focuses on the description of risk management of housing mortgage loans in China and the U.S. China is a representative of emerging market countries, whilst the U.S., as a developed country, is a representative of risk management. So here is the last hypothesis of this thesis:

H3: The risk management of China's banks today is at an appropriate level.

To analysis the hypothesis:

Impact	The U.S.	China	Advanced
Market competition	Complete	Not Complete	The U.S.
Supervision	Complete but not strict	Complete	China
Regulation	Complete	Not Complete	The U.S.
Mortgage registration	Complete	Not Complete	The U.S.
Partners	Complete	Not Complete	The U.S.
Bank Maturity	Mature	Emerging	The U.S.
Internal control capability	Strong	weak	The U.S.
Professional manage ability	Strong	weak	The U.S.
Risk control tools	Mature, Systemic control	Manual control	The U.S.
Staff	Professional team	Corporate credit or personal business transfer	The U.S.
Product innovation	Over	lack	China
Borrower disciplinary punishment	Over harsh	No hard constraints	The U.S.

Source: Author´swork

In terms of market competition, compared to the higher degree of openness in the U.S. market and the realisation of the high degree of the open market, competition in the Chinese market that receives government supervision is not complete. Furthermore, in the Supervision. Due to the decentralisation of power among U.S. government agencies, U.S. supervision is not as strict as the Chinese national government's. Also, because China's education level is lower than that of the U.S., market regulation is still imperfect in China. In the part of mortgage registration, due to the imperfect regulation, China would have mortgage loopholes similar to those mentioned in previous chapter. For example, due to bribery and opaque systems, illegal operations such as unsecured loans may occur. It should be noted that this is not in conflict with the supervision since the supervision refers to macro-supervision for a variety of the country's departments and banks. In terms of partners, mortgages in emerging markets are not as mature as in developed countries, nor are the banking industry and supporting industries so well developed. Indeed, China is still an emerging country in terms of bank maturity and cannot be compared to the U.S.

Internal bank control is also related to regulations. Imperfect regulation has resulted in the weaker internal control capabilities of China's banks, and, therefore, the professional management capabilities for mortgages decrease. In China, mortgage risk control tools are still at the stage of manual screening and manual proofreading, as there are no complete quantitative risk-control tools like those owned by the U.S. Furthermore, in the U.S., there are professional teams for mortgages and institutions such as FAH. However, in China, mortgages are issued by banks, and most of their employees are transferred from corporate credit businesses or personal businesses to mortgages. Meanwhile, for some banks in China, mortgages are included in the scope of personal business processing, not listed separately. For mortgage products, the U.S. is at higher risk because of its excessive product innovation; China has fewer product innovations, so it can take comparative advantage of this risk management. In the last part: borrower disciplinary punishment, since the U.S. has a developed judicial environment, it can take legal proceedings against untrustworthy and default people.

Conclusion: Uncertain.

From the comparison between China and the U.S. expands to the whole world. Judging from the results of the horizontal comparison of various markets, it can be seen that European banks also experienced a subprime mortgage crisis. However, since Europe is not the source of the crisis, the negative impact is not as severe as that in the U.S. At the same time, Europe has always been strict in controlling the risk management of banks, and its approach is not excessively volatile, placing Europe in a better position with regard to risk management. But nowadays, since in the real estate bubbles index, lots of Europe cities in the top level with higher bubbles index. Risk management should be more considered in Europe sincerely to avoid the risks of potential burst real estate bubbles aspect. (Appendix 9) The U.S. is also an advanced economy. However, because there are too many financial innovations there, the risks of financial derivatives cannot be ignored. Compared with the same period in the previous year, the performance of emerging markets in housing mortgage loans is not very good. Because of economic development, the real estate market has greater instability. From the comparison of the BRICS counties as well as some developed countries (Appendix 10), it can be seen that almost all the upper points are from the developed countries and the low residential property prices are mostly from emerging counties. Although the highest line shows the real residential property price is in India, and lowest also belongs to one of the BRICS countries (Russia). Therefore, this shows not only the degree of housing price variation between countries that the housing price in developed countries is generally higher than it in emerging counties but also clearly shows the instability of the housing market in emerging countries.

At the same time, due to technical costs and other issues, the credit information system is unable to achieve widespread acceptance. There are also some other factors, such as bribery, which prevent banks from being able to make accurate risk judgements. As a result, loans may be centralised in the hands of lenders who do not need them. Therefore, compared to the U.S. and Europe, the risks related to the emerging markets are more particular. It is worth mentioning that the risks of financial innovation in emerging markets are relatively minor. The reason is that there is almost no financial innovation in emerging markets.

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6.2. Longitudinal comparison results based on before and after the subprime crisis

After experiencing the subprime mortgage crisis, the global economy began to stop pursuing the previous crazy state and was cautious about financial derivatives. It has gradually become rational for financial innovation. While financial innovation brings higher returns to investors, it spreads risk among a full group and has the function of passing on and amplifying risk. Therefore, after the financial crisis, all countries began to exercise stricter supervision on financial innovation (here especially MBS and related products) and financial derivatives.

Besides, the subprime mortgage crisis also related risks in pursuit of their own interests through selectively ignoring credit risks. The pursuit of their own interests promotes the prosperity and activity of the financial while also amplifying its credit risks. Therefore, in the years since the subprime mortgage crisis, various markets have also strengthened the regulation of banks and supervision of the whole process of housing mortgage loans.

At the same time, the downpayment of housing is stricter than before the crisis, and the phenomenon of zero-downpayment is eliminated in some countries as China and the U.S. They are adopting strict pre-loan credit verification, such as the establishment of credit report systems adopted by various countries, to avoid a high level of non-performing loans. These are the lessons learned from the subprime mortgage crisis, the experience that the world has learned, and markets have been continuously improving over the past ten years.

Conculsion

During the research, the article tested three hypotheses. The first, the first hypothesis was “The subprime mortgage crisis in the U.S. from 2007, it is due to the bank ’s relaxing risk management, which is the root cause of the subprime mortgage crisis”, was confirmed, as found in the thesis statement that the risk management of commercial banks in the U.S. was relaxed and that this was the direct cause of the crisis. Furthermore, it shows with the housing bubble, the innovation in subprime mortgages amplified the crisis.

The second hypothesis was that “China did not break out the subprime mortgage crisis in 2007-mid 2010s, because China did not have the preconditions”. It has been confirmed that China did not have as many housing bubbles as the U.S. had before the subprime crisis. Also, as the facts have proved it, the occurrence of non-performing loans in China is low. With a lack of financial innovation, there is low-risk management in China in housing finance products.

The third hypothesis was that “The risk management of China’s banks today is at an appropriate level” This hypothesis was not able to be confirmed or reject; risk management in China is improving, but there are still weak points. Although China’s risk management is far from the level of the U.S.”, we cannot reject the hypothesis because China has not yet been exposed to a subprime crisis problem.

Topics for further research

Measures in various markets are continuously being improved. It can be said that on a global scale, Europe’s performance of risk management of mortgages is at the top level. Furthermore, for the U.S., which should be more concerned about the over-innovation problem of risk management. In emerging countries, the main focus should be on external risk management during the period of rapid development. All the measures mentioned in the present article are based on the experience and lessons of the subprime crisis. Since changes to the market are a relatively slow process, many measures are still being improved. Due to the pandemic of COVID-19 in early 2020, the world’s economy is facing a new round of crises. The GDP of most countries has shown a significant downward trend, and the unemployment rate has started to increase.

Banks' risk management may face a new round of crises. Unemployment can cause large-scale mortgage borrowers to have insufficient cash flow to cover their mortgage repayments. Under such circumstances, banks do not have sufficient funds to recover and may not be able to meet consumers' needs to withdraw money during the crisis. Therefore, it has not been ruled out that financial institutions have to face the problem of bank runs.

Governments of several countries have introduced policies to postpone the repayments of mortgages to reduce part of the default risk. However, there is always a question of during the recession caused by COVID-19, how long banks' cash flow can be held. Therefore, further research on banks' risk management from the perspective of the current crisis and ongoing pandemic is worthwhile.

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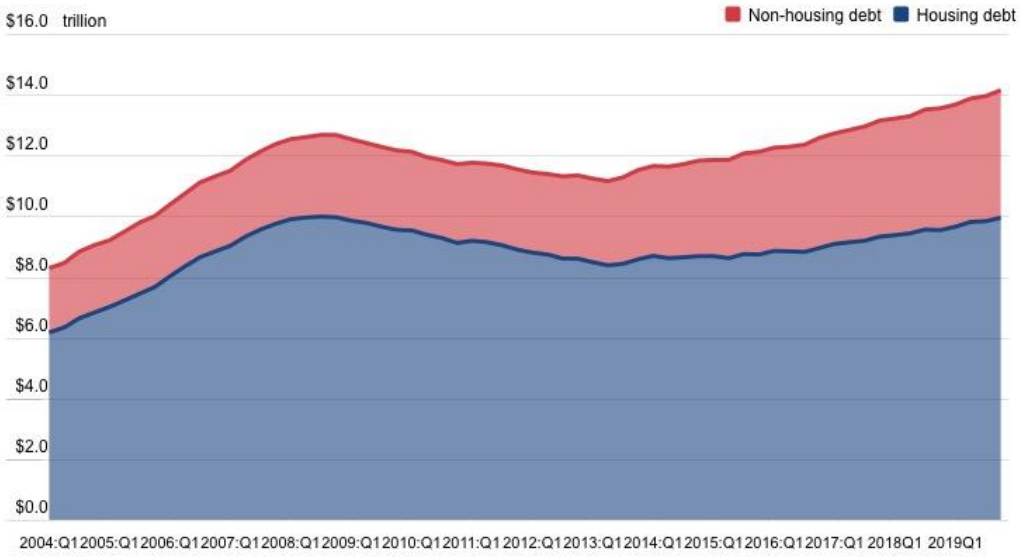
List of appendices

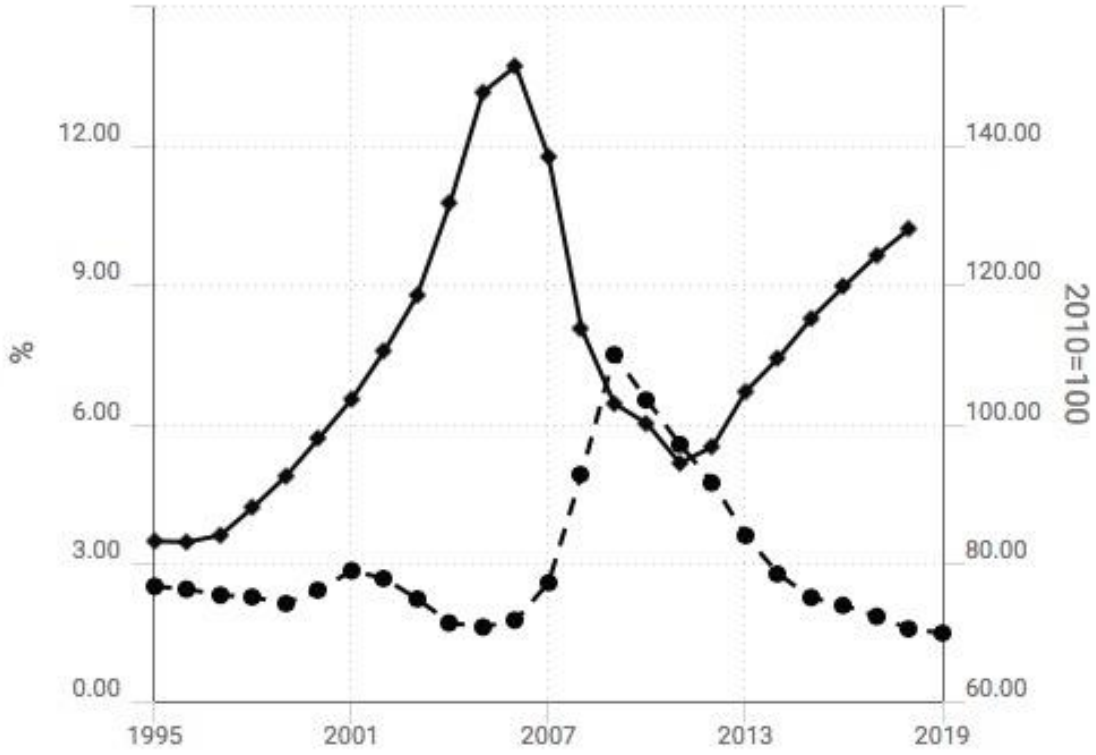
Appendices

Appendix 1: Non-housing debt and housing debt in Total debt balance in U.S. from 2004 to 2019 (chart)



Source: FRBNY Consumer Credit Panel/Equifax, data based on https://www.newyorkfed.org/microeconomics/hhdc.html.

Appendix 2: Relations between real residential property price index and non-performing loans ratio (chart)



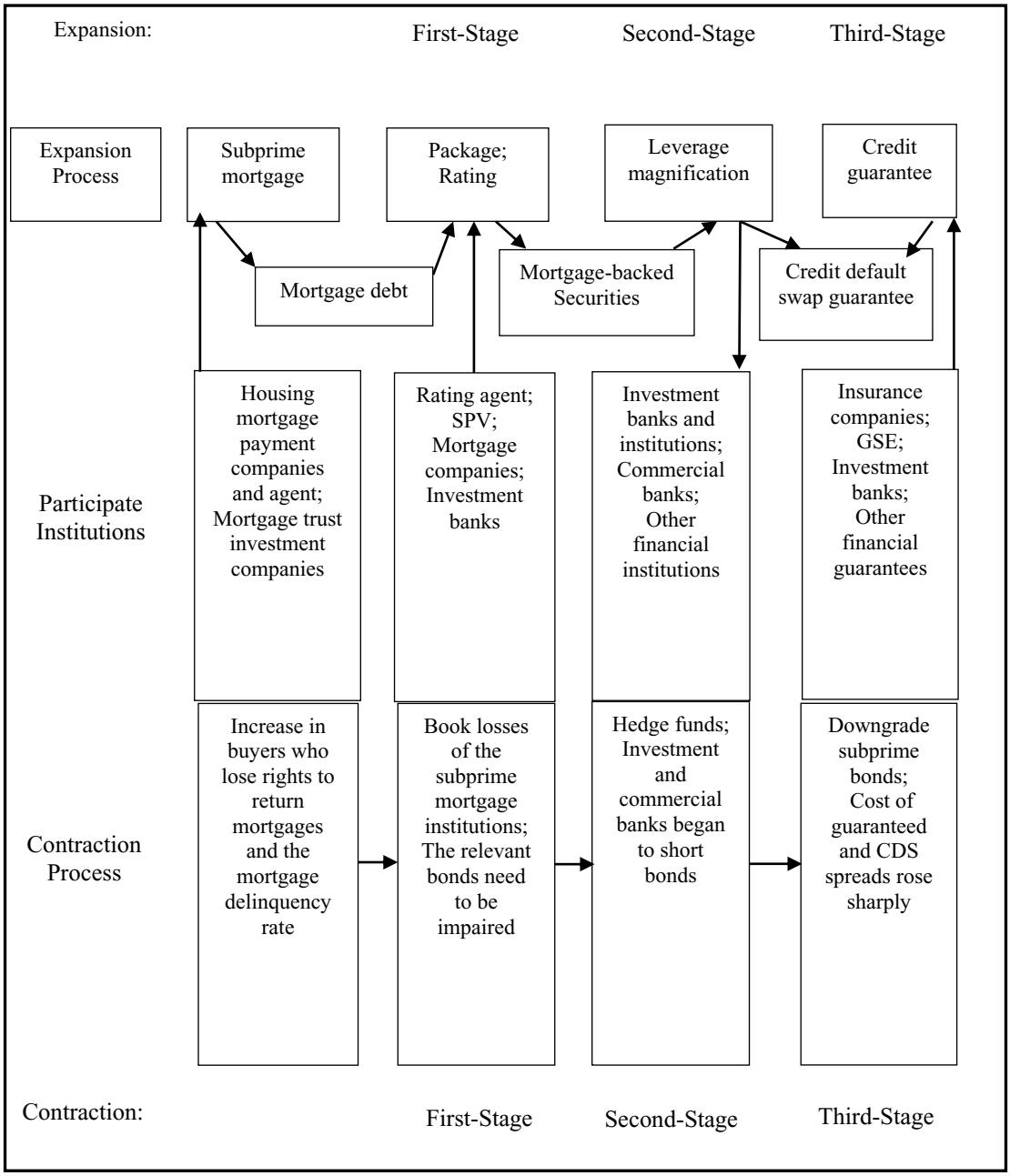
"Solid "-Real Residential Property Price Index: Annual: United States

"Dashed "-Non Performing Loans Ratio: Annual: United States

Source: CEIC Data, data based on https://www.ceicdata.com/en/indicator/united-states/real-residential-property-price-index

https://www.ceicdata.com/en/indicator/united-states/non-performing-loans-ratio.

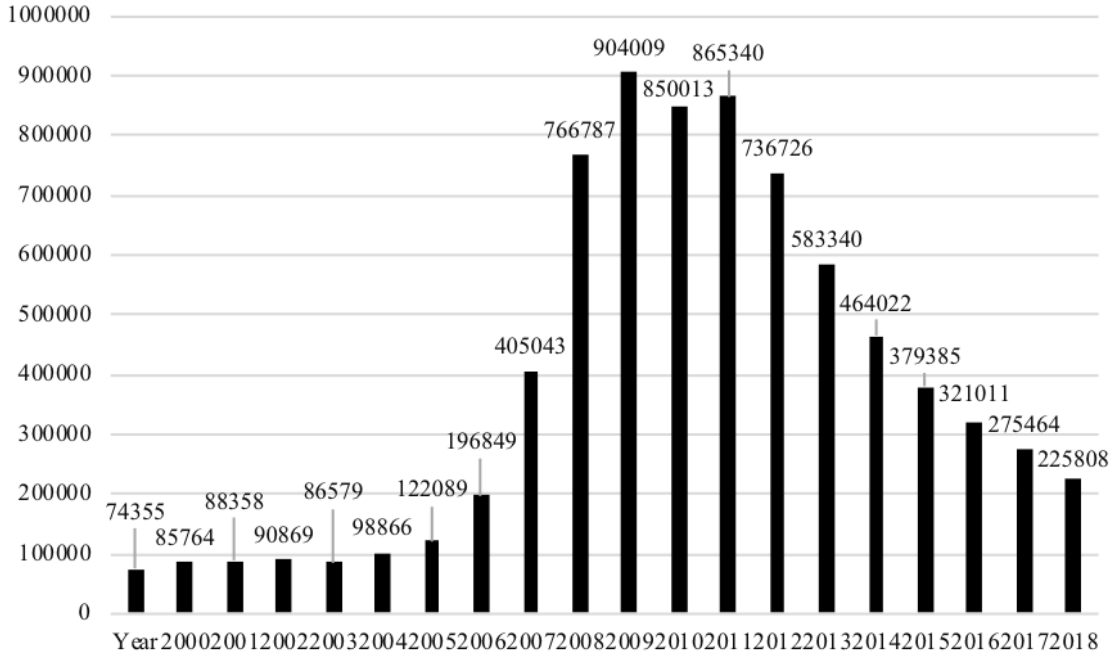
Appendix 3: The process of credit expansion and contraction in the US subprime crisis (chart)



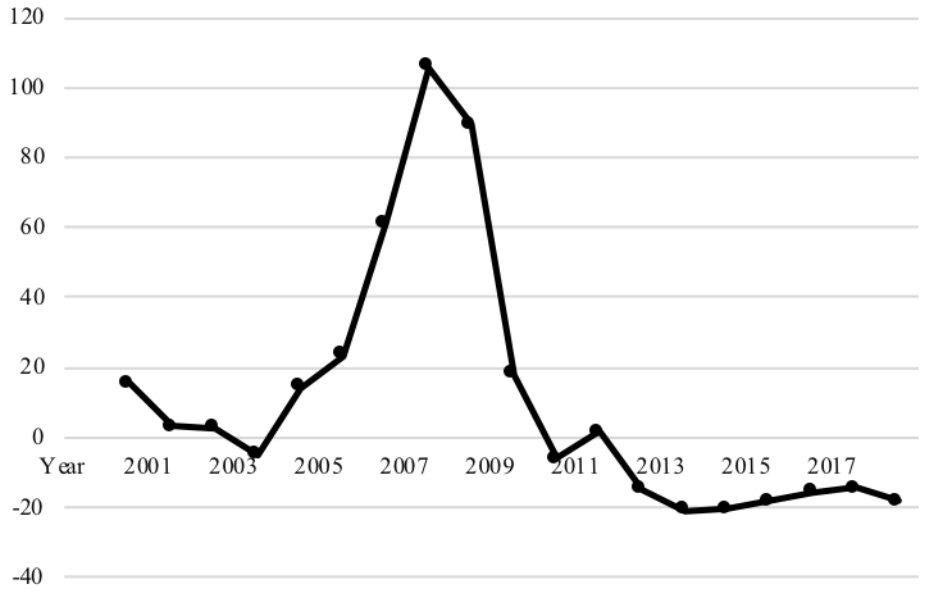
Source: Author'swork

Appendix 4: Delinquencies on All Loans and Leases, Secured by Real Estate, Single-Family Residential Mortgages, Annual (chart)

Delinquencies on All Loans and Leases, Secured by Real Estate, Single-Family Residential Mortgages, Annual(cases)



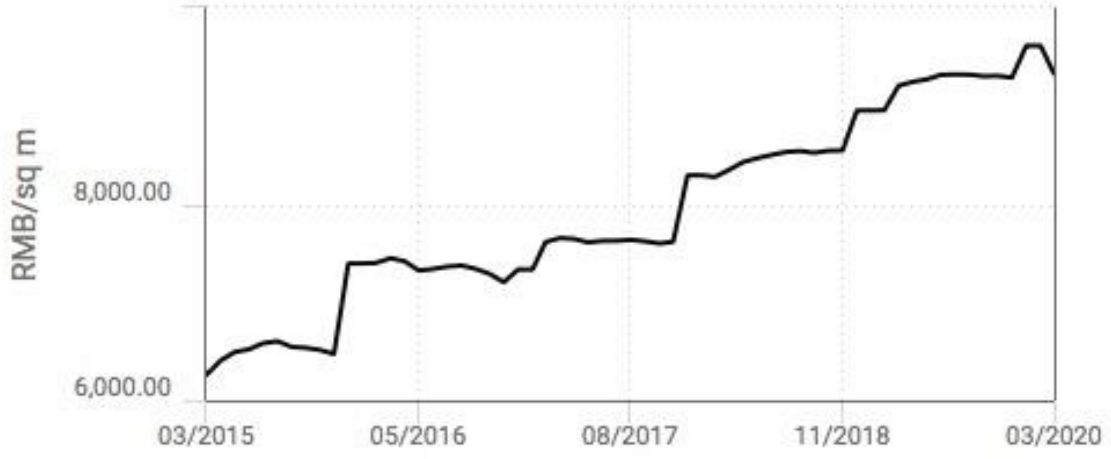
Growth Rate of Delinquencies (Compared with Previous Year, Annual (%)



Source: Author's work, data based on Board of Governors of the Federal Reserve System (US)

https://www.federalreserve.gov/releases/chargeoff/default.htm

Appendix 5: Commodity Bldg Selling Price: YTD Average: Residential (chart)

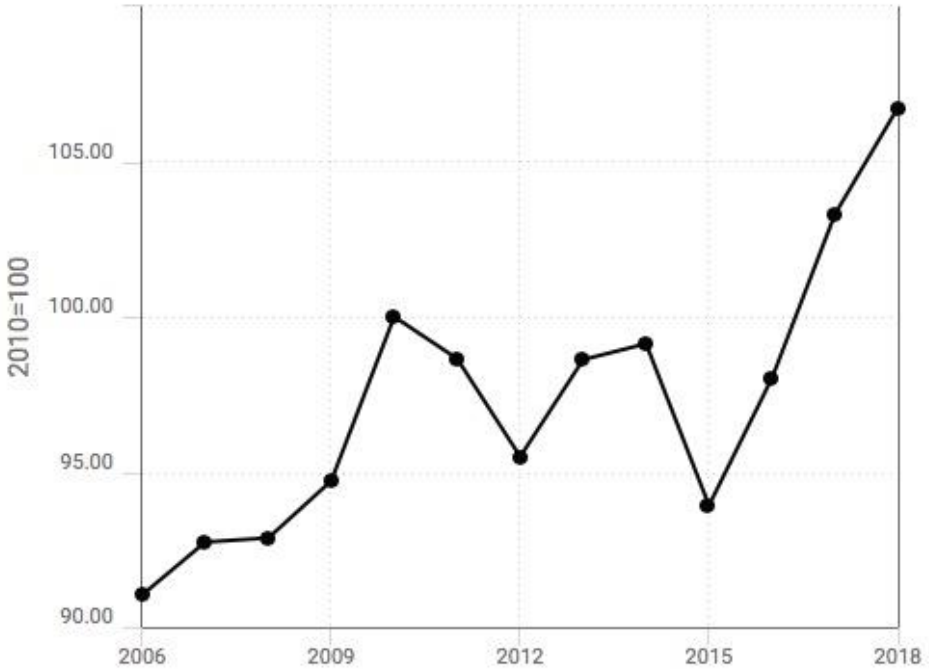


Source: National Bureau of Statistics, data based on

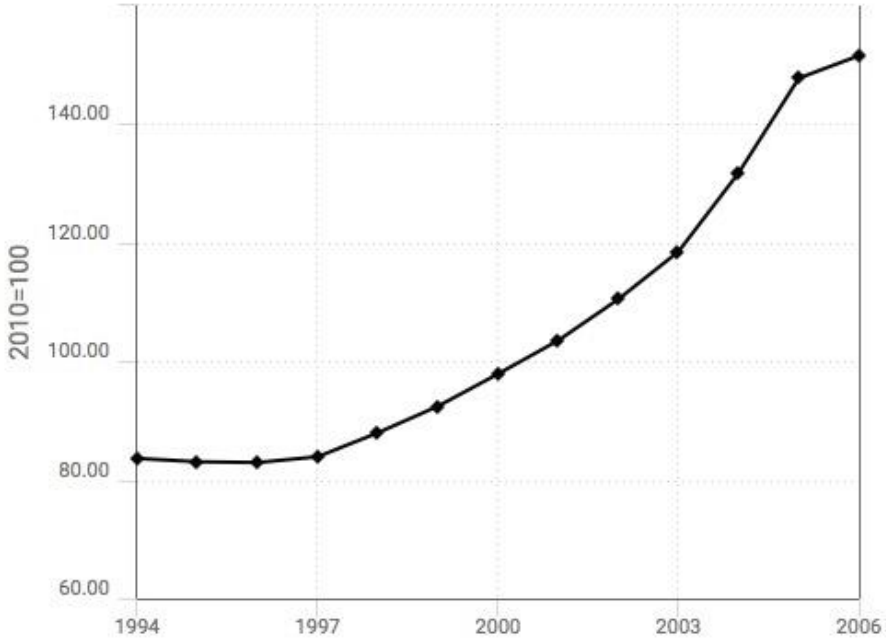
https://www.ceicdata.com/en/china/nbs-property-price/cn-commodity-bldg-selling-price-ytd-average-residential.

Appendix 6: Real residential property price index in china and U.S. (chart)

Real residential property price index in China in 2006-2008



Real residential property price index in U.S. in 1994-2006



Source: Bank for International Settlements, data based on

https://www.ceicdata.com/en/indicator/united-states/real-residential-property-price-index; https://www.ceicdata.com/en/indicator/china/nominal-residential-property-price-index.

Appendix 7: Annual Real residential property price (table)

Country	Year				
	2014	2015	2016	2017	2018
Australia	102.7	110.3	114.9	122.2	118.2
Austria	115.6	119.3	126.9	129.1	135.3
Belgium	99.1	100.1	100.8	102.3	103.1
Brazil	122.4	112.9	101	95.9	93.3
Bulgaria	86.2	88.7	95.6	101.8	105.6
Canada	108.8	113.8	125.7	140.3	140.9
Chile	134.4	147.9	152.1	163.1	175
China	99.1	93.9	98	103.3	106.7
Colombia	125.7	130.7	135.6	138.9	143.5
Croatia	86.4	84.3	86	88.3	92.3
Cyprus	75.2	73.4	73.5	74	74.5
Czech Republic	94.3	97.7	104	113.4	120.5
Denmark	96.7	102.9	108.1	111.7	115.6
Estonia	130.7	140.4	146.8	149.7	153.3
Finland	97.7	97.9	98	98.8	98.5
France	96.3	94.8	95.6	97.6	98.6
Germany	104.9	109.2	116.9	122.2	128.1
Greece	67.2	65	63.9	62.5	63.3
Hong Kong SAR	142.5	160	150.5	173.2	191.1
Hungary	84.7	95.8	108.3	118.6	131.9
Iceland	111.2	118.6	128.9	150.8	158.5
India	149.4	161.9	164.5	172.6	175.5
Indonesia	105.8	105	104.6	104	104.1
Ireland	80.6	90.1	96.8	107	117.3
Israel	123.3	131.4	141.9	147.1	144.7
Italy	81.9	78.8	79	77.2	76
Japan	99.6	101.2	103.6	105.7	106.7
Korea	100.3	103	104.7	104	104.8
Latvia	120	115.7	125.4	132.5	141.6
Lithuania	105.5	110.3	115.2	121	126.5
Luxembourg	108.9	114.3	120.8	125.4	132.2
Malaysia	137.3	144.4	151.4	155.4	159
Malta	97	101.5	106.4	110.5	115.5
Mexico	102.9	108.4	113.1	115	119.3
Morocco	99.7	99.2	98.9	103.5	101.5
Netherlands	79.8	82.2	86.1	91.3	98.2
New Zealand	113.4	127.1	144.2	150.7	153.7
North Macedonia	84.4	84.7	85.8	83.4	84.3
Norway	116	120.4	124.4	128.3	126.6
Peru	151.6	142.3	134.6	134	132.5
Philippines	124.3	135.9	147.6	158.8	169.3

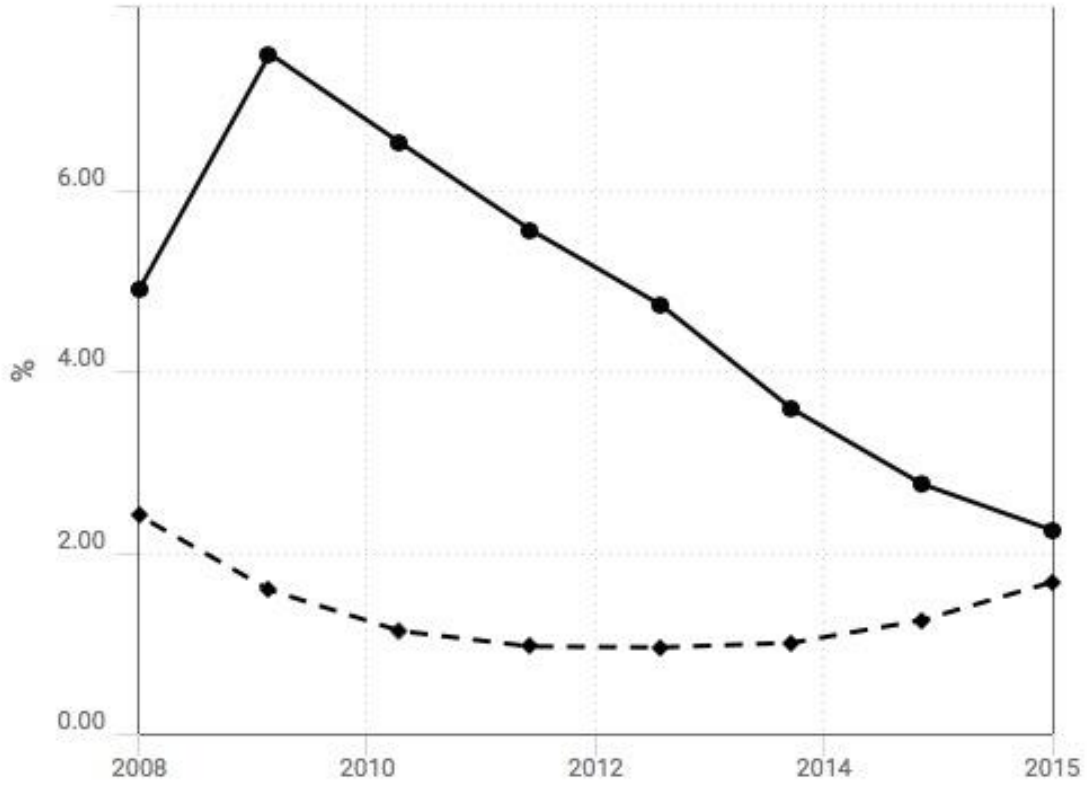
Poland	85.1	87.2	89.4	91	95.3
Portugal	84.9	87	92.6	99.8	109
Romania	70.8	73.2	78.8	82.5	83.2
Russia	73.1	64.1	56.7	52.7	52.4
Serbia	73	74.8	82.2	83.1	89.3
Singapore	98.6	95.3	92.8	91.3	98
Slovak Republic	89.9	95	101.9	106.5	111.6
Slovenia	79.5	80.5	83.2	88.6	95.6
South Africa	99.9	101.5	100.8	99.8	99
Spain	67	69.8	73.2	76.2	80
Sweden	115.3	130.5	139.9	146.5	142.4
Switzerland	122.3	126.4	127.2	127.6	130
Thailand	110.3	114.2	115.5	114.9	120.4
Turkey	109.2	117.8	123.8	122.8	113.2
United Arab Emirates	162.5	142.4	136.5	130.9	117.7
United Kingdom	98.1	103.9	110.4	112.5	113.2
United States	109.4	115.1	119.8	124.2	128.1
Memo:					
All reporting countries (aggregate)	104.8	106	108.7	111.9	114.1
Euro area	91	92.3	95.7	98.3	101.3
Advanced economies (aggregate)	101.6	105.4	109.8	113.6	116.2
Emerging market economies (aggregate)	108	106.8	108.1	110.8	112.8

[1] Annual figures refer to the average of the year.

Source: Author's work, data based on

https://stats.bis.org/statx/srs/table/h2?p=20193&c=.

Appendix 8: Non-performing loans between U.S. and China during 2008-2015 (chart)



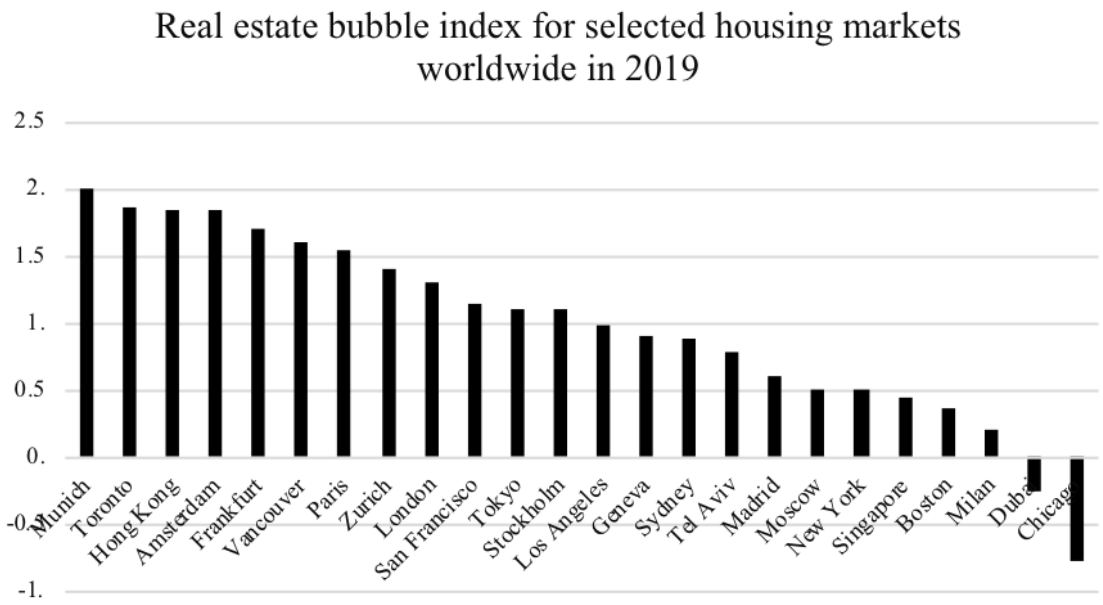
"Solid"-United States

"Dashed"-China

Source: CEIC Data, Databased on China Banking and Insurance Regulatory Commission, Federal Reserve Board,

https://www.ceicdata.com/en/indicator/china/non-performing-loans-ratio, https://www.ceicdata.com/en/indicator/united-states/non-performing-loans-ratio.

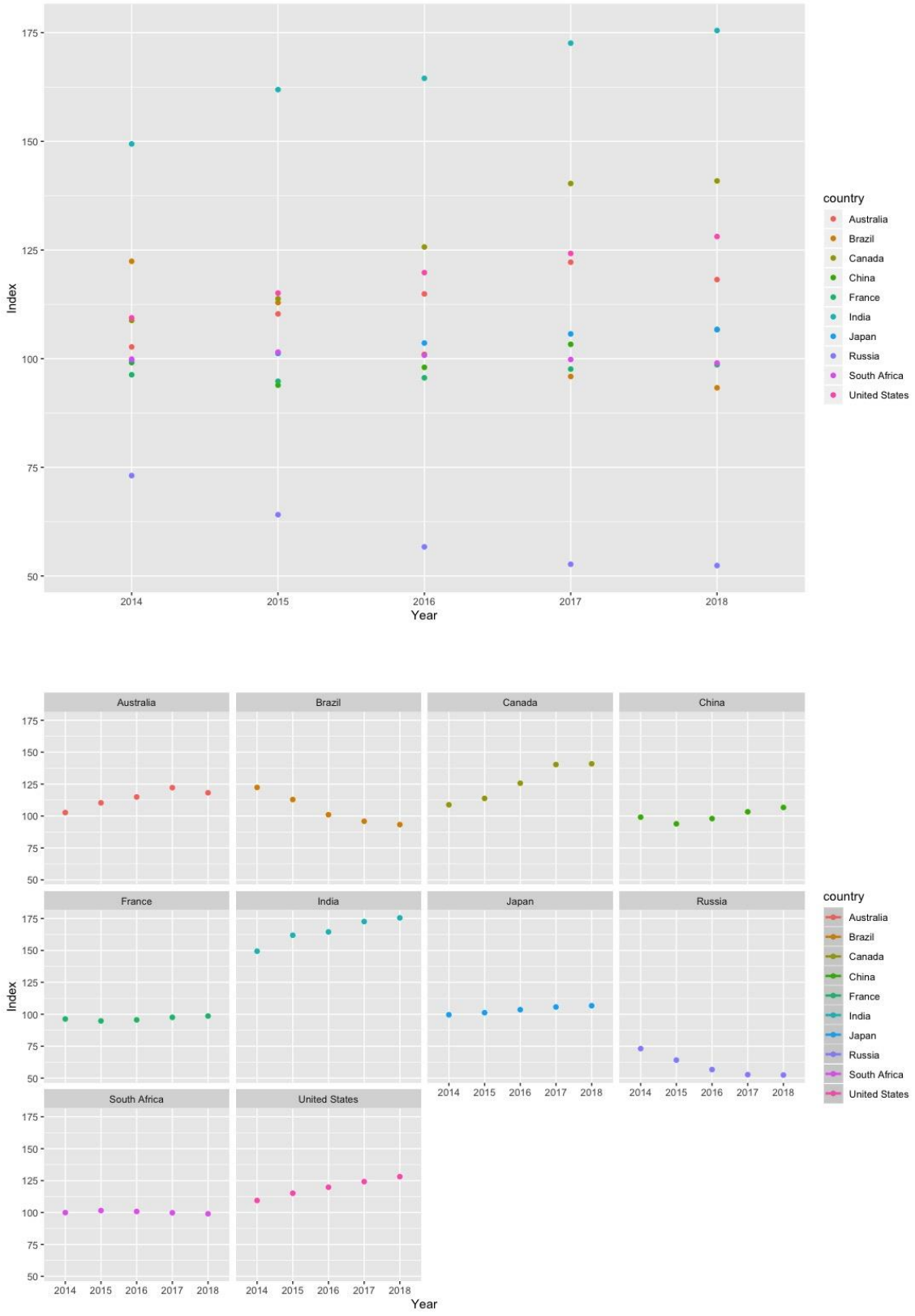
Appendix 9: Real estate bubble index for selected housing markets worldwide in 2019(chart)



Source： Author's work, data based on UBS,

https://www.ubs.com/content/dam/static/emailer/2019/sept/BR-108576/global-real-estate-bubble-index-2019-global-version.pdf?campID=NL-GREBI19-US-ENG-INVESTMENTVIEWS-DOWNLOADREPORT-30092019

Appendix 10: Real residential property price in several countries(graph)



Source： Author's work, data based on Bank for International Settlements,

https://stats.bis.org/statx/srs/table/h2?p=20193&c=