ISSN: 2688-9323

Risk Assessment of Loan Asset Securitization based on Big Data -- Take Housing Loan as an Example

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Abstract

Profit and risk are two eternal topics in finance. People like profit and aversion to risk, but in the financial field, profit and risk always coexist. People are obsessed with the study of returns and often ignore the measurement of risk. The reason is that risk itself is difficult to measure, and its essence is only a kind of uncertainty. With the gradual maturity of big data, AI and other technologies, many scholars have A lot of research and innovation have been done on the measurement of financial risk, and these technologies also provide new ideas and directions for the measurement of financial risk. The decrease in the liquidity of the financial market is also a major reason for the increase of financial risks. This paper will look at the risk measurement in the process of asset securitization from a new perspective and make a detailed study on enhancing the liquidity of the financial market. models and solutions.

Keywords

Big Data Technology; Quantitative Finance; Asset Securitization; Housing Loan; Bank Risk Management.

1. Research Background and Basic Assumptions

In 2008, there was a major crisis in the international financial market, also known as the "subprime mortgage crisis". The main reason for the outbreak of this crisis lies in the important financial system of banks. In order to quickly convert the long-term loans which with poor market liquidity into cash which with strong market liquidity, banks put a series of good and bad loans into the loan asset pool. According to the conventional means of risk monitoring and management, although the risk of a loan can be estimated through a series of parameters, when all kinds of loans with different risks are put into the loan asset pool, and then these loans with different quality are turned into securities (with strong market liquidity) through a series of operations of special purpose vehicle (SPV), Then the risk in the pool can't be well estimated by the general conventional risk monitoring and management means. Unsystematic risk also forms and lurks in the process of loan and securitization. However, in order to quickly obtain cash flow, regardless of the risk in the pool, the bank packaged all of them into securities and put them into the market, and continued the loan business with the cash flow obtained. There is a strong correlation between financial institutions, so when the crisis breaks out, many financial institutions have suffered losses. Now we plan to Study this problem in a different view.

Nowadays, securities company solve this problem by selling in layers, the part with low risk is always easy to sell, the mezzanine is not hard to sell but the high risk part is very hard to sell out. Asset liquidity weakened after the subprime mortgage crisis, "selling in layers" may not the best way to issue the asset backed securities. Financial markets need new theories to improve the liquidity of assets, financial markets can play a better role.

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Securities rating companies have ratings for large enterprises, and bank lending institutions also have ratings for the credit level of ordinary people, but the units and expression methods of these ratings are completely different, which is not conducive to the risk assessment of mixed assets. Financial market needs a unified standard to assess the risk level of each unit. It will be helpful to reduce the difficulty of securities issuance. According to industrial and Commercial Bank of China, from 2006 to 2021, Personal housing loans account for a high proportion of personal loans, especially in recent years, it has reached a surprising 80%, it means an average person who need to repay the loan, almost 80% of the load for the purpose of buying a house. In this context, it's urgent to enhance the liquidity of housing loan asset-backed securities. At the same time, the digital currency plan also provides new ideas and methods for the homogeneous and unified express of solvency indicators of different social units.

The interest rate on a security is fixed at the time of issuance and is related to the yield. The utility function will be a simple binary function when the return in the utility function rises as the risk rises. Based on the empirical assumption that the utility of a security is proportional to its selling rate, we can substitute a standardized risk factor for the selling rate of a security based on this assumption. Assume that all risk-free assets can be sold. But to simplify the model, we set this function to be a quadratic function with the opening facing down. Suppose the selling rate is R and the risk is σ. The relationship between the selling rate of a security and its risk is:

$$R = A\sigma^2 + 1 \quad (A < 0)$$

The W(σ) formula can be obtained by simulating the actual situation of the asset pool. This paper assumes that there is a normal distribution relationship between risk and the proportion of assets with different risks to total assets. Then, W(σ) is (where ε is a constant):

$$W = \frac{1}{\varepsilon\sqrt{2\pi}} e^{\frac{(\sigma-\sigma_p)^2}{2\varepsilon^2}}$$

Suppose the proportion of assets at a risk level is W, set the total sales as Q. In that way, the value of total sales is:

$$Q = \int_0^{\sqrt{-A}} R(\sigma) * W(\sigma)\, d\sigma$$

then the formula can be expressed as this:

$$Q = \int_0^{\sqrt{-A}} (A\sigma^2 + 1) * \frac{1}{\varepsilon\sqrt{2\pi}} e^{\frac{(\sigma-\sigma_p)^2}{2\varepsilon^2}}\, d\sigma$$

The red line represents the sell-through rate, the blue line represents the proportion of various risky assets, strictly speaking, this is just an approximation and can only represent one of many possibilities.

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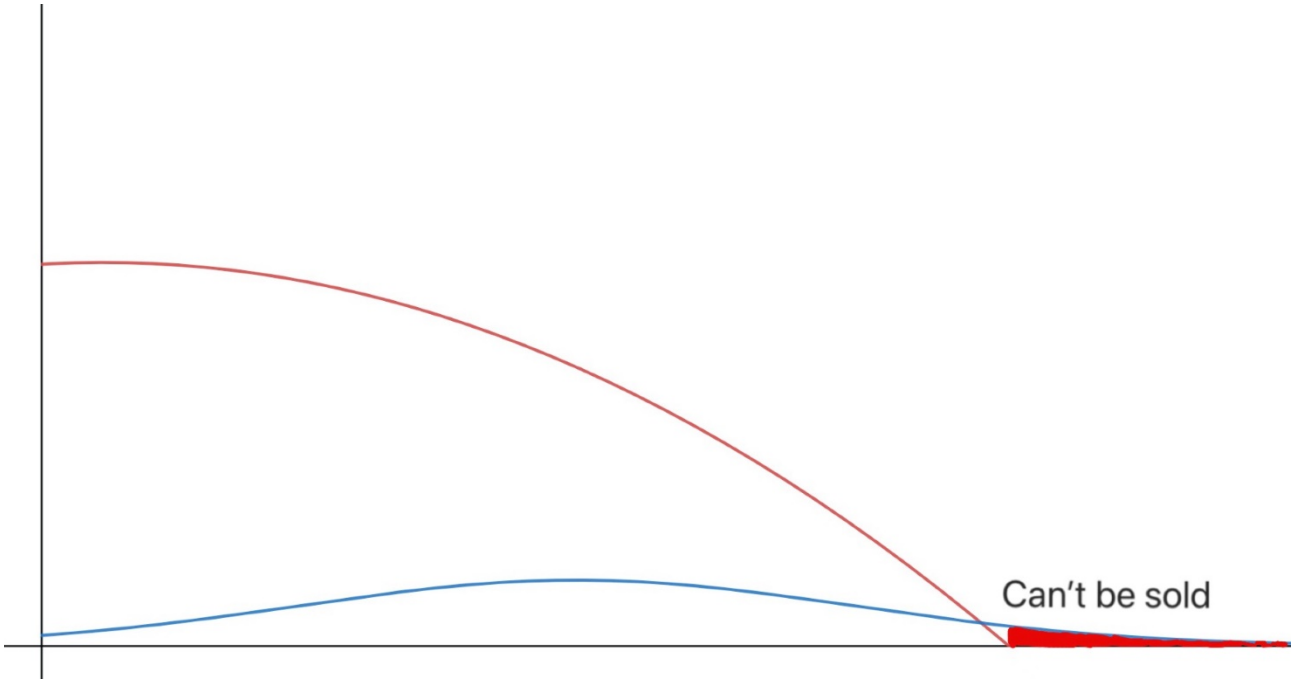

Figure 1. Worst Asset Proportion

2. Analysis of Personal Housing Loans in China

According to the data survey of the Industrial and Commercial Bank of China in the past 15 years, (2006-2021) Investigation finds Chinese personal housing loan volume has grown exponentially over the past 15 years, R-squared have reached 0.9908 which Prove that the model fits very well. This is the result of using the exponential model to fit:

Table 1. Data analysis results

Dependent Variable: LOG(Y) Method:
Least Squares Date: 04/18/22 Time:
22:02 Sample: 2006S1 2021S1
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.94130	0.030678	421.8498	0.0000
X	0.093567	0.001674	55.90775	0.0000
R-squared	0.990807	Mean dependent var		14.43837
Adjusted R-squared	0.990490	S.D. dependent var		0.854659
S.E. of regression	0.083344	Akaike info criterion		-2.069330
Sum squared resid	0.201442	Schwarz criterion		-1.976815
Log likelihood	34.07462	Hannan-Quinn criter.		-2.039173
F-statistic	3125.676	Durbin-Watson stat		0.329962
Prob(F-statistic)	0.000000			

In addition, from the proportion of personal housing loans to personal loans and The trend of total housing loans in the past fifteen years, we can also see the continuous and rapid growth of China's housing loan market. This is the precise data (Take the Industrial and Commercial Bank of China as an example):

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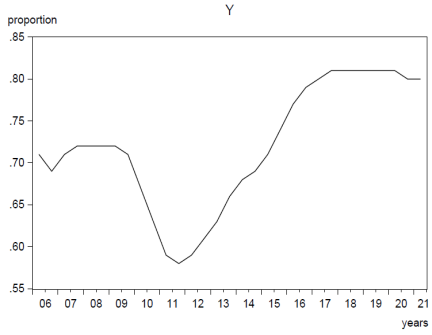

Figure 2. Changes in the proportion of personal housing loans in total personal loans(Industrial and Commercial Bank of China)

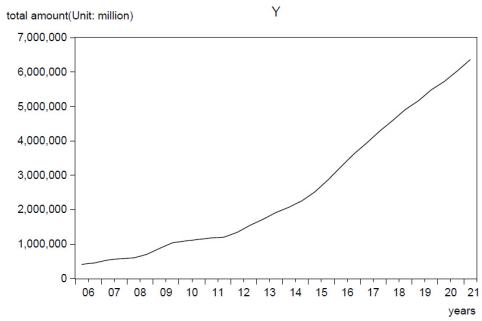

Figure 3. Chart of Changes in Total Personal Housing Loans (Industrial and Commercial Bank of China)

According to the above data, the securitization and risk assessment and prevention of housing loans in China will become very important. For asset pools with various risk assets, it is a common practice to sell loans with different risk levels at different layers. The securities corresponding to extremely high-risk assets are difficult to sell, and securities companies often need to hold them by themselves. According to the formula, the total amount of securities that can be sold can be found. In this way, the total amount of assets that cannot be sold in a certain asset pool can be estimated in advance. When facing the underwriting method, securities companies can use this formula to make predictions. The securities are underwritten by agency. If the part that cannot be sold is small, or the risk of the unsellable part is within the willingness of the securities company, the securities can be underwritten in the form of underwriting.

In China's asset securitization asset pool, taking personal housing loans as an example, (there are three types of housing loans in China) these loan types are: personal housing commercial loans, personal housing provident fund loans, and personal housing portfolio loans. Data shows that personal housing loans account for about 75% of China's asset securitization asset pool, of which personal housing provident fund loans account for a very small proportion, while the other two account for a large proportion of the securitized asset pool. Therefore, the liquidity of securities packaged by personal housing loans plays a key role in the liquidity of securities securitized in China.

From the data analysis, it is clear that housing loans account for a very high proportion of China's indebted population. It's worth noting that, according to classic portfolio theory, when investing in securities, you shouldn't just buy assets of the same type. If you have enough investment funds, you should diversify your investments as much as possible. Under normal circumstances, when the economy is down, the liquidity of the capital market will weaken and systemic risks will increase. This means that there will be more high-risk assets, and the normal

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distribution curve in Pic a will shift to the right, then the area of the red area will increase, which also means that more assets cannot be sold, which can explain why the economy is under downward pressure to a certain extent. When it increases, the liquidity of the capital market will weaken, which is in line with objective facts.

From the data analysis, it is obviously that the proportion of housing loans in China's indebted population is very high, it is speculated that it may be related to the influence of Chinese traditional mindset. It is noteworthy that according to classic portfolio theory, when investing in securities, you should not only buy the same type of assets. If you have enough investment funds, you should diversify your investments as much as possible. For example, Markowitz's theory believes that diversified investments can be effective reduce risk. From the bank's point of view, a housing loan is an investment, reasonable allocation of loan should ask the bank try to avoid a disproportionately large proportion of assets allocated to a certain social group, for example, when the automobile manufacturing industry is booming, many employees of enterprises related to automobile manufacturing may apply large loans to buy houses, banks cannot only take into account their personal credit level and proof of repayment ability, because if the auto manufacturing industry enters a cold winter, the risk of this type of loans will increase simultaneously, diversified lending can also effectively reduce the unsystematic risk of such investments. Chinese banks do not seem to have detailed statistics on the occupation of lenders, although the mortgage loan ratio is high and the housing price is basically on the rise, the risk of China's housing loan securities is not high, however, under the trend of slowing housing price growth, this risk still needs to be taken seriously, try to avoid homogenization of loans.

3. Control of Original Risk by Big Data Technology

Using big data to assess housing loan risk can constitute a cycle. First, it's need to collect the basic information of the borrower to rich information database. This information includes, but is not limited to: Occupation (industry classification), Income, Credit history, Amount of loan, Personal indebtedness status. the meaning and guiding significance of these information indicators will be discussed in detail below:

1. Occupation, a borrower's occupation is not directly related to his repayment ability, but in terms of big data, there is a relevance between occupation and the risk, as the saying goes "Don't put all your eggs in one basket", if a bank just loan money to workers in a certain industry, that will bring a higher risk than loan money to people of different occupations with the same repayment ability, the reason is that the risk of a decline in the income of employees in all social industries is obviously less likely than that of a specific industry. Under the technology of big data analysis, we should analyze a large amount of data to determine whether the bank lent most of the money to workers in a certain industry, it's interesting that this happens more often than randomly, because when an industry thrives, people in that industry spend like crazy, they are optimistic about their expected future income, these people tend to overspend. However, if the industry enters a cold winter, when workers in the entire industry are implicated, borrowers in this industry are borrowing a high percentage of the bank's total housing loan borrowings, banks will face a high risk of default. The purpose of analyzing this indicator is to understand the social sector classification and composition of borrowers.

2. Income, the bank should obviously focus on the income of the borrower. This indicator can reflect the average income level of a bank borrower. Income level is an important indicator to measure repayment ability. At the same time, income level is a quantitative value, which is very suitable for big data analysis. With the support of big data, if the average income level of all borrowers and the average income level of defaulted lenders are compared horizontally, a numerical value can be obtained, which can reflect the high probability of default of borrowers

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under a certain income level and predict how likely a lender at a certain income level is to default. Of course, the possibility of default is not only related to this indicator, but through the comparative analysis of big data, how much different income levels contribute to loan default.

3. Credit history, according to the research, people who have defaulted are more likely to default again. China has a complete credit record system. For those who have a credit default record, they will generally be rejected by the bank. Having a good credit history will increase the likelihood that a financial institution will lend. conversely, if the credit history is not so good, it is likely to be denied lending.

4. Amount of loan, given the income level and other influencing factors, the higher the loan amount, the greater the risk of default, the smaller the remaining balance, the lower the default risk

5. Personal indebtedness status, users with poor personal credit ratings are at greater risk of default

The calculation method of the contribution of an indicator to loan default by the control variable method is as follows: (take the income level as an example)

Income level Suppose the income level is recorded as A, and other indicators are comprehensively recorded as B.

a. Call out all the data whose indicators conform to B from the database

b. Sort by different A in these data

c. Establish a functional relationship between default rate and income level R=f(A)

d. The contribution of the income level to the loan default rate is the first derivative of the function

If it is difficult to establish a regression model due to the small amount of data after the indicators are unified, the following scheme is applicable

e. Establish a binary function (even multivariate) of default rate combined with income level and other indicators R=f (A, B)

f. The first-order partial derivative of A for the function f (A, B) is the contribution of the income level to the default rate.

There are also some indicators related to default that have not been verified for the time being, these indicators are easily available, such as the borrower's gender, age, household registration, physical condition and so on. Then use the database of these data to build a “profile” of the borrower, compare all defaulter's “profiles” with new borrowers' “profiles”, then banks can use the “profiles” to estimate the probability and amount of a borrower's default, Law of Large Numbers can be well used in risk assessment. Just as the best way to measure the volume of a cup is not to use mathematical formulas to calculate, but to fill it with water and measure how many milliliters of water there are.

Information on defaulting borrowers is collected to build a database, by comparing the average level of each data value in this database with the average level of the database of total borrowers, it can reflect the characteristics of the defaulting borrower, so that when a new borrower applies for a loan, the borrower's information can be compared with the database to determine the risk of a certain loan. Take the advantage of big data technology, it can save the bank a lot of cumbersome evaluation steps, and it is more accurate and reliable than conventional risk assessment methods, and can find many inherently interrelated risks that cannot be found by conventional methods. For example, it may be difficult for you to use mathematical formulas to find the relationship between a person's likelihood of defaulting and their religious beliefs. But use big data technology, you don’t need to know what is the relationship between the two, banks just need to know the answer, but not the process.

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4. Unified Securities Model

After conducting a large amount of data research, it is found that at least 90% of domestic securities companies use underwriting methods when selling housing loan securitization products. The reason why most securities companies underwrite securities in the form of underwriting There are basically two: First, the underwriting method can get more commissions and service fees. Second, securities companies are willing to keep the so-called "high-risk securities" for themselves. These securities have high returns. As long as there is no systematic risk, securities companies can get great returns. Securities companies themselves have a strong ability to resist risks, and China's housing prices have been on the rise in recent years. Even if there is a default, since most housing loans are mortgage loans, the possibility of a "subprime mortgage" in the true sense is extremely small. Even if it occurs, the amount of loss is very small, so securities companies will underwrite this kind of securities on a large scale, which also shows that this kind of securities is a very high-quality security. In addition, this survey investigated a total of 18,000 housing loan data in different regions. The bad debt rate of this kind of loan is only 1.7%, and most of them are only within 180 days of overdue. Auction can be carried out. Under the momentum of rising housing prices in China, even if there is a complete default, the house may even be auctioned at a higher price than the selling price. So the securities backed by housing loans are extremely risky. However, if house prices fall, securities companies may have to keep this part of high-risk assets passively. Otherwise, securities companies will keep these high-risk assets on their own initiative, which is equivalent to actively purchasing these high-risk parts, so the sales rate of these securities is Almost one hundred percent. The model proposed in this paper should be suitable for the situation of economic downturn. Only when the brokerage is under great downward pressure, securities companies are unwilling to keep these high-risk assets. This time, it is necessary to further rationally plan whether to sell these securities in layers or use them. The sale takes place in the form of the "unified securities" proposed in the model.

Based on the above analysis, the ratio of the total amount of securities underwritten in the national securities market to the total amount of all underwritten securities can be defined as the "rate of underwrite". This indicator can reflect the financial market from the perspective of the primary market. If most securities companies do not underwrite securities, it can indicate that these securities are illiquid. From a macro perspective, if the proportion of these securities is high, the liquidity of the entire financial market will be low, and if the proportion is small, the liquidity of the financial market will be high.

In traditional operations, securities companies will divide the assets of this asset pool into several levels and sell them according to different risks, and the packaged securities will be different. However, when the downward pressure on the economy increases, this approach obviously leads to some Assets cannot be sold, then when these assets are allocated proportionally to the same security, we give a definition of "average risk σ_a (obviously, this is not a simple weighted average of the risks of these assets) Under this risk, there will be A corresponding sell rate, multiply the corresponding sell rate by the total amount of assets, you can get the total value of the assets available for sale, compare the percentage of the white area in the normal distribution curve with the sell rate. For "uniform securities", the bank will There is a theoretical basis to decide whether to package these assets into "unified securities" or normal hierarchical packaging to generate securities. The expression for the maximum sale volume is as follows:

$$Q_{max} = \max\left[\int_0^{\sqrt{-A}} (A\sigma^2 + 1) * \frac{1}{\varepsilon\sqrt{2\pi}} e^{\frac{(\sigma-\sigma_p)^2}{2\varepsilon^2}} d\sigma \, , Q * (A{\sigma_a}^2 + 1)\right] (A < 0)$$

ISSN: 2688-9323

Most housing loan securitizations are sold in the form of underwriting by securities companies, so overall, the securities are sold at a high rate. Under the premise of the "unified securities" model, securities companies can selectively retain the high-risk and high-yield assets they are willing to accept, and the remaining assets with lower risks are sold in the form of "unified securities". Autonomy can be improved because, as securities buyers, securities firms are always more resistant to risks than individuals or ordinary institutions.

Acknowledgments

Funded by Anhui University of Finance and Economics College Student Innovation and Entrepreneurship Training Program(S202110378410).

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