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How do Financial Institutions in China Mitigate Risks in Securitization Markets?

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Abstract: Asset securitization as the essential financial tool has increased the liquidity of underlying assets and promoted rapid economic development. In 2008, the outbreak of Subprime Mortgage Crisis that brought by the collapse of securitization triggered the U.S. securitization market to realize the risks involved in structured financial products, and thus facilitated the development of risk controlling tools. Through the analysis of securitization process, drivers, and credit rating agencies, the study concentrates on the formation of risks and modeling evaluation with evidence in both China and the U.S. markets. Statistical analysis was conducted on Chinese securitized products combining with risk management models built in the U.S. market. The results not only show risk evaluation tools that could improve the market maturity but also reveals the lack of information disclosure in China with the limited access to historical data. The paper attempts to address policy recommendations on mitigating potential risks and promoting financial developments in the China securitization market.

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I.   Introduction

Securitization has been perceived as one of the most innovative financial tools in recent decades and played an essential role in promoting international financial markets. Referring to the process of converting illiquid credit assets or instruments (a portfolio of bonds or credit default swaps) into marketable securities, securitization creates liquidity in the marketplace for the securitized assets (Cerrato, Choudhry, Crosby, etc. 2012, p.2). Since the 1970s, home mortgages pooled by U.S. government agencies. In the 1980s, other asset classes with continuous cash flow start to pool and repackage into marketable securities. A company as the originator firstly combines loans or income-producing assets into the reference portfolio and then sell the pool to an entity, usually a financial institution. In the second step, the financial institution, known as Special Purpose Vehicle (SPV), would sell the pooled assets to capital market investors by issuing tradable, interest-bearing securities. The process of employing securitization allows financial institutions transfer the credit risks from their balance sheets to other entities, such as banks, hedge funds, and insurance companies. From the view of the originating banks, securitized assets are less costly to hold and also result in an inflow of cash. In theory, the transaction transfers credit risk to a third party. Though issuers take advantage of accounting rules, the risks of owing the assets could not be neglected in reality (Jobst, 2008, P.9).

In fact, a detailed analysis of the legal structure of asset securitization reveals that it is primarily a process of reallocating investment risks. In addition to increasing capital liquidity, investment risks are made between different stakeholders and enlarge the difficulty of control with extended financing chain. The recent "subprime mortgage crisis" in the United States shows the risks involving in securitization and vulnerability of the financial system: excessive risk transfers, implicit guarantees, conflicts of interest between repeat mortgages and rating agencies

(Zhou and Chen, 2014, p.3). The paper aims to contribute to the prevention of potential risks in China's progress of asset securitization through the warning from the crisis and the comparison between the U.S. and China securitization markets.

A.   The trend in global securitization
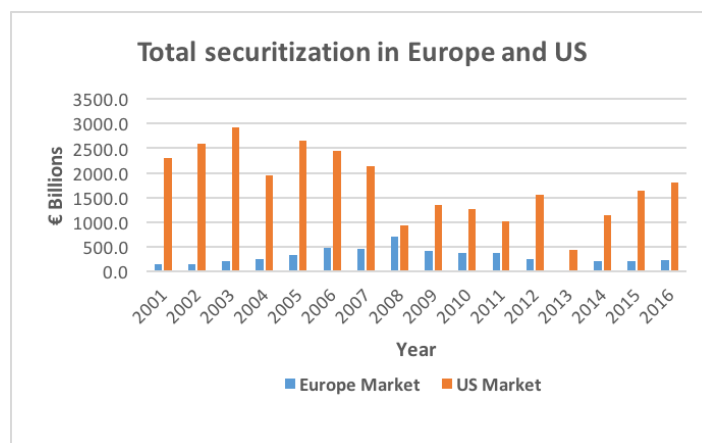
Figure 1: Total securitization in Europe and US between 2001- 2016   Source：SIFMA

Banks were typically using deposits to finance and hold loans until maturity before the development of the securitization market. Therefore, loans funded by deposits and debts (Cerrato, Choudhry, Crosby, etc. 2012, p.2). Arose from the secondary market in 1970, the first mortgage-backed securities (MBS) passing principal and interest payments on mortgages to investors was guaranteed by Ginnie Mae. Fannie Mae, a federal-government chartered corporation, also fostered the development of home mortgages (Cowan, 2003, p.2). Cited by Mordel (2010), from 1996 to 2006, the asset-backed securitization (ABS) market along with MBS grew from $456 billion to $2.8 trillion, an astonishing 500% growth (p.51). The involvement of U.S. subprime mortgages was the driver of global financial crisis, which caused the sudden drop in total securitization in the worldwide market. Figure 1 shows the overall securitization in the U.S. and European market between 2001 and 2016. The market reached its peak in 2008 at the start of financial crisis.

B. **China securitization market**
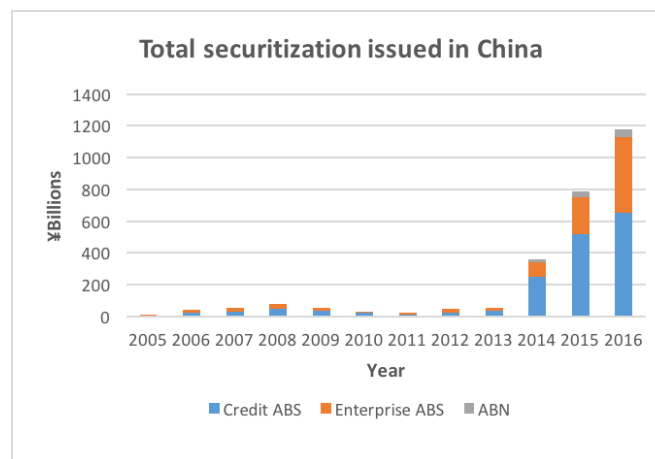
Figure 2: Total securitization in China between 2005 to 2016

Source： Wind news, and Central Clearing Company

Compared to the global trend in securitization, China started the attempt to securitize non-performing assets much late than other markets. In 2005, China began to pilot work on the asset securitization under the particular asset management plan of securities companies, which marked the official launch of asset securitization. Though the government issued incentive policies and improved relevant taxation, the development process was relatively slow from 2005 to 2013. Especially in 2008, due to the fear of being hit by the financial crisis, China suspended its approval of asset securitization projects (Zhou, 2014, P.69). The securitization market has seen explosive growth since 2014, the issuance size of credit asset-backed securities reached an increase of 285% over the previous year. From the product structured, credit ABS has always accounted for a significant proportion. The scale of securitization products expanded significantly in recent years. Figure 12 shows the total securitization issued in China market between 2005 and 2016.

Though the securitization market in China has developed quickly that ranks as the first in the Asian market, compared to the U.S. market, it is still young on risk management in the fields of risk evaluation tools and regulatory support. This paper combines evidence in both China and the U.S. to attempt to address the implications for financial stability arising from securitization after the global financial crisis. In the following section, the paper discusses the existing literature. Section 3 illustrates the empirical evidence on the role of securitization. Section 4 specifies data description and research methodology. Section 5 presents a discussion of results. The paper ends up in section 6 and 7 with a summary of the policy implications and conclusions.

II.   Literature Review

Existing research about risks specified in China securitization market concentrates more on regulatory improvements due to the limited credible domestic cases for statistical analysis. The U.S. securitization transactions with sufficient data and theoretical support have analyzed in previous studies. This paper carries out evidence-based studies using data in the U.S. and China markets, and also literature research on both aspects.

Cerrato, Choudhry, and Crosby (2012) stated on the primary motivation for banks to securitize. They gathered dataset covering annual accounts for 690 UK banks during the period 2000 to 2010. Using six different measures of liquidity, including interbank ratio, Liquid Assets/Customer Deposits and Short term funding, Liquid assets/Total deposits and Borrowing, Net Loans/Deposits & Short-term funding, Net loans/Total Assets, Net Loans/ Total deposits and Borrowing. The results apparently show that the principal driver of securitization is liquidity, whether banks need to fund their balance sheets. Zhou and Chen (2014) illustrated that the driver behind securitization was enhancing capital liquidity, which inevitably increases the potential investment risk. Firstly, since the risk of asset securitization mainly comes from the underlying

assets composed of the debts assets with future earnings, the risk transfer would not reduce and mitigate risks even though being recomposed. Secondly, the intricate designs and repackaging of asset securitization extended risk effects. Investors-holding securities mean that risk spreads from the minority to the majority. Such proliferation may be negligible when the total risk is small, but as promoters and SPVs continue to increase for self-interest debt of the underlying assets, the scale of asset securitization and market coverage enlarged significantly. Mandel, Morgan, Wei (2012) investigated the role of banks as credit enhancements in the securitization process. They used cross-sectional regression models to examine the relationship between the performance of securitized assets and the extent of credit enhancements. The results put forward the buffer hypothesis that improvements are a buffer against observable risks and also serve as a signal of unobservable quality.

Salah, Fedhila, and Hassouna (2012) sampled 174 US commercial banks between 2001 and 2008 to analyze the impact of securitization on risk behavior. Combining commercial banks' accounting data and macro-economics variables, they reported a greater recourse to securitization is associated with an increase of the credit risk in their balance sheets. To further analyze the effect of securitization on credit risk in American commercial banks, they modeled with the ratio of risk-weighted assets to total assets. The results revealed that different classes of securitized assets lead to heterogeneous effects on bank credit risk. Krahnen and Wilde (2006) focused on a strong relationship between that the announcement of securitization and systematic risks of all tranches. They used a simulation of European banks' returns and bank's equity beta measures a risky activity during the launch of a securitization transaction. Also, Interbank linkages would increase when risks are transferred to other banks and therefore augment systemic risks. Wu, Yang, and Hong (2008) researched the impacts of asset securitization of U.S.

commercial banks' risk exposure during the period 2003-2007. To access banks' exposure to various risk factors in the securitization market, they adopted a time-varying risk beta model, in which a bank's exposure to a common risk factor and a function of multi attributes. Their results of 229 banks in the model revealed that banks' securitization activities increased their exposure to credit, liquidity, and secondary market risks.

Santiago, David, and Francisco (2011) analyzed the quality of MBS and ABS securitization in Spain from 2000 to 2010. They sampled 565 securities of MBS and 420 securities of ABS to identify the primary determinants of the changes in the quality of MBS and ABS. Their estimation model concluded that the sequence of credit quality mainly determined by loan growth on loan performance. Subsequently, they generalized their findings to other countries where securities allow issuers to transfer credit risks usually involve a more extensive retention of the underlying risk within banks' balance sheets. Segoviano, Jones, Lindner, and Blankenheim (2013) explored the financial stability implications resulting from securitization markets. They addressed the factors that either are currently facing obstacles or have contributed to the financial crisis. Besides regulation initiatives mentioned in most of the other papers, they discussed the role of operation infrastructures; insufficient resources and contradictions between services and trustees suggested that additional reforms put forward to lower their overwhelming places in financial crisis. Guided by features of securitization, they further proposed policy recommendations to mitigate impediments affecting financial stability and thus to build a healthy securitization market. Na, in his paper (2011, P326) worked on American development process about the asset securitization. Narrowing down the topic of the U.S. mortgage securities study, he focused on the impact of mortgage securitization on financial stability in the U.S. economy. Fluidity, the risk transfer and diffusion mechanisms of Mortgage-Backed Securities (MBS)

addressed as factors contributing to the outbreak of the financial crisis, which brought by the asset securitization. Securitization caused the risk of continuous expansion, circulation, and return, along with the increase of credit scale. Sub-debt then turned into bad debt, the financial chain is destroyed, which leads to the financial and economic instability. Concentrating on the situation in China, they proposed recommendations for the authorities to be aware of the rapid increase of asset bubbles and non-performing loans, for the governments to compensate defects in market liberalization, for improving the credit system, laws and regulations in China.

III.   The securitization motivation, risk, and financial stability

A.   Product structure design, risk transfer, and credit enhancement

Going depth into the analysis of product structure of asset securitization, it is the process of asset restructuring and financial intermediation utilizing financial instruments. The basic structure involves same segments throughout the world having securitization products: First, the asset pool, or asset packaging, means that sponsors can produce a stable cash flow of similar debt assets and regroup, forming a "pool of assets." Second, the transfer of assets means that the promoters transfer the assets to an SPV through trust or transfer, which constitutes the basis for SPV's issuance of securities. Third, credit enhancement refers to the process that SPV increases the credit level of the accepted assets to meet the required standard of issuing securities. Maintaining the level of investment credit becomes the basis of the asset. Fourth, the issuance of securities by SPV is to obtain the appropriate funds. Fifth, pay the consideration, SPV use funds raised by the publication of securities to pay the sponsors as the transfer of the attention of the assets and then use the proceeds of the transferee to pay securities investors securities principal and interest (Zhou and Chen, 2014, p.4). The security instruments are doing well on improving the operational efficiency of assets; transferring the future of the debt assets into securities assets

successfully changes the illiquid assets. The overall structure seems to be a perfect design that risks transferred from sponsors to the SPV and eventually dispersed to investors to buy securities. Actually, just because of the structural design and motivation, potential risks spread from the minority to the majority. Even worse, without the necessary precautions and controls, risks would affect the macroeconomics like the U.S. subprime mortgage crisis.

In the system design level, the risk transfer is actually the re-allocation of risk and is also the primary motivation of securitization. Because the risk of asset securitization mainly comes from the securitization of the underlying assets, the transfer of risk is not possible to reduce the objectively existing risk. With the new allocation and the transfer of underlying assets, the risk of the original claims borne by the sponsors also transfers to the SPV and the securities holders. Asset securitization has changed the status of risk, making the risk switching from stock to liquidation. Regarding the characteristic of risk transfer for securitization, if asset-backed products lost supervision, the risks would spread and harm the financial markets.

The other driver of securitization, credit enhancement, refers to the issuer using various methods to improve the credit rating of securities, which ensures investors pay interest and principal on time and therefore enhances the wide acceptability of the securities. The design seems to reduce overall risks of underlying assets, especially credit risk, and disperse to those who can and are willing to tolerate. However, asset securitization may make the originator's risk content more complicated, and credit enhancement may keep the risk of asset securitization still at the originator (Pan, 2011, P3). For example, banks construct the principal and interest payment order for credit enhancement of credit assets and only selling the priority bonds. Reserving of subordinated bonds moves assets subordinated bond, but banks can do little on mitigating risks on subordinated bonds. Therefore, after the securitization of assets, although the amount of the

assets initiated by the agency decreases, the risk level of the assets may increase instead. Risk transferring and credit enhancement, as the significant benefits, motivate agencies to securitize assets, but they are also the causes of financial disaster on the other hand.

B.　　　Securitization products and associated risks

There are four types of structured mortgage products (SMPs) in the typical U.S. market and similar types of products in China market. Every kind of products has its related risk: The underlying assets of ABS include credit card loans, car loans, student loans, equipment lease payments, trade receivables, tax liens, etc. As the financial crisis erupted, the size of ABS shrank dramatically. In 2013, the volume of U.S. asset-backed securities dropped to $1.2 trillion from $1.9 trillion in 2007. MBS includes Residential Mortgage-Backed Security (RMBS) and Commercial Mortgage-Backed Security (CMBS). The balance of MBS had a nearly 10% decrease as of the second quarter of 2013. The potential risks of ABS and MBS mainly concentrate in the underlying assets themselves. Factors such as rising interest rates, falling housing prices and dropping economics all have a negative impact on cash flows of underlying assets. For example, in the sub-prime crisis, the cost of MBS decreased significantly due to the rise of the default rate of subprime mortgages and the deterioration of underlying assets. Collateralized debt obligation (CDO) includes corporate bonds, emerging market bonds, and bank loans, and later gradually comprises mortgage loans, MBS and ABS and other securities. By 2008, the size of the global CDO has expanded to $1.4 trillion, while affected by the financial crisis it dropped to $803.5 billion by 2013. Some types of CDO have complicated structures with repeat securitization, which lengthens the intermediary chain of funds and exacerbates the asymmetric information so that investors are hard to know included underlying assets and the percentage of toxic assets. Repeat securitization is aiming to package low-quality assets, so the

default risk mostly is hidden in CDO. Asset-backed commercial paper (ABCP) is a securitized commercial paper. The underlying assets of the ABCP include trade receivables, car rental loans, credit card receivables and securities with 3-5 years' maturity, while the majority of commercial paper issued within 30 days. The earnings of ABCP come from mismatched spreads of assets and liabilities. Once the confidence of investor declines, refusing to finance the newly issued ABCP, the market would quickly fall into the liquidity crisis (Zou Xiaomei, Zhang Ming, Gao Pei, 2014, P14).
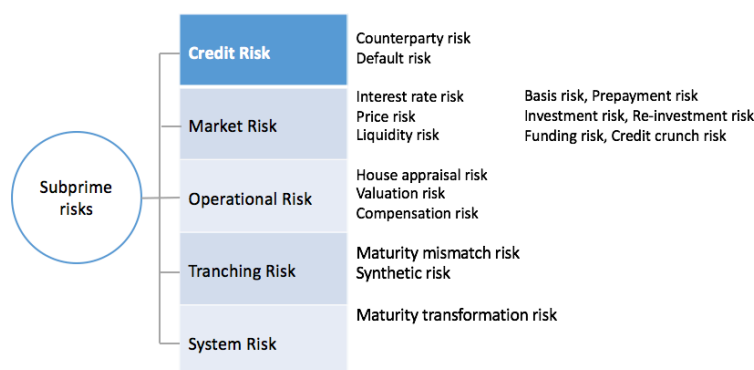
Figure 3: Overview of Subprime Risks

Significant risks arising from SMPs are credit, market, operational, tranche and systemic risks. All categories of risks describe as subprime risks. Petersen, Mukuddem, Waal, etc. (2011) provided the figure above shows the diagrammatic overview of the mentioned subprime risks (P14). The most primary dangers among all above are credit and market risk. Credit risk may cause the mortgage loss of originator and the possibility that SPVs are unable to make payments. Credit risk will be analyzed in detail in later sections with financial models and banks' financial statements during the financial crisis. Subcategories of market risk consist of interest rate risk, liquidity risk, and price risk: interest rate risk results from the fluctuations of SMP interest rate returns, and Liquidity risk arises from SMPs could not be bought or sold as anticipated, which

also include funding and credit crunch risk. Operational risk occurs when the insufficient or inadequate procedures, processes, systems or improper actions have taken during the process of securitization. In structured finance, a tranche refers to security can be split into smaller pieces and sold to investors. Tranching risk causes the complex associated with the slicing of SMPs into tranches in securitization deals. Another tranching risk, maturity mismatch risk, arises from the discrepancy between the economic lifetimes of SMPs and the investment horizons of investment banking. In banking, systemic risk is the risk for the whole banking system, meaning that a single failure can cause a bankrupt in the banking system or market.

C.   Rating changes and financial stability

Credit rating agencies (CRAs) have contributed a lot to the growth of the securitization market. At the early age of mortgage securitization, CRAs always gave out AAA for investment grade ratings regarding the continuously rising house prices and relatively low-interest rates at that time. Triggered by the marketability of ABS deals, CRAs as underwriters gradually acknowledged the complexity and opacity of ABS instruments. Before the subprime mortgage crisis (SMC), the quality of mortgages was more important than quantity of originated mortgages. The desired high-yielding ABS deals make CRAs face a demand for grade inflation. CRAs have two primary incentives to give out over-optimistic ratings on structured mortgage products: First, issuers want higher scores on their products, while issuers are clients of CRAs and would jump to other agencies if they cannot receive satisfied ratings. Second, investors like banks and insurance companies desire to use high-rated securities to reduce capital on hand. However, over-optimistic ratings of structured mortgage products helped inflate the housing bubble, so that embedded credit risk of mortgages outsources through the securitization process. Moreover, individuals and institutions put excessive confidence and reliance on credit ratings

provided by CRAs before SMC. In 2006 and 2007, refinancing faced more difficulties, so that mortgage delinquencies increased and RMBs lost value suddenly. Petersen, Mukuddem, Waal, etc. (2011) investigated 19 American banks from 2001 to 2005 on the information asymmetry issues in agencies using bank credit risk evaluation models. Their findings show that issues in agencies themselves and information asymmetry problem significantly caused the deviation of agency credit ratings (P34). Because of the failure of independent analysis on the underlying assets, during the SMC, the house prices declined, the value of securities decreased, and default rates increased dramatically. As a result of SMC, the RMBS market frozen, which spread to the whole financial system and result in the collapse.

The risks along with asset securitization continue to expand and transfer; as a result of the SMC, the securitized financial chain destroyed, and financial institutions with connection affected each other, leading to the financial instability. From the point of rating agencies, to obtain more profits, they liberalized the condition of loans. The action prompted some investors who could not have permission to enter the real estate market, resulting in the collapse of the real estate bubble. Once the financial chain among a series of financial institutions broke, investors lost confidence in the market and led to fluctuations in the financial system. From the perspective of currency liquidity, asset securitization caused inflation, which affected the overall economic stability. In the meanwhile, the paradox between the need for innovative financial products and damaged credit rating led to the credit market supply exceeds demand. Eventually, the collapse of the final innovative financial product price undermined financial stability. Liu (2017) also analyzed the effect of risk transfer and diffusion mechanism to financial stability: the credit risk was initially locked to banks, but then spread to pension funds, mutual funds, commercial banks, insurance companies and foreign investors through asset securitization process in the United

States. The credit risk spread to a greater extent due to the risk transferred. Because of the default

of investment bonds, its investment value depreciated and its liquidity declined. This reduced

investor confidence and led to a depressing bond market and financial market turmoil (P20).

IV.   Data Description and Methodology

A.   Altman Z-score: A tool to predict credit risk for an individual bank

Edward I. Altman published The Altman Z-score formula in 1968, which is a value to predict

the likelihood that a firm will go bankrupt in two years. The score is usually used to predict

default risk, to measure financial distress and the financial health of a company. Investors could

use Altman Z-scores to determine the underlying company's financial strength and whether to

invest in the company or not. In 2007, while credit ratings of securities generally higher than

they should be, the Altman Z-score indicated the companies' risks. The average Z-score for

companies in 2007 was 1.81, meaning that over 50% of companies was overvalued and

experienced high financial pressure by credit agencies. Garg (2017) calculated the Altman Z-

score for Lehman Brothers and Northern Rock in 2007, a year before financial bankruptcy, to

support the argument of credit risk in the securitization market. This paper developed an analysis

of commercial banks in China using Altman Z-score, which hasn't utilized in previous studies.

As an example, the financial data of China Construction Bank uses for the calculation of Altman

Z-score, which is the first bank to attempt securitization in China. Data obtained from

companies' annual report. The Altman Z-score is calculated using five financial ratios:

profitability, leverage, liquidity, solvency, and activity. The equation is as follows:

$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1.0X5.$

$X1$ = working capital / total assets.

$X2$ = retained earnings / total assets.

X3 = earnings before interest and taxes / total assets.

X4 = market value of equity / book value of total liabilities.

X5 = sales / total assets.

Table 1: Financial Statement of 2007, in millions		
	Lehman Brothers	Northern Rock
Total Assets	$691,063	$109,321
Total Liabilities	$668,577	$106,621.7
Working Capital	$22,486	$2,700
EBIT	$6,013	$5,979
Retained Earnings	$19,698	$1,251.9
Market Value of Equity	$22,490	$1,23.90
Net Revenue	$19,257	$6907.5

The following table shows the financial ratios and corresponding Altman Z-score for Lehman Brothers and Northern Rock:

Table 2: Results of Altman Z-Model for Two Banks		
	Lehman Brothers	Northern Rock
(Working Capital/Total Assets)*1.2	0.0325	0.02469
(Retained Earnings/Total Assets)*1.4	0.0285	0.0115
(EBIT/Total Assets)*3.3	0.0087	0.0546
(Equity/Total Liabilities)*0.6	0.0336	0.0011
(Revenue/Total Assets)*1.0	0.0278	0.0631
Z-score	0.1464	0.289668

The zones of discrimination for Altman Z-score: Z > 2.99 – "Safe" Zone; 1.81 < Z < 2.99 – "Gray" Zone; Z < 1.81 – "Distress" Zone. The table 2 above clearly showing that Lehman Brothers (Z-score: 0.1464) and Northern Rock (Z-score: 0.2897) were on the verge of bankruptcy in the year 2007.

Analysis of China Construction Bank Using Altman Z-Model (Data retrieved from bank's annual report 2007, in billions in Renminbi):

Total Assets = ¥65,981.77   Retained Earnings = ¥17,845

Total Liabilities = ¥61,758.96   Market Value of Equity = ¥4,222.81

Working Capital = ¥4,233   Net Revenue = ¥691.42

EBIT = ¥3,257

Table 2: Results of Altman Z-Model for China Construction Bank	
Financial Ratios	Result
(Working Capital/Total Assets)*1.2	0.0760
(Retained Earnings/Total Assets)*1.4	0.0028
(EBIT/Total Assets)*3.3	0.1617
(Equity/Total Liabilities)*0.6	0.1458
(Revenue/Total Assets)*1.0	0.0105
Z-score	0.3968

The Altman Z-score result of China Construction Bank is 0.3968. Though the value is higher than that of Lehman Brothers and Northern Rock, it is still far below the safety line of 1.81. It is "lucky" for commercial banks and corporations in China that the government forced

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stopped the approval securitization securities. Before the global financial crisis, commercial banks in China were facing huge financial pressure as well and default risk became even worse after being affected by the crisis. Altman X1 measures liquid assets compared to the size of the firm, providing the short-term financial position of the business. Generally, the more working capital to total assets is, the better the liquidity situation. However, if the value is too high, it may result from high inventory and improper use of excess cash. X2 measures profitability in relation to the company's earning ability and how much the company relies on its debt. Retained earnings would be used for a company to operate a further business and to pay off debt. So, if the firm is luck of retained earnings, it will borrow from debt. X3 measures operating efficiency that how a company could generate profits before interest and taxes from assets. The ratio shows operating earnings in relation to long-term viability. X4 measures how is the market value of the company and also shows the security's price fluctuation. However, the ratio is controversial because when the stock price of the firm is high, the ratio rises up, which could be the reason that coefficient is the least among all components. X5 measures asset turnover, indicating efficiency and business quality of the firm. The ratio shows higher when the ability to generate more profits from assets. The original test was collected from 66 manufacturers and did discriminant analysis based on their common financial ratios. Then, Edward used the method for other industries and eventually set for the zone of safety, zone and dangerous. In 1999, the model was tested to be 80-90% accuracy in the use of predicting the likelihood of bankruptcy. In 2009, Graham Secker, an analyst in Morgan Stanley, collected data from European companies and analyzed with Altman Z-score. Results show that companies with lower Z-score value are actually underperforming than the market average performance ("Is it possible to predict corporate bankruptcy using a formula?" 2011).

B.   Z-score: A risk-taking measurement for an overall banking system

The famous bank risk measurement was primarily proposed by Roy (1952) and subsequently used by Goyeau and Tarazi (1992), Laeven and Levine (2006), indicating for the ability of bank risk-taking. The calculation assessed by the accounting of banks, showing the distance from insolvability that a higher Z-score means a lower probability of default risk. To capture the default risks in a country's banking system, the formula would weight regarding the total assets of an individual bank. Mathematically, it denotes as follows:

$$Zscore_{it} = \frac{ROAA_{it} + E_{it}/A_{it}}{\sigma(ROAA_{it})}$$

The numerator shows banks' buffers of returns and capitalization, and contrasts to the denominator explains the volatility of returns. The ROAA defines as the average return on assets (ROA), Equity/Asset defines as the capital ratio, and standard deviation of ROAA shows the volatility of the average return on assets. Based on the accessibility of data on Federal Reserve Economic Data (FRED), especially the length of Chinese banks data published, the graphs below present bank z-score comparing China and the United States from 2000 to 2015.
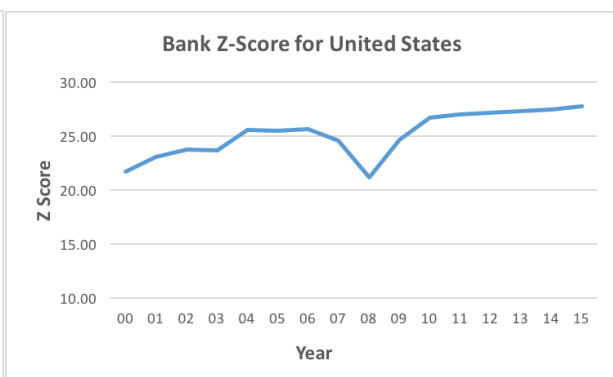

Figure 4: Bank Z-Score in China 2000-2015   Figure 5: Bank Z-Score in the U.S. 2000-2015

The results compare the volatility of equity returns and the volatility of earnings as measures of bank risk. The approach constructs the time-varying z-score consisting with the banks' risk profile and risk-taking ability throughout the time. The Z-score is useful to identify the minimum level of a capital amount in banks and standardize credit risk level in the banking system.

Besides the contributions of ROA and capital ratio to banks' Z-score in China, a regression model further developed among Bank Lending Deposit, 5-Bank Asset Concentration, Outstanding Domestic Public Debt Securities to GDP and Credit to Government and State-Owned Enterprises to GDP. The multiple regression results showed in table 3. The multiple regression can express as followed regarding to the results:

Z-score = -4.82 + 6.27 X1 + 13.11 X2 – 0.42 X3 +1.31 X4 -1.06 X5

X1: Return on Asset (An indicator to show commercial banks' net income compared to total assets). The observation combined with Return on Equity (ROE) could show the profitability of countries' commercial banks.

X2: Bank Lending Deposit Spread (Difference between the lending rate charged by commercial banks on loans and deposit interest rate on three-month deposits). Mortagage and securitization are both methods of financing for firms that relationship indicates in the equation. Moreover, mortgage uses as collateral for the ABS trust that sold to investors.

X3: 5-Bank Asset Concentration (Five largest commercial banks in a country as a share of total assets in banks. Total assets include total earnings, cash and due, fixed assets, current and deferred tax assets, goodwill, other intangible and other assets). The role of assets is critical to determine whether the banks in a country are on the edge of default.

X4: Outstanding Domestic Public Debt Securities to GDP (Total amount of domestic public debt securities/outstanding compared to the share of GDP. The total amount of debt securities includes long-term bonds and short-term notes, short-term notes, treasury bills, commercial paper). The observation shows the relationship among debt securities, insolvent bank risk and being available to analyze contributions for securitization status.

X5: Credit to Government and State-Owned Enterprises to GDP (Compared credit by domestic money banks to the government and state-owned enterprises and GDP). The observation of enterprises value owned by the government is valuable due to the power of Chinese government in the banking system and percent of government-owned enterprises and banks as well.

The equation selects five indicators to analyze the relationship contributing to banks' Z-score. The purpose of analyzing the observations is to forecast Z-score and risks involved in a country's banking system, which is closely related to securitization volatility.

C.   Risk pricing mechanism: A model to measure prepayment assumption

Compared to the developed market, the current transactions of asset securitization market in China relatively lacks liquidity, information disclosure system, and credit rating mechanism. The current pricing models in China securitization market bases on the future cash flow, anticipated yields or spread difference of interests. More quantified pricing models built concentrated on liquidity and capital costing, but the models cannot adequately reflect real risks level. With the variety of underlying assets and transaction structure for securitization continue to increase, product risk assessment is more difficult. Incomplete and not matching product pricing mechanism also leads to potential risks in China securitization market.

Big differences are affecting the prepayment behavior between China and the United States: First, the most important factor motivates the U.S. borrowers to prepay is to benefit from interest rate differences. However, in China, since borrowers are not allowed to refinance, if a borrower intends to refinance when the interest rate drops down, he can only pay ahead relying on his income. Therefore, income level is the most determinant factor affecting borrowers in China. Since income per capita in China is lower than that in the U.S., and Chinese borrowers are less sensitive to market interest rate, the borrowers in China have higher willingness to pay ahead than US borrowers. Moreover, because Chinese residents have different understanding in mortgage owning to culture differences, they are more likely to use excess deposits to pay off home mortgage loans in advance, which rarely happens in the U.S.

Mortgage loans issued by commercial banks generally give borrowers the right to pay off in advance. The right is valuable for loan lenders, but the prepayment option will lead to future cash flow instability of RMBS, which forms prepayment risk. Prepayment becomes a risk on fixed-income securities when the principal is returned ahead, so that investors on RMBS would not receive expected interest paid on principle. Fixed-income securities like MBS products and callable bonds would be affected by the prepayment risk. The prepayment rate measures the percentage of the current outstanding loan balance, which is generally expressed by Single Monthly Mortality (SMM) and Constant Prepayment Rate (CPR). SMM expresses monthly mortgage prepayment rate of the existing mortgage pool. CPR refers to the annualized percentage of the mortgage pool that is expected to prepay in a year. The conversion between SMM and CPR expresses as following:

SMM = Prepayment Amount / (Loan Balance at the beginning of the month – Expected Amount to pay in the month) or SMM = 1- (1 – CPR) ^ (1/12)

Because prepayment rate volatility mainly affects RMBS market and the limited information disclosure for other securitization products, data collects from RMBS products in recent ten years. In December 2005, "CCB 2005-1", the first RMBS security in China was initiated by China Construction Bank and officially issued to institutional investors in the national interbank bond market. Since "CCB 2005-1" is the longest-lived home mortgage-backed bond in China, its data is mostly complete. The process of calculating SMM from historical data of "CCB 2005-1" is shown in Appendix Table 4. "PSB 2014-1" is the first personal housing loan supporting securities issued by Postal Savings Bank of China in 2014. "CCB 2005-1," "CCB 2007-1," and "PSB 2014-1" are highlighted as research object:

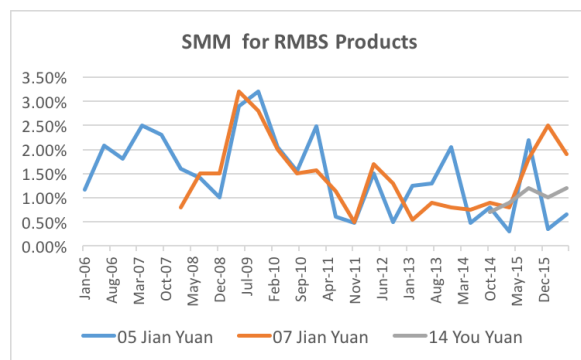|	Mean	Max	Min	S.D.
CCB 2005-1	1.38%	3.11%	0.27%	0.63%
CCB 2007-1	1.39%	3.03%	0.35%	0.56%
PSB 2014-1	1.09%	1.73%	0.66%	0.26%
Total	1.36%	3.11%	0.26%	0.58%

Figure 6: RMBS Prepayment SMM Summary

Figure 7: SMM Movements of RMBS Products

Resource: HTFICC Macro-Scale Research
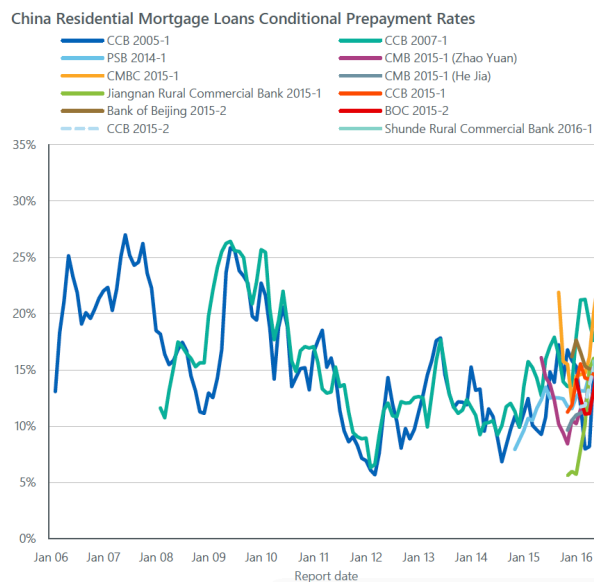
Figure 8: China RMBS CPR from 2006 to 2016
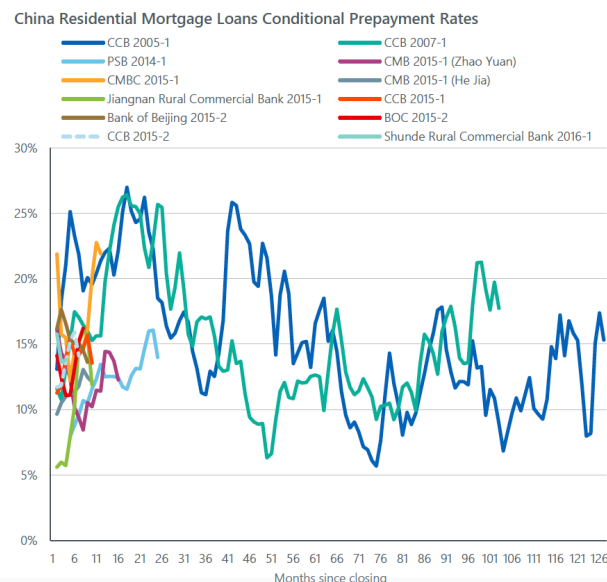
Figure 9: Chinese RMBS CPR based on Months since Closing   Resources: Fitch Ratings

The figure 6 shows statistical description of the three typical RMBS securities in ten years. The figure 7 presents SMM value of the three products on a semi-annual basis. The Figure 8 and 9 obtained data from Fitch Ratings, presenting CPR of most active RMBS on an annual basis and based on months since closing. The most three longest RMBS securities ("CCB 2005-1," "CCB 2007-1," and "PSB 2014-1") presents both in SMM and CPR value.

V.   Discussion of Results

A.   Altman Z-score model

Altman Z-score formula is one of the good indicators to predict the probability of bankruptcy in the credit market. Altman himself believed a crisis was going to happen from corporate defaults before SMC, while a large-scale meltdown started from MBS market and then a widespread failures spread to enterprises in 2009. From the analysis of financial statements in 2007, a year before the financial crisis, Lehman Brother has Z-score of 0.1464 and Northern

Rock has Z- score of 0.2897, which are far below the "grey line" of 1.8. In September 2008, Lehman's share tumbled over 90% and Dow Jones dropped over 500 points, which was the most massive drop in a single day. In February 2008, Northern Rock already lost over 90% of its value, and it was taken into the state-owned bank then. The exposures to large-scale distress risk gave the market alert of using Altman Z-score formula as one of controlling measurements for potential vital risks.

China Construction Bank, the second largest bank in mainland China, is the first commercial banks launched credit asset securitization in 2005 as a pioneer in the pilot program. From Altman Z-score of 0.39 above, in 2007, China Construction Bank experienced financial distress as well. Moreover, financial crisis started in the United States and mainly caused by securitization terrified Chinese government. To relieve economic pressures and restore investor confidence, the United States and the United Kingdom adopted buyout policy or recognized the value of securitized products. However, the Chinese government was aware of the source of risk involved in securitization, and the credit market was shrinking, so that securitization projects were wholly suspended by government since 2009. Though the action that entirely denied the value of securitization was considered as a failure by some economists, it survived the recovery of Chinese economics based on a degree of oversensitivity (Hong, 2010). After the credit market was getting restored and flaws in securitization getting appeared, Chinese market restarted securitization market on a more safety basis with reform of financial regulation. Promoting risk-control models, including the Altman Z-model, would contribute to stabilize financial market and improve the legal system.

B.   Bank Z-score

Banks' Z-score is valuable to measure the ability of risk-taking in a country's banking

system and the distance to insolvent. The accounting-based value relates banks' capital level to

their variability in returns, assuming a bank would become insolvent if its capital level drops to

zero. The graphs above illustrate the volatility of Z-score during 2000 and 2015 comparing

China and the U.S. banking system. Since a higher Z-score implies a more stable condition, it is

clearly shown on the graphs the U.S. banks performed better in recent fifteen years. The variance

from 2000 to 2015 in the U.S. is 4.259, while the variance in China is 18.813 that is much more

turmoil. In the U.S., Z-score is generally above 25 after 2005, except the year of global financial

crisis in 2008. In China, the banks' condition just became steady after 2009. The bank default

risk was highest in 2004 with 0.53 Z-score and lowest in 2014 with 1.43 Z-score.

The multiple regression analysis outputs present in Appendix examined the effectiveness

of Z-score with other bank-related variables on an annual basis: Bank Lending Deposit, 5-Bank

Asset Concentration, Outstanding Domestic Public Debt Securities to GDP and Credit to

Government and State-Owned Enterprises to GDP. The R Square of 0.95 and Adjust R Square of

0.926 indicate that about 95% of the variation of variables has explained by the model. The

small significance F also verifies the validity of the regression. Since all P-value of coefficients

is below 0.05, null hypotheses are accepted. The lower the P-value is, the higher valid of the

ratio is. Overall, the bank Z-score and its comparison with other parameters are the good

indicators for financial distresses and measurement for banks' decision making. Contributing to

the progress of securitization market, banking system needs good approaches in measuring

individual risk and systemic risk. Especially in the Chinese market, due to the lack of exposure

of banking data, methods for rating agencies and regulatory authorities are needed to mitigate potential risks.

C. Prepayment model

According to the historical data analysis of "CCB 2005-1," "CCB 2007-1," and "PSB 2014-1", the mean SMM rate of China's earliest RMBS securities is 1.36%, which is equivalent to 15.14% of CPR. The three-single RMBS historical prepayment rate data shows a high correlation, and the first personal housing loan supporting securities "PSB 2014-1" has lower SMM rate. However, the volatility of prepayment rate is relatively strong. The highest value of SMM is 3.11% (equivalent to CPR 31.58%), while the lowest value is 0.26% (corresponding to a CPR of 3.08%). According to statistics from the US Securities Industry and Financial Market Association (SIFMA), similar RMBS products' CPR in the US is much lower than that in China, which is between 2.5% and 8%.

The research of prepayment risk model in the U.S. has experienced the following stages: Federal Housing Authority (FHA) firstly assumed that most borrowers would pay off their mortgage loans within 12 years. Then, an empirical model established FHA links between prepayment rate and durations left to pay off loans, while neglects other factors. Public Security Association (PSA) proposed a model, implying the prepayment speed of securities. The PSA Model divides a pool of assets into two different periods. The initial period assumes the prepayment rate experiences a steadily rising period in the first 30 months, considered as "the ramp." It assumes standard prepayment starts at zero and increase by 0.2% each month, and a 6% CPR used. In realistic, yields usually bases on a higher or lower prepayment assumption: 50% PSA assumes a 0.1% monthly increase in CPR until the 3% CPR reaches. 200% PSA assumes a 0.4% CPR monthly rise until the 12% CPR reaches. The

250% PSA indicates that CPR of the base models is multiplying by 2.5 for every month in first 30 months until 15% CPR reaches. After 30 months, the prepayment rate gets slowing down, considered as "off the ramp," and then the speed remains constant until the remaining life. The graph below compares brand new loans' prepayment speeds (CPR) at different percentages (50%, 100%, and 250% PSA) with upcoming months. ("Measuring Prepayment Speeds: CPR, PSA, SMM," 2016).

PSA "Model" (Assuming Brand-New Loans)
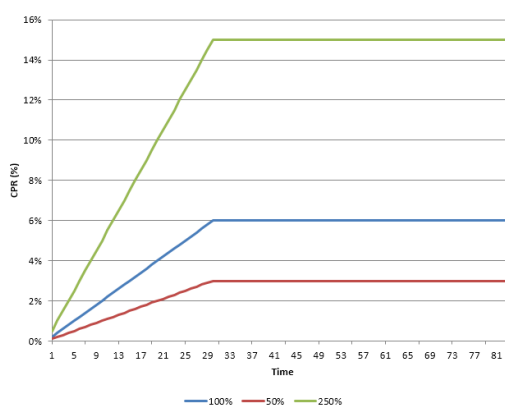
Figure 10: PSA model for Brand-new Loans

Usually, there is a high negative correlation between interest rate changes and the U.S. prepayment rate. In China, there are four characteristics and trends of prepayment rate of RMBBS in China: Firstly, the prepayment rate of China's RMBBS products has a strong seasonal fluctuation, and the first quarter in each year is clearly in peak season. The primary reason is that most companies will issue year-end bonuses during the period from New Year's Day to the Spring Festival. Borrowers tend to use the surplus to pay off the rest of the loans. Then, the interest adjustment day for most loans is on January 1st. in each year. So, if the benchmark lending rate increase, borrowers may choose to pay early to reduce the debt burden. Secondly, along with the increasing age of issuance, prepayment rate will enter stable periods after MBS issued for 6 to 7 years. According to the assumption of the PSA model, the

prepayment rate is getting stable after 30 months (the 5th year). Based on limited historical data of RMBS issued in China, the overall prepayment rate doesn't show a stable condition along with the increasing age as the PSA described. Observing the CPR of the most extended "CCB 2005-1" and "CCB 2007-1" in figure 9, the two products did show a gradually declining trend after 45 months. For reducing the random factor influence, movement shows on a semi-annual basis that could better reflect moving trends. Thirdly, the active level of real estate market is one of the most critical factors affecting prepayment rate, which negatively correlates with long-term financing interest rates. Besides the reason that U.S. borrowers would prepay for the loans because of increasing interest rates, most of the Chinese residential housing mortgage loans are floating interest rates. Borrowers have neither motivation to refinance nor possibility to refinance. Therefore, most of the prepayments occur in China are caused by the sale of the real estate asset. Further research can develop on the correlation between prepayment rates and the quantities of commercial housing dealings. Moreover, other factors also affect the activity level of real estate market, such as macro-economics condition, national policies, residents' income expectations, etc. Since transactions of real estate market become active while the interest rate is getting lower, the long-term interest rate has a negative relationship with prepayment rates. Fourthly, prepayment rate has a significant effect on shortening the duration of RMBS products. According to the analysis of the composition of the three single RMBS prepayment rates, 85% homeowners chose to prepay entire mortgage amounts, while only 15% or less decided to prepay part of the sun. The characteristics above indicate a more volatile prepayment rate in China securitization market. Due to the differences in mortgage policies, prepayment assumptions in China need to adjustments based on foreign models and related models to other factors, such as aging analysis, the activity level in real estate market, market interest rate, etc.

VI.   **Policy implications on risk control**

On the one hand, asset securitization, as one of the most creative financial instruments, reduces liquidity risk and interest rate risk resulted from to short-term deposits and long-term loans. Also, it dramatically improves the profitability of commercial banks. On the other hand, asset securitization increases systemic risk in financial market. The original goal for the financial tool is hedging and diversifying risks, if it is not regulated effectively, it would eventually become a risk for investors and may transform to a massive systemic risk like the SMC. Because of varieties among different countries' securitization policies and process, risk management in Chinese securitization market needs to study from developed countries and specialize in the Chinese market. Combining above fundamental and modeling analysis, recommendations to control risks has made as followings:

a). Improve market pricing maturity: The pricing of credit asset securitization products depends on the supporting of a large amount of credit rate and related information. Only when a complete and effective mortgage loan information database have established, credit risk and prepayment risk could better analyze that suitable pricing methods for securitization products can be used to reflect their true value. Improving pricing methods in sponsoring and investment institutions can guide investors to obtain a reasonable valuation from the perspective of reducing credit risk premium and liquidity risk compensation. Besides investors' independent due diligence, investors need to identify securities based on qualitative modeling analysis, bank assessed the credit risk, refinancing risk, and early-compensation risk of asset pools and subordinated securities, combined with scenario analysis and stress testing, and loss distribution measurement. Asset securitization pricing is gradually shifting towards marketization and standardization.

b). Improve information disclosure system: The lack of information disclosure mechanisms and transparency of the credit rating system are considered to be the major causes of the financial crisis. During the research about risks on securitization products, it is clear that related data is much open in the U.S. market. The transparency and independence in the credit rating agencies are crucial for the Chinese market, which is beneficial for investors to quickly and clearly understand the degree of risk.

c). Improve market supervision system: Financial institutions may transfer all or part of risk assets from the balance sheet through asset securitization, which thereby would shift credit risk from the credit market to the capital market. The separation of credit and capital market supervision would result in a vulnerability in surveillance. Though credit rating agencies distinguishes between the U.S. and China market, governments need to coordinate microscope risks supervision on financial institutions with macro-scope control on laws and regulations. Legal insufficiency on bankruptcy and segregation of underlying assets need to be solved. Moreover, the government could not be too restrictive to control the market that may limit the activeness of the secondary market.

d). Improve accounting regulatory system: IAS 39–Financial Instruments: Recognition and Measurement describe that if the cash flow generated by the acquisition of financial assets has expired by contracts, enterprises should terminate the confirmation of financial assets. It is controversial whether the process of asset securitization shall terminate the recognition as an asset. It is hard to fully confirm termination conditions due to the complexity of the securitization activities, including the transfer credit agencies of asset pools, excessive cash flow, credit enhancements, etc. (Pan, 2010, P6). Therefore, having a completed accounting and law regulatory system are needed to standardize securitization market.

VII.   Conclusion

The object of this research is to promote financial institutions in China to mitigate potential risks and facility the maturity in the securitization market. Through analyses on essential causes of the financial crisis started in the U.S. and comparison on progress in Chinese securitization market, this paper put effort on improving risk evaluation models and address regulatory recommendations.

The third part of the research concentrate on how and why securitization products has been designed in the market, which contributes to the risks analysis based on nature of the products. Different underlying assets for securitization then facilitate their associated risks. The maturity of risk evaluation and supervision mostly affect the stability in the financial market. Data from both American and Chinese banks are used for the Altman model, focusing on individual banks' credit risk. Z-score model further analyzes the risk-taking ability of banking system in the U.S. and China. The third prepayment model specifies in Chinese RMBS market that guides on securitization pricing methodology.

Securitization has two sides. Though its risks can cause market turmoil and financial system instability, securitization plays a vital role in promoting financial development. Previous trials on securitization and long-term data from developed markets would provide support for Chinese financial institutions to mitigate risks in promoting the development of securitization.

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Appendix

Table 3: Multiple Regression

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.97504549
R Square	0.95071371
Adjusted R Square	0.92607056
Standard Error	1.17933552
Observations	16

ANOVA

	df	SS	MS	F	Significance F
Regression	5	268.2862211	53.6572442	38.5792346	3.2036E-06
Residual	10	13.90832264	1.39083226		
Total	15	282.1945438			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-4.8180445	9.781338714	-0.4925752	0.63294798	-26.612225	16.9761363	-26.612225	16.9761363
ROA	6.26550977	1.796785383	3.48706631	0.00585164	2.26202245	10.2689971	2.26202245	10.2689971
Bank Lending Deposit	13.113846	2.755638848	4.75891317	0.00076981	6.97390002	19.253792	6.97390002	19.253792
5-Bank Asset Concentration	-0.4210326	0.048283717	-8.7199702	5.4932E-06	-0.5286154	-0.3134497	-0.5286154	-0.3134497
Outstanding Domestic Public Debt Securities to GDP	1.30748701	0.321721815	4.06402971	0.00227182	0.59064614	2.02432789	0.59064614	2.02432789
Credit to Government and State-Owned Enterprises to GDP	-1.0583858	0.339001101	-3.1220718	0.0108357	-1.8137273	-0.3030443	-1.8137273	-0.3030443

RESIDUAL OUTPUT

Observation	Predicted Z- Score	Residuals
1	23.3298731	0.660126923
2	18.4875278	-0.797527782
3	17.3815305	-0.291530496
4	17.1164715	1.553528487
5	17.1374955	-0.977495511
6	19.3637903	-1.003790327
7	22.9956009	1.254399078
8	29.1468912	-0.836891191
9	24.1226517	0.937348295
10	23.7138483	-0.433848345
11	25.899677	-0.359677005
12	24.2027726	0.657227356
13	25.5454618	0.144538153
14	27.6912267	-1.871226749
15	28.6797147	0.780285344
16	28.0354662	0.58453377

Table 4: SMM Calculation for CCB 2005-1

	Beginning Month Principle Balance	Planned Principal Repayments	Prepayment Amount	SMM
Dec-05	3,016,683,137.52	31,583,433.76	82,653,113.85	0.027689
Jan-06	2,900,982,933.70	15,204,854.86	33,537,356.02	0.011622
Feb-06	2,851,418,804.9	15,011,973.77	62,714,806.73	0.022111
Mar-06	2,772,649,983.95	14,948,230.97	70,279,261.62	0.025485
Apr-06	2,686,248,044.64	14,655,775.40	63,911,404.47	0.023923
May-06	2,606,662,622.73	14,364,390.00	42,621,545.41	0.016442
Jun-06	2,548,675,570.66	14,155,424.13	52,780,445.33	0.020825
	…	…	…	…
Apr-15	203,277,211.42	2,521,119.62	2,384,611.97	0.011878
May-15	198,091,548.68	2,392,327.69	1,307,109.91	0.006679
Jun-15	194,235,017.06	2,323,427.47	4,202,754.31	0.021899
Jul-15	187,554,275.66	2,283,019.40	1,730,845.65	0.009342
Aug-15	183,411,334.81	2,260,863.18	2,916,024.97	0.016097
Sep-15	178,094,925.30	2,235,862.89	2,203,269.60	0.012529
Oct-15	173,566,604.05	2,215,935.24	2,909,271.49	0.016978
Nov-15	168,353,434.18	2,061,948.37	2,220,518.93	0.013353
Dec-15	163,937,749.86	2,145,267.12	1,775,042.19	0.010971