The Northern Rock bank run

When, why and how?

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Table of contents

Introduction

A bank run is an event in which 'depositors rush to withdraw their deposits because they expect the bank to fail' (Diamond and Dybvig, 1983), this can potentially happen to every bank in the world. This is very dangerous for a bank, because there is a large probability that the bank will face liquidity problems. Eventually, the bank may go bankrupt if it does not get any support from the government or central bank. This was the case for the bank run of the DSB Bank in the Netherlands in 2009. Also, a failing bank may be very costly for the economy. For example, during the bankruptcy of Icesave in 2008, the Dutch provinces lost more than 140 million euro's. Fortunately, the central banks do have some policies to diminish the probability of bank runs. For example, the central bank can act as a lender of last resort and uses a deposit insurance scheme. However bank runs still happen in the modern world and in order to prevent them completely we will have to know what cause the bank runs.

A model which can explain the cause of a bank run is the model from Diamond and Dybvig (1983). This model is one of the most influential models about bank runs. The conclusion of their model is that bank runs may occur if there is some panicking among depositors. However a system of deposit insurance will always prevent a bank run.

Another example of a bank run is the bank run of Northern Rock on the 14th September 2007. This was the biggest banking problem in the United Kingdom since the banking crisis in the seventies, this was also the first bank run in the United Kingdom in 150 years. Eventually, this resulted in the nationalization of Northern Rock. It is interesting to analyze this bank run because it is one of the most recent bank runs in Western Europe. Furthermore, the bank run from Northern Rock is a special case because it was a 'reversed bank run'. Normally during a bank run, a lot of depositors first withdraw their money, due to lack of confidence for example, and then the bank will as a result of the huge withdraws get into a liquidity crisis. However, in the case of Northern Rock, the bank first got into a liquidity crisis and as a result of that, depositors withdrew their money from the bank.

This thesis uses the Diamond and Dybvig model to explain the bank run of Northern Rock. The research question which is answered in the conclusion is 'To what extend can the Diamond and Dybvig model explains the bank run of Northern Rock'. To answer this question this thesis present an extension of the model so it can be used to describe the situation in the time of the bank run, it also uses a questionnaire about the financial knowledge of agents and their actions during a (potential) bank run. Furthermore this thesis provides a literature study about the Northern Rock case. From this study it follows that the problems in the mortgage market triggered the liquidity crisis at Northern Rock and that the anti-moral hazard policy of the Bank of England triggered the bank run.

This thesis is structured as follows. Part 1 is a theoretical part about bank runs and the policies to prevent bank runs in general, this part explains and extends the model of Diamond and Dybvig (1983). Part 2 describes the policy and financial activities of Northern Rock. Furthermore this part explains why Northern Rock got into a liquidity crisis and what could have done Northern Rock or the Bank of England about it. This thesis ends with a conclusion, where Part 1 and Part 2 are summarized and the research question is answered.

Part 1: Bank Runs

This part analyses the theory about bank runs. Section 1.1 explains the Diamond Dybvig model (1983), which is one of the most influential models about bank runs. In section 1.2 an extension is made to the model so the model describes the policy of the Bank of England during the bank run. Section 1.3 gives criticism on the model and presents what is missing. Section 1.4 describes the two main policies to prevent bank runs, deposit insurance and lender of last resort. Finally, section 1.5 gives a conclusion on this part.

1.1 The Diamond-Dybvig model

The Diamond-Dybvig model shows that the welfare of the agents can be improved when a banking system with depositor contracts is introduced in the market. This model also analyses different policies in which depositors lose their incentives to participate in a bank run. There are several assumptions made in this model, first, there are three periods (T=0, 1, 2). Also, there is only one good in the model and the production output of that good is R>1 in period T=2 for each investment in period T=0. However the production can be interrupted in period T=1, the production output is then equal to the initial investment in period T=0, which is 1, and there is no output in period T=2. The choice about the interruption is made in period T=1. There are two types of agents; the utility of type 1 agents only depends on the consumption in the first period and the utility of type 2 agents only depends on the consumption in the second period. The agents have a utility function of the form

$$U=\begin{cases} u(c_1) & \text{if the agent is of type 1} \\ pu(c_1+c_2) & \text{if the agent is of type 2} \end{cases}$$

where $R^{-1}<p\leq 1$ and c_T is the consumption in period T[1]. Also, the agents are risk averse, so the agents have a decreasing marginal utility of consumption. Furthermore the agents maximize their expected utility. Assume that the fraction of type 1 agents is given by t, where $0\leq t\leq 1$. Also, every agent gets an initial endowment of 1 in period T=0. The consumption is given by c_T^i, where i stands for the type of the agent and T for the period. So the optimal consumption level is $c_1^1{}^*=1$, $c_2^1{}^*=c_1^2{}^*=0$ and $c_2^2{}^*=R$. In this case the type 1 agents only consume in period 1, and thus interrupt the production, and the type 2 agents only consume in period 2.

The model now introduces the banking industry, which exist only of one bank. The role of the bank is to give insurance for agents who turn out to be of type 1, the business model of the bank is to use all the deposits for investment. The bank uses a 'first come, first served' policy for agents who want to withdraw. Each depositor who wants to withdraw will get his money until the bank run out of assets. In the model, the bank is fully liquidated in period 2 and every agent who did not withdraw in period 1 will get a share of the bank's assets. If a depositor withdraws his money in the first period he will get return of r_1 for each unit deposit at period 0. In the model V_1 stands for the payoff in period 1 for depositors who withdraw in period 1, for each unit deposit withdrawn. V_2 is the payoff for depositors who did not withdraw in period 1, for each unit deposit not withdrawn. V_1 and V_2 can be written as

[1] Although, Diamond and Dybvig used here the k for period, I prefer to use the T for period.

$V_1=\begin{cases} r_1 \text{ if } f_j \leq r_1^{-1} \\ 0 \text{ if } f_j > r_1^{-1} \end{cases}$ $V_2=\max\{R(1-r_1 f)/(1-f),0\}$

where f_j stands for the number of withdraws before agent j as a fraction of the total deposits withdrawn f. The bank is out of assets when $f_j \geq r_1^{-1}$. The consumption of a type 1 agent is $w_j V_1$, where w_j is the fraction the agents tries to withdraw at period 1. The consumption of a type 2 agent is $w_j V_1+(1-w_j)V_2$, note that an agent can store the good for free.

There are two equilibriums; the first one is referred to the 'good' equilibrium. This is the equilibrium when $r_1 = c_1^1 *$. In this equilibrium type 1 agents will withdraw at T=1 and type 2 agents will not withdraw, so f is equal to t. The second equilibrium is that of a bank run. In this equilibrium the agents are panicked and trying to withdraw at period 1, which will have the effect that everyone prefers to withdraw at period 1 because the probability is great that r_1 will be higher than V_2. A bank run can only be an equilibrium if $r_1>1$, in the case of $r_1=1$ the result of the banking industry is just the same as the result in the competitive market where an agent will get one in the first period if he interrupts the production and R in the second period if he do not interrupts the production[2].

A policy which can be used to prevent bank runs is suspension of convertibility. With this policy a bank can choose to stop paying agents who wants to withdraw at a certain period, this can prevent a bankruptcy of a bank because it has more time to collect loans. In the model $\hat{f}$ is the highest number of f_j before the bank stops paying out deposits and $\hat{f} < r_1^{-1}$. So in the case of suspension of convertibility V_1 and V_2 can be defined as

$V_1=\begin{cases} r_1 \text{ if } f_j \leq \hat{f} \\ 0 \text{ if } f_j > \hat{f} \end{cases}$ $V_2=\max\{R(1-r_1 f)/(1-f),\ R(1-r_1 \hat{f})/(1-\hat{f})\}$

With this policy the type 2 agents lose their incentive to withdraw at period 1, because they will have a higher return in period 2. So even if there is a bank run, it is still better not to withdraw and not to participate in the bank run.
However this policy only works when t is known ex ante. In the case of an unknown t it could be possible that some type 1 agents are not able to withdraw in period 1 if $t > \hat{f}$. Although this policy may prevent bank runs, it has not the most efficient outcome. Because there are some type 1 agents who are not able to consume in period 1 and thus they have a utility of 0.

The final policy which is treated in this model is deposit insurance backed by the government or the central bank. Deposit insurance cannot be backed by a private institution, because the institution may come into liquidity problems itself. The government or central bank can use taxes in order to prevent illiquidity. In the case of deposit insurance V_1 and V_2 can be defined as

$V_1=\begin{cases} c_1^{1*} \text{ if } f \leq t \\ 1 \text{ if } f > t \end{cases}$ $V_2=\begin{cases} c_2^{2*} \; if \; f \leq t \\ R \; if \; f > t \end{cases}$

[2] If $r_1=1$ is used in the model, $V_1=1$ and $V_2=\max\{R(1-f)/(1-f),0\}=\max\{R,0\}=R$.

With deposit insurance no type 2 agent has an incentive to withdraw at period 1 because $V_1<V_2$ for any t. Each type 1 agent, and only type 1 agents, have an incentive to withdraw at period 1 because $V_1>0$ for any t. So $f=t$ and thus the optimum is achieved with this policy which is $V_1=c_1^1*$ and $V_2=c_2^2*$.

So according to the Diamond-Dybvig model the best policy to achieve the optimum solution and to prevent bank runs is a deposit insurance system backed by the government or central bank, suspension of convertibility is only a second best outcome.

1.2 Extensions to the Diamond-Dybvig model

In this section extensions of the model are presented. In the first extension the deposit insurance is only on a percentage of the total deposit, in the second extension there is a limit on the deposit insurance. Both of these policies were used in the deposit insurance scheme in the United Kingdom during the bank run in 2007.

1.2.1 The first extension

During the time of the bank run, depositors in the United Kingdom were only guaranteed for 90% of the amount between 2.000 pounds and 35.000 pounds and depositors in the Netherlands were only guaranteed for 90% of the amount between 20.000 and 40.000 euro. However with this kind of deposit insurance depositors will always have an incentive to withdraw their money and to deposit it into another bank even if they think that the probability of a falling bank is very small, because the costs of depositing money to another bank are very low and thus exceeds the expected loss of staying at the bank.

Assume that d is the fraction of the deposit which is insured, where $0<d<1$. With this policy V_1 and V_2 are now defined by

$$V_1=\begin{cases} r_1 \text{ if } f_j \leq r_1^{-1} \\ d \text{ if } f_j > r_1^{-1} \end{cases} \qquad V_2=\max\{R(1-r_1 f)/(1-f), dR\}$$

In the 'good' equilibrium $r_1=c_1^1*$ and $f=t$, so V_1 is equal to c_1^1* and V_2 is equal to c_2^2*. However this is different in the panicked equilibrium. The question is now; will the agents with this type of deposit insurance withdraw at period 1? It is clear that all type 1 agents will run to the bank, because they only care about the consumption in period 1 and V_1 is larger than zero for any f_j. The above question is less clear for type 2 agents. In the case when the bank is already out of assets, thus when $f_j \geq r_1^{-1}$, when agents want to withdraw at period 1, they will receive d and if agents do not withdraw at period 1 they will receive dR in period 2[3]. And because $R>1$ it is better for type 2 agents not to withdraw at period 1. If the agents withdraw when the bank still does have assets, thus when $f_j<r_1^{-1}$, they will receive r_1, if they do not withdraw they will receive V_2. So if $r_1>R(1-r_1 f)/(1-f)$ they will withdraw their money in period 1. This equation can be rewritten as $r_1>R/(1-f+Rf)$. However, this equation cannot be used because f is unknown ex ante. From the model it is clear that $V_2 \geq dR$, so if $r_1<dR$ type 2 agents will certainly not withdraw in period 1. This extension shows that the probability that a type 2 agent withdraws at period 1 increases if d decreases, this depends on the ratio of the returns.

[3] Clearly when the bank is out of assets, they will not try to withdraw but they will gain their deposit insurance, which is d in period 1. Also, when the bank is out of assets, $r_1 f$ is per definition equal to 1, so V_2 is equal to dR.

1.2.2 The second extension

Also a lot of countries have a maximum amount for which the deposit insurance is valid. In most European countries this is now 100.000 euro, this number has increased for most European countries during the financial crisis.

Now some other variables are added to implement this policy in the original Diamond Dybvig model. First there is a limit on the deposit insurance *D*. Also, in the original model every agent got an initial endowment of 1, however now some agents get an endowment of E_L and some agents get an endowment of E_H where $E_L<D<E_H$. Also, *e* stands for the probability that an agent has an endowment of E_H where $0<e<1$. For simplicity, assume that *e* is the same for the two different types of agents. These implications do not change anything for the 'good' equilibrium where V_1 is equal to c_1^1* and V_2 is equal to c_2^2*. However there are some changes for the 'panicked' equilibrium. V_1 and V_2 for the agents with E_H are now defined as

$$V_1=\begin{cases} r_1 \text{ if } f_j \leq r_1^{-1} \\ \frac{D}{E_H} \text{ if } f_j > r_1^{-1} \end{cases} \qquad V_2=\max\{R(1-r_1 f)/(1-f), \frac{D}{E_H}\}$$

Again, type 1 agents will always try to withdraw in period 1 because $V_1>0$ for any f_j. Type 2 agents with a high endowment are indifferent between claiming their deposit insurance in period 1 and 2, when the bank is already out of assets. These agents will always get a return of D/E_H, which in fact is a negative return because $E_H>D$. If the bank still does have assets type 2 agents will run to the bank if $r_1>R/(1-f+Rf)$, however it is stated before that *f* is unknown ex ante and thus this formula cannot be used. However $r_1>D/E_H$ so if the expected *f* is high, which is reasonable when agents are panicking, then type 2 agents will all participate in a bank run trying to get a return of r_1[4]. For the agents with a low endowment the result is the same as in the original Diamond Dybvig model with a deposit insurance, where type 2 agents will not participate in a bank run. Note that in the case of $RE_L>D$, type 2 agents with a low endowment will act the same as type 2 agents with a high endowment and participate in a bank run. If the bank is out of assets their return is $\frac{D}{E_L}$.

This extension shows that a higher *e* increases the number of agents who participate in a bank run. It is clear that there is a negative correlation between *D* and *e*, so a lower *D* means a higher *e*. Also, in the model without a limit on the deposit insurance *f* was equal to *t*, but in this extension *f* is given by $f=t+e(1-t)$. So more depositors are trying to withdraw their money.

1.2.3 Conclusion

These extensions of the Diamond-Dybvig model shows that the deposit insurance scheme used in the United Kingdom during the bank run increases the chance on a bank run. The low limit of insurance on the deposits and the non-full coverage of the deposits created a lot of depositors who would lose a part of their money when Northern Rock, or any other bank, would fall. This greatly increases the incentive to participate in a bank run. The fact that the

[4] Other stated, if the agents expect that the bank will run out of assets.

bank run on Northern Rock stopped when it became known that all the deposits were fully insured support this conclusion. Section 1.3 discusses the problems with the model.

1.3 Criticism on the Diamond Dybvig model

In the original Diamond Dybvig model, the decision the depositor makes about withdrawing depends on his type and on the 'weather'. If it is 'bad weather', all agents are panicking and the probability that a bank run occurs will depend on the kind of deposit insurance. If it is 'good weather', none of the agents are panicking and each agent who does not need the money for consuming will not withdraw his money, even in the case without a deposit insurance. So whether the outcome of the demand deposit contract, in the case without deposit insurance, is a first-best outcome depends on an exogenous variable like the 'weather', a bank run also depends on this variable. Postlewaite and Vives (1987) rejected this view and created a standard demand deposit contract in which a bank run can always occur without the need of an exogenous variable. In their model, there are two agents and the choice about withdrawing in a certain period is an example of a Prisoner's Dilemma. Whether there will be a bank run depends on the returns given in the different periods, if the return is lower in the later periods, agents have an incentive to withdraw their money in the early periods even if they do not need it for consumption. Finally, in this model a bank run is, obvious, not a Pareto efficient outcome and there is always one unique equilibrium.

Besides the problem in the previous paragraph, the Diamond Dybvig model does also neglects some important real world facts. One basic ingredient of the model is rationality, however in the real world people do not act fully rational. The questionnaire used for this thesis shows that 32 percent of the respondents who are aware of the deposit insurance (n=71) want to withdraw their money in the case of a bank run, even if their deposit is fully guaranteed[5]. However, this large number can be explained by the fact that it takes time and cost for the depositor to get his money back after a bankruptcy. Also, depositors need money to pay for the daily groceries, so if a depositor does not have an account at another bank he has the choice between participating in the bank run and borrowing money from his friends or relatives. In this case, it is not unimaginable that most depositors choose for the first option. Another real world fact is that most people do not have a degree in economics, so they may not understand the results and effects of certain policies or actions of the central bank or government. This is also visible in the results of the questionnaire. The average general knowledge level of the respondents is 4.2 on a 5 point scale, this is only 3.1 for their financial knowledge level. The model also neglects the fact that in the real world there are multiple banks. So if a depositor did have more than 2.000 pounds on an account at Northern Rock he would definitely had an incentive to try to withdraw his money, because the expected costs of switching to another bank were lower than the expected costs of not withdrawing, even if the depositor thought that there was only a minor probability that Northern Rock would fall. The internet makes it also easier, and thus less costly, to switch to another bank. Finally, the model neglects the moral hazard which can be created by deposit insurance, section 1.4 explains this in more depth.

[5] The total amount of respondents for the questionnaire was 121. The answers to the questions can be found in the appendix.

1.4 Policies to prevent bank runs

There are two important policies which, in theory, will prevent banking failures and bank runs. The first one is deposit insurance and the second one is lender of last resort. Deposit insurance should remove the incentive from depositors to withdraw their money and the lender of last resort should give confidence to depositors by giving liquidity to illiquid banks.

1.4.1 Deposit insurance

Deposit insurance is a measure to protect bank depositors from losses caused by a bank's inability to pay its debt when due, it was first implemented in the United States in 1934 after the Great Depression, this insurance was implemented to prevent bank runs which were very common during the Great Depression. However it took many years before other countries implemented a system of deposit insurance. Today all modern European countries do have some sort of deposit insurance. According to the Diamond-Dybvig model deposit insurance is the best policy to prevent bank runs, because agents do not have an incentive to participate in a bank run when all their deposit is insured. So this will prevent the self-fulfilling effect of a bank run. However, deposit insurance also has a negative effect, which is moral hazard. When banks know that the government will insure the deposits when the bank will go bankrupt, the bank has an incentive to take more risk. The moral hazard is especially dangerous in highly competitive markets, since there is a positive correlation between risk and return. The bank will take huge risk so they can offer higher returns which will attract more depositors. Also, with deposit insurance the depositors themselves lose the incentives to monitor the bank, because the government will bail them out if their bank will go bankrupt. Moral hazard was an important cause of the Saving & Loan crisis in the 1980s in the United States. Banks which were very insolvent and nearly bankrupt, so called 'Zombie-banks', took excessive risk and played a sort of all or nothing game. These banks invested in very risky activities. If they did make high profits with the risky investments, the banks 'won', however when they got a negative return with the risky investments, the government had to pay the deposit insurance and thus the government 'lost'. So the banks could only win with this business strategy. As a result of the risky investments of the banks, a lot of banks went bankrupt.

On the one hand deposit insurance has the effect that it prevents self-fulfilling bank runs, on the other hand deposit insurance will create moral hazard in which banks will take too much risk. So is this a good or a bad policy? Demirgüç-Kunt and Detragiache (2002) did an empirical study about this question. They used data from 61 countries over the period 1980-1997 and analyzed whether a deposit insurance scheme increases the probability of a banking crises[6]. They found that indeed deposit insurance increase the banking system fragility. They also found that this effect is greater in countries with weak institutions and in countries where interest rates are deregulated. For countries with good institutions, they found that in some cases the effect of deposit insurance on the banking system fragility was

[6] They used all the countries covered in the International Financial Statistics, however they excluded economies in transition, non-market economies, countries for which one or more date series were missing and a few countries with chronic banking sector problems. They used a banking crisis dummy variable and defined a banking crisis as a period in which one of the following events occurred: non-performing assets reached at least 10 percent of total assets, the cost of the rescue operation was at least 2 percent of GDP, the banking sector problems resulted in a large scale nationalization of bank, an episode with extensive bank runs, emergency measures such as deposit freezes, prolonged bank holidays or generalized deposit guarantees.

not significant. So this study shows that only for countries with good institutions and regulated interest rates deposit insurance may have a positive effect on the economy.

1.4.2 Lender of last resort

In most of the developed countries the central bank acts as a lender of last resort, for example, the ECB in the Eurozone, the Federal Reserve in the United States and the Bank of England in the United Kingdom. In the 19th century, Thornton and Bagehot were one of the first who proposed a lender of last resort for the banking sector, although the term lender of last resort comes from Sir Francis Baring (1797) who wrote about a -central- bank as *the dernier resort* for banks who needed liquidity. According to Thornton and Bagehot there were several reasons why there should be a lender of last resort in their time. A lender of last resort removes uncertainty from agents during a crisis, like the deposit insurance today, this give confidence to the whole financial system. Also, the lender of last resort should protect the money stock and money growth. Unfortunately, the lender of last resort creates moral hazard because depositors would lose the incentive to monitor their bank because their bank would always be liquid. So the lender of last resort creates the opportunity for the bank to always borrow money and take excessive risk with it. Therefore Thornton and Bagehot made several advisements to reduce the moral hazard. For instance, the lender of last resort should let insolvent institution fail and lend only to creditworthy institutions at a penalty rate (Humphrey, 1989). Today, the main goal of the lender of last resort is to give liquidity, in the form of a loan, to banks that are illiquid but solvent.

1.5 Conclusion

The model in section 1.1 shows that a deposit insurance which coverage the whole amount of all deposits is the best solution to prevent bank runs. However during the bank run of Northern Rock the deposit insurance in the United Kingdom was far from best. Depositors where only guaranteed 100 percent for the first 2.000 pounds and after that 90 percent for the next 33.000 pounds, which is effectively a guarantee of 31.700 for the first 35.000 pounds. The model in section 1.2 implement this scheme and shows that the deposit insurance scheme used during the bank run did increase the 'participation grade' in the bank run in comparison with a deposit insurance scheme with full coverage, note that this also depends on the amount of depositors who have more than the deposit insurance threshold. What also contributed to the bank run is that the Bank of England did not use the two main policies to prevent bank runs properly. It used a flawed deposit insurance scheme and it did not give Northern Rock an emergency loan immediately when Northern Rock needed it.

In Part 1 the theoretical part of a bank run and its policies to prevent it is explained. Part 2 gives a practical view on the case of Northern Rock and shows why Northern Rock got into a liquidity crisis and what triggered the depositors of Northern Rock to participate in the bank run. With both these parts, the research question can be answered in the conclusion of this thesis.

Part 2: The Northern Rock case

This part describes the case of Northern Rock more intensively and shows why Northern Rock got into a liquidity crisis and what triggered the depositors of Northern Rock to participate in the bank run. This part also describes the effects of the bank run on the rest of the banking sector. First, section 2.1 shortly describes the history of Northern Rock. Then, section 2.2 describes the business model of Northern Rock and the causes of the liquidity crisis. After that, section 2.3 summarizes other literature about the bank run from Northern Rock. And last, section 2.4 gives a conclusion about this part.

2.1 History of Northern Rock

Northern Rock is based in Newcastle and was founded in 1965 as a result of the merger of two building societies named Northern Counties Permanent Building Society and the Rock Building Society, both established in the 19th century. Before it went to the stock exchange in 1997 Northern Rock was a building society[7]. In 2000 Northern Rock was promoted to the FTSE 100 index, which is a share index of the 100 most highly capitalized companies listed on the London Stock Exchange. The assets of Northern Rock grew with 20% each year between the years that it went to the stock exchange and the year of the bank run in 2007. Before the bank run Northern Rock was the fifth largest bank in the United Kingdom according to the value of their mortgage assets.

2.2 The policy of Northern Rock and how it failed

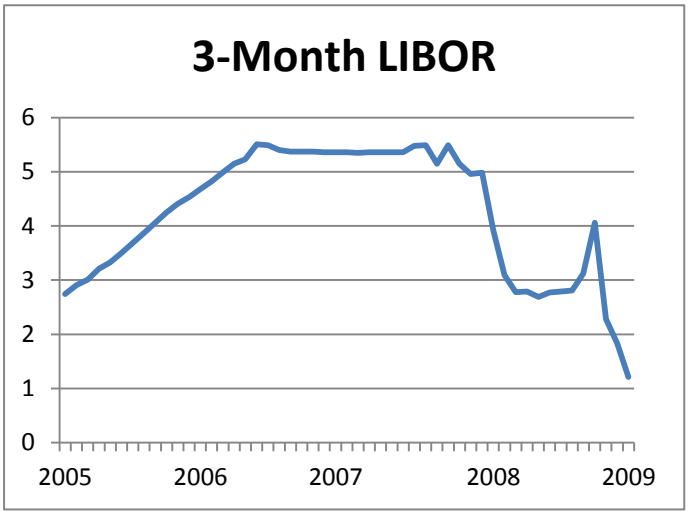
Between the time Northern Rock went to the stock exchange and the bank run, their assets grew from 17.4 billion pounds to 113.5 billion pounds. However the share of retail deposits dropped from 60 percent to 20 percent in that same period. Northern Rock did have a business model in which it relied heavily on the wholesale markets instead of the retail deposits to finance their lending activities. In 2007, Northern Rock was the biggest player in the securitization market of the United Kingdom. Northern Rock gathered money with bundling and packaging its loans and selling them as bonds to investors around the world. With this policy it could raise money more cheaply than their competitors in the United Kingdom. Unlike the other banks that used retail deposits more as a way of funding their lending activities, Northern Rock could price it mortgages lower and this made the big expansion in the mortgages market possible.

The negative site of this policy is that when the markets are not liquid anymore banks are not able to raise enough funds to finance their activities and thus come into liquidity problems itself. If the initial investors do not refund their investments anymore then the bank faces a fall in assets, this is comparable with a bank run in which depositors trying to withdraw their money. This was exactly what happened with Northern Rock during the summer of 2007 (Shin, 2009). Also, Northern Rock did not have a plan in case of this worst possible scenario. In 2007 the housing prices in the United States declined, as a result of this many poor homeowners could not pay their mortgage anymore. Because most mortgages were bundled together and resold many times, it became unclear which mortgages packages were toxic and which were clean. This event panicked the investors and as a result the mortgage market became less active and thus liquid. The problems in the American

[7] A building society is a mutually owned savings and mortgage bank

mortgage market let the confidence between financial institutions drop, this let the LIBOR[8] increase. The LIBOR is a good indication of the liquidity of the interbank lending market, where a higher LIBOR means a less liquid market. Figure 1 shows that the LIBOR was very high from the second half of 2006 till the end of 2007, the LIBOR also reached a record high rate in the beginning of September 2007 of more than 6.75 percent. The LIBOR was a good sign that Northern Rock would get into trouble.

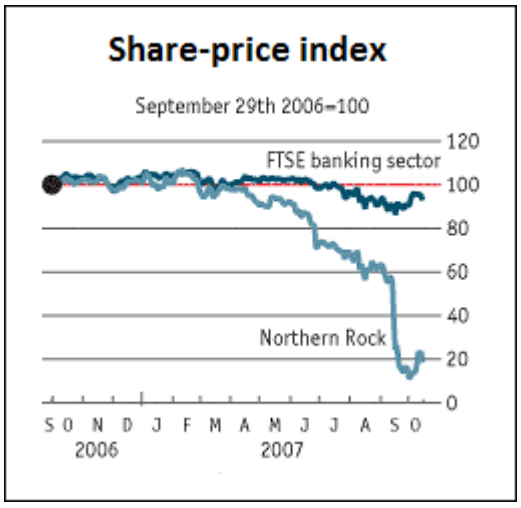
Figure 1: The 3 month LIBOR from 2005 till 2009.



Source: FedPrimeRate

Another sign was the share price of Northern Rock. In general, the share price of a company is a good indication about the future expectations from investors. Figure 2 shows that the share price of Northern Rock dropped about 40 percent from January 2007 till August 2007. So the investors in the stock market did not have much confidence in the future results of Northern Rock. The investors still have more confidence in the rest of the banking sector in the FTSE, which 'only' dropped 10 percent during the same period.

Figure 2: The share-price index of Northern Rock from September 2006 till September 2007.



Source: The Economist.

[8] LIBOR stands for London Interbank Offered Rate and is the interest rate in the interbank lending market in London.

These signs were not noticed by the Financial Services Authority (FSA), whose job is to supervise individual banks in the United Kingdom. Besides missing clear signs, the stress test it used was not flawless either, because it did not incorporate a scenario in which the markets were very illiquid. Concluding, the FSA did a bad job in the Northern Rock Case. Besides the FSA, the Bank of England also made some mistakes in the Northern Rock case. Unlike the FED and the ECB, the Bank of England did not gave emergency loans more quickly to troubled banks than usual and did not injected liquidity in the dry financial markets, because it wanted to send a message to the bankers that they would not help them if the bankers would take excessive risk.

In the beginning of August 2007, the wholesale market completely dried up as a result of the further uncertainty in the financial system. This was the last drop and Northern Rock let the FSA and the Bank of England know that it was in liquidity problems. The Bank of England was hoping that a stronger bank would take over Northern Rock. There was one serious candidate for the takeover of Northern Rock, Llyods TBS, which is also a British bank. However Llyods did only want to go on with the deal if they got backed with a loan of 30 billion pounds from the Bank of England. The Bank of England refused this because it would be 'inappropriate to help finance a bid by one bank to for another' (The Economist, 2007). Because the deal with Llyods did not continue Northern Rock was still in liquidity problems. Finally on 13th of September the Bank of England acted as a lender of last resort and provided a temporary emergency fund to Northern Rock. This was leaked to the BBC and they reported about this in the evening news. The leaked news in combination with the flawed deposit insurance scheme did trigger the confused and panicked depositors to withdraw their savings with the argument 'better safe than sorry'[9]. The bank run stopped on 17th of September when the Bank of England guaranteed full coverage over all the deposits. Eventually, the bank run of Northern Rock led to its nationalization in February 2008. The spillover effects of the bank run to the rest of the banking sector is covered in the next section.

2.3 Literature review on the Northern Rock Bank Run

The previous section already described the bank run of Northern Rock. This section gives a review of literature which deals with the Northern Rock bank run.

2.3.1 *Reflections on Northern Rock: The bank that heralded the global financial crisis*

The first paper which is reviewed here is written by Hyun Song Shin (2009). This paper did include an analysis of the balance sheet of Northern Rock. It found that in the last half year of 2007, so before and after the bank run, the wholesale and retail funds did decline almost with 60 percent. However, the other liabilities of Northern Rock, the covered bonds and the securitized notes, stayed stable during that period. The conclusion from this is that the run in September 2007, where customers tried to withdraw their money was not the only run on Northern Rock. Another run on Northern Rock did happen in the wholesale market as a result of the illiquidity in that market due to the problems described in the previous section. As a result of this Northern Rock did face a loss in their assets. This is only a problem if it is

[9] See also http://news.bbc.co.uk/player/nol/newsid_7000000/newsid_7000600/7000655.stm?bw=bb&mp=wm&asb=1&news=1&bbcws=1 for reactions of the people queuing during the bank run.

hard to attract new investors, unfortunately this was the case in the distressed markets in 2007. Naturally, this problem did also arrive by other financial institutions which used the wholesale market as a funding resource. However, in the whole financial system there will always be some institutions that cannot raise enough new equity and Northern Rock was one of those institutions.

2.3.2 *Internet Banking and the question of Bank Run: Lesson from the Northern Rock Bank case*

The second paper is written by Nathalie Janson (2009). This paper analyzes the importance of internet on the banking sector with regards to bank runs. According to this paper, internet banking makes it harder to deal with a liquidity crisis. Firstly, it is very hard to predict a liquidity crisis, because it is easier for depositors to withdraw their money and open a new account at another bank. And secondly, due to the internet, (bad) news about banks arrive much faster to depositors, this may create a bank run within a few minutes. Therefore, the central bank should response quickly and adequate as a lender of last resort in the case when a healthy bank has a temporary liquidity problem. If the central bank does not do this, an almost harmless temporary liquidity problem can lead to a dangerous bank run. During the Northern Rock case the Bank of England failed with their policy, if they gave Northern Rock immediately a temporary loan, then the bank run did probably not happen. The paper also states that if the Bank of England gave full coverage insurance, the run did not happen in the first place either. The fact that the bank run stopped on September 17th, when the Bank of England gave full coverage on the deposits, also supports this statement. Lastly, another result of this paper is that most of the depositors do not act fully rational. Instead of using the available public information from the stock market, they relied more on the items they saw on the news and in the newspapers. This is based on the fact that there were not many withdraws before the bank run, although the share of Northern Rock declined sharply in the first half of 2007.

2.3.3 *Liquidity, Bank Runs and Bailouts: Spillover Effects during the Northern Rock Episode*

The last paper is written by Tanju Yorulmazer (2008). This paper analyzes the spillover effects of the bank run to the rest of the banking sector in the United Kingdom. The analysis uses the stock price of the ten biggest UK-owned banks and concentrates on the days that the BBC leaked the news about the rescue operation of the Bank of England (13 September) till the day after the day that the government bailed out Northern Rock (18 September). This paper examines whether there were abnormal returns on those days and whether this could be explained by the rationality of the investors in the stock market. The first conclusion of the analysis is that there were abnormal returns for the other banks, these returns were negative on the day after the leaked news (14 and 17 September) and positive after the day of the bailout (18 September). This is exactly what one would expect because the problems at Northern Rock did give rise to unrest, but the bailout of the government did give more confidence because it was clear that the government would not let a large bank fall. The second conclusion is that the investors did act rational to the giving news. This can be explained by the fact that the abnormal returns of the banks with a similar balance sheet as Northern Rock were more significant. So banks which also depends on the wholesale and mortgage market did face a larger decline of their share value on 14 and 17 September and a larger raise on 18 September.

2.3.4 Conclusion of the literature review

These literature shows that the crisis at Northern Rock was a direct result of the problems in the United States mortgage market. These problems caused the 'first run' on Northern Rock, where investors did not renew their investments at Northern Rock. Consequently, this resulted in a liquidity crisis at Northern Rock. The policy of the Bank of England was an important factor for the 'second run'. If it did have a better deposit insurance scheme or if it did react more adequately to the problems of Northern Rock, the second run could have been prevented. Although, the government did react adequate after the bank run by bailing out Northern Rock. This gave confidence to the market and as a result it diminished the negative spillover effects of the bank run to the rest of the banking sector. This literature also shows that depositors do not act rational, which has also been addressed in section 1.3.

2.4 Conclusion

The second part shows that there were several events which contributed to the bank run of Northern Rock. The most important event were the problems on the mortgage market in the United States. This gave less confidence to the financial institutions and as a result the wholesale markets became less liquid. Naturally, one can argue that Northern Rock would not get in liquidity problems if they did not depend heavily on the wholesale markets like the rest of the banking sector in the United Kingdom. However, the business model of Northern Rock made them very competitive and let them grow quickly. Another event was the bad policy of the Bank of England during the time of the bank run, instead of giving confidence and calmness to the financial markets its policy was focused on preventing moral hazard. This can be seen in the fact that the Bank of England did not support Northern Rock in first instance when they were in trouble and it is also visible in the flawed deposit insurance scheme. The deposit insurance scheme did have two flaws. Firstly, the deposit of a depositor was only guaranteed to 35.000 pounds and secondly, agents did not even have a full coverage beneath that threshold. The Bank of England chose for this deposit insurance schema because it would also preventing moral hazard, if agents would be guaranteed for the full amount, they would not monitor their bank, was the reasoning of the Bank of England.

Conclusion

This thesis explained the liquidity crisis and the resulting bank run of Northern Rock by using different kinds of bank run models, a questionnaire and a literature review on the case of Northern Rock.

To summarize, this thesis found that the liquidity crisis at Northern Rock was a result of the huge financial crisis at the end of the last decade. It started with the problems on the mortgage market in the United States, which led to a loss of confidence between financial institutions. Unfortunately, Northern Rock was a large player on the mortgage market and was very depending on the wholesale market, as a result of the loss of confidence the wholesale market dried up. In first instance the Bank of England did not provided an emergency loan to the illiquid Northern Rock in August, when it did provide the emergency loan in September this news was leaked by the BBC and triggered the panicking of the depositors. The model in section 1.2 shows that panicking depositors in combination with the flawed deposit insurance would lead to a bank run, in fact this was exactly what happened a day after the leaked news.

As stated above, the model in section 1.2 describes that flawed deposit insurance and panicking depositors leads to a bank run, which was exactly what happened with Northern Rock. So to this extend the bank run model did predict the bank run of Northern Rock accurately. However, the model assumes that the bank run is a self-fulfilling bank run in which the bank is fully liquid. This was not exactly the case with Northern Rock, as stated before, the bank run of Northern Rock was a 'reversed bank run'. During this run Northern Rock first got into a liquidity crisis and, as a result, the depositors tried to withdraw their money. This is something that the model did not capture, although one can argue that Northern Rock was liquid before the bank run because of the emergency loan provided by the Bank of England. A problem with the model is that it neglects the reason of panicking, which may be an important aspect of the bank run.

As stated above, the model only describes the actual bank run of Northern Rock. However, the crisis of Northern Rock can be divided in two problems. The first problem was the illiquidity crisis at Northern Rock and the second problem was the actual bank run. It is hard to prevent a liquidity crisis like the one of Northern Rock. It would therefore be nice for the future to research whether a business model comparable with the business model of Northern Rock would be sustainable in the long run, without the need for emergency loans from the central bank. If this business model would be unsustainable in the long run, the policy makers should at least make rules to prevent such policy. The actual bank run could be prevented by the Bank of England if it used a better deposit insurance scheme. The Bank of England has learned from this mistake and today, depositors in the United Kingdom are guaranteed for 100% over the first 50.000 pounds, this is certainly an improvement with regards to the old deposit insurance. Although, one may not forget that deposit insurance leads to moral hazard, therefore if central banks want to have a more generously deposit insurance scheme to prevent bank runs, it should also regulate and supervision the banks more intensively.

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Appendix

Results of the questionnaire

Explanation of the question and answers of the questionnaire:

#: Number of the respondent.
NL/EN: 1 for Dutch respondents, 2 for English respondents
M/V: 1 for males, 2 for females
Edu1: General education level (scale 1 to 5)
Edu2: Financial education level (scale 1 to 5)
Cust: 1 for customers of DNB/Northern Rock, 0 otherwise
BR1: Would you withdraw in a situation like the DNB (when someone 'announce' a bank run)*
BR2: Would you withdraw in a situation like the Northern Rock (when there is already a bank run)*
*) 1= Yes, only with more than the deposit insurance limit
2=Yes, even with less than the deposit insurance limit
3=No
4=I don't know
Dep: 1 for respondents who do know what the deposit insurance is, 0 otherwise
Change: 1 for respondents who would change their previous answer now they know what the deposit insurance is, this is explained before the question, 0 otherwise

#	NL/EN	M/V	Age	Edu1	Edu2	Cust	BR1	BR2	Dep	Change
1	1	2	23	3	1	0	4	4	0	0
2	1	1	18	5	3	0	1	1	1	0
3	1	1	46	4	3	0	3	3	1	0
4	1	2	19	4	2	0	3	4	1	0
5	1	1	55	3	3	0	2	2	1	0
6	1	1	25	5	3	0	3	4	0	1
7	1	2	29	4	3	0	3	3	1	0
8	1	1	51	3	3	0	3	2	1	0
9	1	1	62	4	2	0	2	1	1	0
10	1	1	44	5	2	0	3	3	0	0
11	1	1	24	5	4	0	3	2	1	0
12	1	1	25	4	2	0	3	3	1	0
13	1	1	21	4	3	0	2	2	0	0
14	1	1	23	4	2	0	2	2	1	0
15	1	1	23	4	4	0	3	1	0	0
16	1	1	20	5	3	0	3	2	0	0
17	1	1	37	4	3	0	3	2	0	0
18	1	1	21	4	2	0	3	3	0	0
19	1	1	17	5	4	0	3	1	1	0
20	1	1	34	5	3	0	1	1	0	0
21	1	1	20	4	2	0	2	4	0	0
22	1	1	21	5	3	1	3	4	0	0
23	1	1	22	4	2	0	3	2	0	1
24	1	1	24	4	1	0	2	2	0	0

25	1	1	23	4	2	0	2	2	0	0
26	1	1	27	4	5	0	3	1	1	0
27	1	1	24	5	3	0	3	1	1	0
28	1	1	23	4	3	0	4	4	1	0
29	1	1	23	5	3	0	3	2	0	0
30	1	1	32	3	4	0	3	3	1	0
31	1	1	22	5	2	0	3	2	0	0
32	1	1	22	3	1	0	2	2	0	1
33	1	1	22	5	4	0	1	1	1	0
34	1	1	22	5	3	0	1	1	1	0
35	1	1	18	1	1	0	3	2	0	0
36	1	1	23	4	5	0	1	1	1	0
37	1	1	24	5	4	0	1	1	1	0
38	1	1	22	4	4	0	2	1	1	0
39	1	1	20	5	4	0	1	3	1	0
40	1	1	20	4	3	0	3	4	0	0
41	1	1	22	4	3	0	1	2	1	0
42	1	1	23	5	3	0	3	2	1	0
43	1	1	22	3	2	0	3	2	0	0
44	1	1	22	4	2	0	3	2	0	0
45	1	1	21	5	5	1	3	1	1	0
46	1	1	30	5	3	0	3	1	1	0
47	1	1	21	4	3	0	1	1	1	0
48	1	2	21	3	2	0	1	2	0	1
49	1	1	22	4	5	0	2	2	1	0
50	1	1	25	5	4	0	1	1	1	0
51	1	1	22	5	3	1	3	1	1	0
52	1	1	26	5	2	0	4	2	0	0
53	1	1	19	4	4	0	1	1	1	0
54	1	1	25	5	2	0	3	1	0	1
55	1	1	21	4	4	0	4	2	0	0
56	1	1	20	4	4	0	2	2	1	0
57	1	1	22	4	4	0	3	1	0	0
58	1	1	36	5	4	0	2	1	1	0
59	1	1	18	3	3	0	3	1	1	0
60	1	1	23	4	3	0	3	2	1	0
61	1	1	30	5	3	0	2	2	1	0
62	1	1	20	4	3	0	3	4	1	0
63	1	2	44	5	4	0	4	1	1	0
64	1	1	19	4	1	0	4	2	0	0
65	1	1	19	4	5	0	1	1	1	0
66	1	1	18	4	4	0	3	2	1	0
67	1	1	25	4	3	0	2	2	0	0
68	1	1	18	5	4	0	2	2	1	0
69	1	1	24	5	4	0	3	3	1	0

70	1	1	22	4	2	0	3	2	0	1
71	1	1	20	5	3	0	3	1	0	0
72	1	1	24	4	4	0	1	1	1	0
73	1	1	22	5	3	0	3	2	0	1
74	1	1	19	4	4	0	1	1	1	0
75	1	1	19	5	4	0	2	2	0	0
76	1	1	20	4	4	0	2	2	1	0
77	1	1	25	5	4	0	3	3	1	0
78	1	1	21	5	5	0	3	3	1	0
79	1	1	19	5	3	0	3	4	0	1
80	1	1	18	3	3	0	1	1	1	0
81	1	1	26	4	4	0	3	1	1	0
82	1	1	24	5	5	0	2	2	0	0
83	1	1	22	4	2	0	3	3	1	0
84	1	1	27	5	5	0	2	2	1	0
85	1	1	23	5	4	0	3	1	1	0
86	1	1	22	5	4	1	3	4	1	0
87	1	1	33	5	4	0	2	2	1	0
88	1	1	43	5	4	0	2	2	1	0
89	1	1	21	3	2	0	1	1	0	0
90	1	2	47	4	2	0	3	2	0	0
91	1	1	37	3	2	0	4	2	1	0
92	1	1	17	4	2	0	3	3	0	0
93	1	1	23	5	3	0	3	3	1	0
94	1	2	57	4	3	0	1	1	1	0
95	1	2	50	3	2	0	2	2	0	1
96	1	1	23	5	4	0	1	1	1	0
97	2	1	20	4	3	0	2	2	0	0
98	1	1	50	3	2	0	2	3	0	0
99	1	1	24	4	4	0	1	1	1	0
100	1	1	20	4	1	0	3	4	0	0
101	1	1	26	5	1	0	4	1	0	0
102	1	1	29	2	4	1	2	3	1	0
103	1	1	25	5	2	0	2	2	1	0
104	2	1	28	4	3	0	3	3	1	0
105	2	1	37	5	3	0	4	4	1	0
106	2	1	37	5	5	0	1	1	0	0
107	2	1	34	5	5	0	1	3	1	0
108	2	1	65	5	3	0	1	1	0	0
109	2	1	33	5	4	0	2	2	1	0
110	1	2	45	4	3	0	4	2	1	0
111	1	1	20	4	2	0	3	2	0	0
112	1	1	21	5	3	0	1	1	1	0
113	1	1	52	4	3	0	4	2	0	0
114	1	2	47	4	2	0	3	2	1	0

115	1	2	50	3	3	0	2	2	1	0
116	1	1	34	4	3	0	1	1	0	0
117	1	1	44	5	3	0	3	1	1	0
118	1	1	20	5	3	0	2	2	0	0
119	1	1	52	3	4	0	3	4	0	0
120	1	1	37	3	3	0	3	1	0	0
121	2	2	26	4	2	0	2	2	1	0