

Research on Bank Runs Based on Game Theory

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Abstract. In contemporary society, with the continuous development of social economy, the financial industry has also made considerable progress. As one of the three pillars of the financial industry, banks will inevitably affect the development of the entire social economy while developing and improving. The global financial crisis that broke out in September 2008 has had a profound impact on the entire world economy. A bank run occurs when a large number of people withdraw cash from a bank, and the bank reserves are insufficient to pay them, resulting in a cash shortage. The research results show that the sources of funds and investment directions of banks are related to bank runs. Banks must appropriately diversify their sources of funds and investment, and pay attention to good operating performance, so as to make people believe in repayment ability. It is of great significance for the stability and development of the financial market to use the game model to understand the causes of bank runs, analyze the relationship between bank depositors and find out the correct countermeasures.

Keywords: Bank run; game theory; case analysis.

1. Introduction

Influenced by the complex and volatile economic situation at home and abroad, and the popularity of the application of new network media, the risks of negative or false information are very likely to cause a run-on banks and other deposit-type institutions, which has a great negative impact on social stability and financial stability. Although China's banking system is relatively stable, there have been many runs. During the Great Depression and the financial crisis in 2008-2009, there were bank runs. In modern history, bank runs often accompanied the Great Depression. After the stock market crash in 1921, the first bank failure caused by large-scale withdrawal occurred in Tennessee, because American depositors were afraid that the banks could not take out their savings and sought refuge by holding physical cash. This also triggered a series of bank runs and affected the whole country. Because people hear what happened and try to withdraw their deposits before losing them, this herd behavior will only accelerate more bank runs through negative feedback loops. In the simple game between banks and depositors, banks refer to ordinary commercial banks that have neither formed a reputation nor a state's implicit guarantee, such as small and limited urban commercial banks and other local commercial banks. According to the banks' asset quality and profitability, such banks can be divided into strong commercial banks and weak commercial banks.

The commercial banks with good asset quality and strong profitability, such as the few urban commercial banks that are in the first tier are Strong commercial banks refer to the commercial banks with good asset quality and strong profitability, such as the few urban commercial banks that are in the first tier; On the contrary, it is a weak commercial bank. When there is adverse news about the operation of a bank in the society, from the perspective of maintaining the confidence of the bank operation and depositors, generally, the bank will respond to the adverse news with a positive attitude, which will form a dynamic game of incomplete information with banks and depositors as participants. The operation of banks is closely related to the operation of social economy and the life of residents which are on daily basis. Secondly, because of the important special status of banks, banking business has penetrated into all aspects of social and economic life, and it has become inevitable for residents to deal with banks (savings, credit, remittance) in their daily life.

2. The definition bank run

As an important national financial institution, some national banks have run events. In recent years, the market and social risks brought by bank runs have emerged in endlessly. It is very important to establish a pre-prevention mechanism for the prevention and control of bank runs, effective handling procedures in the process and the summary of experience afterwards. In recent years, relevant domestic and foreign researchers have also studied more and more financial industry or bank run events, and received widespread attention. When depositors are worried about the payment and repayment ability of banks and other financial institutions, depositors will simultaneously withdraw money from banks to prevent their own losses. When a large number of people begin to withdraw money from their accounts, a bank run will occur. In most cases, the bank run is usually due to people's distrust and doubt on the solvency of the bank, rather than the real solvency. Admittedly, banks do have the risk of default because individuals continue to withdraw funds. Therefore, it starts from panic and may eventually evolve into default. The reason for this phenomenon is that most banks do not have so much money in their branches. In fact, every institution has a fixed limit on how much people can store in their accounts every day. This rule is for safety reasons. The Federal Reserve Bank has also set internal cash limits for institutions. For example, if there is news that the whole economy will face a crisis next year, people will lend out the money in the bank. This is because people do not believe that banks can repay money. These restrictions tell them a rule: the sooner you go to the bank to borrow money, the more likely you are to have all the money. Otherwise, they may lose money. Therefore, the bank runs because they are unable to provide the same amount of funds.

3. Results analysis of game theory model

Bryant (1980) and Diamond and Dybvig (1983) have provided us with the classic benchmark model for a bank run [1]. Assume there are only two savers in a bank. Each saver has 10 million dollars to store in the bank and all are time deposits [2]. The bank invested 20 million dollars in one project. Assuming that the project is profitable with sufficient funds. When the project is closed, the bank can take out 24million dollars to give back to the depositors, and each depositor can get 12 million dollars. However, if the bank withdraws its capital from the project in advance, the bank will be punished for the early withdraw. Assuming that the penalty ratio is 20 percent, the bank can only get 16 million dollars from the project, also thy do not have the ability to pay all 24 million dollars to two depositors [3]. In that case, this paper could write a game theory about weather two depositors are going to take out their money in advance

Table 1. Game theory about weather two depositors

		B	
		In advance	Till deadline
A	In advance	800, 800	1000, 600
	Till deadline	600, 1000	12000, 12000

As can be seen from Table 1, first situation: If two depositors take away their savings at the same time, the bank can only withdraw from the investment project in advance. Thus, the bank will receive a20 percent penalty for early withdraw of capital, that is, only16 million will be disbursed. At the same time, the bank will also go bankrupt, and each depositor can only get 8 million yuan. If both A and B chose to withdraw the deposit after the maturity. At this time, the bank investment project is profitable, and each depositor can get 12 million yuan. If one party withdraws money in advance, the party who withdraws money in advance can get it. The original deposit was 10 million yuan, but at this time the bank had to withdraw money from the project due to the advance withdrawal of the depositor. When another depositor withdraws money, he can only get 6 million yuan, which is far less than his original deposit of 10 million dollars. In the rectangular game chart, this paper can use the method of drawing lines with relative advantage strategy to analyze: when depositor A chooses

to withdraw money in advance, depositor B will also choose to withdraw money in advance because the fund is $800 > 6$ million yuan; When depositor A chooses to withdraw at maturity, depositor B will also choose to withdraw at maturity, because $1200 > 10$ million dollars. In this way, this article can get two Nash equilibrium by analyzing the game: One is that both Party A and Party B will withdraw the money when it is due, and each person can get 12 million dollars. The other is both parties scrambled to withdraw their deposits in advance, which resulted in a cash run elephant [4].

In addition, if a depositor withdraws in advance, the other party will strive for early cashing, which will also cause bank runs. In fact, most banks run occur when it is rumored that the bank may go bankrupt due to poor management. Once bankrupt, depositors' deposits in the bank will suffer serious losses. Therefore, the depositors will redeem as early as possible, this has also caused a bank run. In order to simplify the discussion, we assumed that the bank has only two depositors. However, let's assume that the bank has 20000 depositors, but these 20000 depositors have only two behavior modes. 20000 depositors are divided into two equal groups according to these two behavior modes (withdrawal in advance and withdrawal at maturity Section). The analysis method of both sides' game is consistent with the above process. Whether it's 2 depositors or 20000 depositors, the proportion of early withdrawals is very large. After the above analysis, the results of this paper show that early withdrawal will lead to bank runs, so it is better not to withdraw money in advance after handling fixed deposit in the bank? Now, let's analyze another situation to answer this question. That is, will a few depositors withdraw money in advance cause a bank run [5,6].

Suppose there are 10000 depositors in the bank, and each depositor deposits 10000 dollars in the bank the deposit term is the same. We divide these 10000 depositors into two groups, Group A including 0.5% of the depositors, that is, 50 depositors with 500000 funds; Group B contains the remaining 99.5% of the reserves 9950 depositors, i.e., 99.5 million dollars. The bank invested all its money in several projects. Other assumptions are the same as the above game. If the capital is withdrawn in advance, the bank will be punished by 20%, group A and B can get 20% additional income from the bank when withdrawing money at maturity.

The game of whether A and B withdraw money in advance is as follows (unit: 10000 dollars): If Group A and B, i.e., all depositors withdraw money at the same time, the bank must withdraw money from the invested project withdrawal. At this time, the bank will be punished by 20% because of early withdrawal, only 80 million can be paid, while each saver could only get 8000 dollars. If Group B withdraws money in advance but a few people do not withdraw money in advance, and the bank will also withdraw money because of only 80 million dollars was finally paid to most people due to withdrawal from the project. The bank failed because it had no money for a few people. When Group A, that is, a few people withdraw money in advance, the bank have the ability to pay 500000-yuan deposit, the remaining funds are still abundant, even if it has an impact on the investment project, the bank is still profitable. So, when Group B is due, that is, when most people go to withdraw money, the bank with the ability to pay, depositors can get capital plus income. Assume that the final depositor gets the funds H, which should be 79.6 million dollars more than the capital after punishment and 11940 dollars less than the maximum amount paid by the bank ten thousand dollars.

After understanding the game rectangle, this paper can use the method of drawing lines for comparative advantage strategy to analyze this game. As can be seen from Table 2, when group A, i.e., a minority, chooses to withdraw money in advance, Group B, i.e., a majority, will choose withdrawal at maturity (because $M > 7960$). When Group A, a minority of people, chooses to withdraw at maturity group B means that most people will choose to withdraw money at maturity (because $M < 11940$). When Group B chooses to advance withdrawing, group A will also choose to withdraw in advance (because $40 > 0$). When Group B chooses to expire withdrawing money, group A will also choose to withdraw money at maturity (because $60 > 50$). Therefore, in this game the latter situation is a situation of "following the crowd", that is, how do most people act to drive over all action. In the former case, no matter what strategy Group A chooses, Group B will choose to withdrawal at maturity. In other words, a few people withdraw money in advance will not cause a bank run [7-10].

Table 2. Game matrix

		A	
		In advance	Till deadline
B	In advance	7960, 40	8000, 0
	Till deadline	M, 50	11940, 60

4. Conclusion

Reviewing the bank runs in China in recent years, most of them are caused by negative public opinion. The monitoring and early warning ability, assessment management ability and emergency response ability of commercial banks to negative public opinion have not reached the professional disposal level, and they are unable to provide preventive measures and carry out risk disposal, further expanding the run risk. The spread of external adverse news will reduce the public's confidence in banks, easily cause public panic, cause credit crisis for deposit-type financial institutions, and greatly affect the confidence of investors and depositors. It is clear that from the above analysis, the bank's capital source, the direction of the investment and other aspects have connections with the bank run. Thus, bank have to diversify their sources of funds and investment appropriately and pay attention to good business performance in order to make people believe the repaying capability. Otherwise, once there is some turbulence occur in the economy, banks will easily go bankrupt. When a bank goes bankrupt, the most serious loss is to the depositors, which is extremely easy to cause social unrest. The objective reason for the bank run is the loss of non-performing assets in the bank operation, and the subjective reason is that the depositors' confidence in the bank is shaken, its harm to economic development and stability is severe. This paper finds out the causes of the bank run phenomenon through comparison, and simply points out several measures to prevent the occurrence of this phenomenon, find solutions to the causes, prevent the occurrence of the bank run, which is meaningful to ensure the development of the entire economy and society healthily and stably.

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