

Bank runs: A comparison between two English liquidity crises



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Academic Year

2014-2015

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Introduction

Banks make loan that cannot be sold quickly at a high price. Banks issue demand deposits that allow depositors to withdraw at any time. This mismatch of liquidity, in which a bank's liabilities are more liquid than its assets, has caused problem for banks when too many depositors attempt to withdraw at once, a situation referred as a bank run. (Diamond, 2007)

A bank run is an event that occurs in a fractional reserve banking system when a sizeable number of clients (depositors) withdraw or try to withdraw their deposits from a financial institution, in fear that their bank (the financial institution) may be insolvent or nearly so. When the fear of not being able to redeem their deposits spreads among bank's clients, it creates a self-fulfilling prophecy mechanism, in which as more people withdraw their deposits, the likelihood of bank failures increases, triggering even more withdrawals. Eventually, even if the financial institution was effectively solvent, it may in the end go bankrupt if not helped by the central bank or the government.

Bank runs have been part of the financial system since the advent of credit cycles (with its expansionary phase and its subsequent contraction phase) in the 16th century. Old English promissory notes issued by goldsmith unable to repay the debt due to bad harvest, the Dutch tulip manias (1634-1637) and the British South Sea Bubble (1717-1719) are all examples of financial crisis happened well before the computerization of financial markets and the globalization of international trade. A bank run is often followed by a chain reaction in which, due the interconnections between banks and the increased uncertainty of investors, other depositors run on the bank in fear that their own bank may be insolvent. This phenomenon is called bank panic and it is a very dangerous event for the wealth of a nation because it causes a long economic recession as domestic business and consumers are left without a channel to obtain credit for capital investments and consumption (credit crunch).

A failing bank may be very costly for taxpayers: for example, during the bankruptcy of IceSave of 2008, the Dutch government paid more than 140 million euro. Although, if contained, a single bank run is just a minor event for the overall health of a nation's economy. Instead, a bank panic, or even a systemic banking crisis (an event in which all or almost all of the banking capital is wiped out), is a serious threat to the economy of a nation and the wealth of its citizens. According to former U.S. Federal Reserve chairman Ben Bernanke, much of the harm to the real economy during the Great Depression came directly from bank runs. Furthermore, it has been estimated that the costs on average of a bank panic reaches 13% of fiscal cost relative to GDP and 20% of lost GDP in term of output, sampling major financial crisis from 1970 to 2007. (Laeven & Valencia, 2008).

Diamond and Dybvig developed an influential model in 1983 to explain why bank runs occur and why banks issue deposits that are more liquid than their assets. This model has built a strong base for all future literature on the subject and it is nowadays still the basic model on bank runs. The conclusion of the model is that bank runs may occur if there is some degree of panicking among investors. However, some policies, namely *suspension of convertibility* and *government deposit insurance*, could prevent bank runs. We also present extensions to the model, in order to better describe real world situations, as the one that we analyses in the second part of this thesis.

This thesis analyses a real bank run that happened in the United Kingdom financial history; the recent Northern Rock bank run happened on the 14th of September 2007. It was the biggest banking distress since the seventies and the first bank run in the UK in 150 years. It is an interesting case to analyze since it was a non-ordinary bank run, since usually a bank run happens when there is a lack of confidence of depositors, causing them to withdraw their deposits triggering the liquidity problem of the bank. In the Northern Rock's case, the bank firstly got into liquidity problem and, when the news spread, depositors withdrew their money from Northern Rock. This particular case is called a "reversed bank run". The thesis will also briefly examine another famous bank run, the Overend,

Gurney & Company bank run in 1866 and make a comparison with the recent Northern Rock run, highlighting similarity and differences between them.

This thesis is structured as the following. Part 1 deals with the theoretical aspect of bank run and the main policies to prevent it, explaining and discussing the Diamond-Dybvig model. Part 2 analyses the policy and financial activities of Northern Rock, reconstructing the event that led to Northern Rock's liquidity crisis and the financial situation of the period. Furthermore, this part makes a comparison with the recent Northern Rock bank run in 2007 with the Overend, Gurney & Company bank run in 1866, and the resulting reactions of the Bank of England. The thesis ends with a conclusion, where Part 1 and Part 2 are summarized and tied together.

Part 1: Bank Runs and Liquidity Risk Sharing

1.1 The Diamond–Dybvig Model

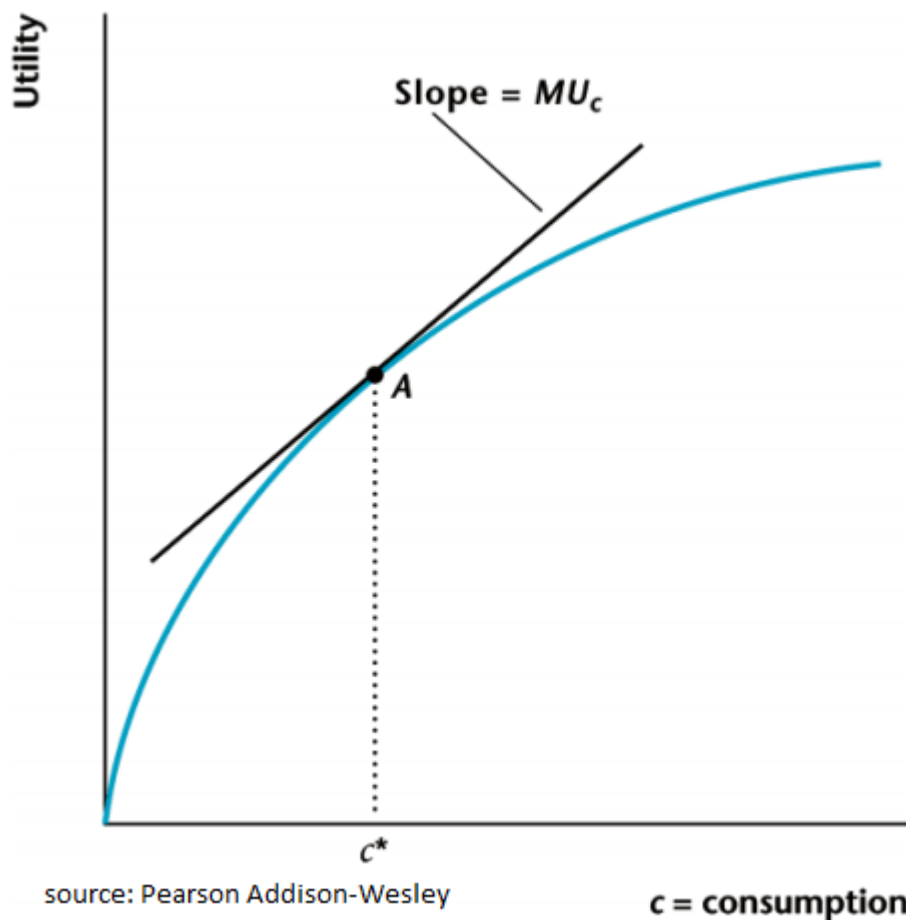
The Diamond-Dybvig model explains why banks choose to issue deposits that are more liquid than their assets and how this improves the welfare of the agents who use depositor contracts. It also helps us understand why banks are subject to runs.

There are several assumptions made in this model:

- The economic system is formed by N individuals that are risk averse and rational (they maximize their utility)
- The individuals live only in three periods: t_0 ; t_1 ; t_2
- Every individual gets an initial endowment of 1
- At time t_0 no individuals are interested in the consumption of their initial endowment
- There is only a single homogenous good
- The productive technology yields in period t_2 a return of $R > 1$ for each unit of output invested in period t_0 . However the initial production can be interrupted in period t_1 , so that there will be no output in period t_2 and the individual will reclaim the salvage value of its initial investment which will be just 1. The choice of interruption is made at period t_1
- $1 < c_1^{1*} < c_2^{2*} < R$

Period	0	1	2
Endowment	1	0	0
Investment	-1	1	R

- There are two types of individuals; individual type 1 has a utility which depends only on consumption on the first period (t_1), while individual type 2 has a utility which depends only on consumption on the second period (t_2)
- Individuals can privately store consumption goods at no cost
- Banking Industry consists of only one mutually owned bank
- Individuals' utility functions are:
$$U = \begin{cases} u(c_1) & \text{if the individual is of type 1} \\ \rho u(c_1 + c_2) & \text{if the individual is of type 2} \end{cases}$$
 with $R^{-1} < \rho \leq 1$ and c_t is the consumption in period t
- $\rho = 1$ for simplicity sake
- Furthermore assume that the fraction of type 1 individuals is given by k , where $0 \leq k \leq 1$



So the optimal consumption levels for the two types of individuals are:

$$c_1^{1*} = 1 \quad c_2^{1*} = c_1^{2*} = 0 \quad c_2^{2*} = R$$

Practically, the type 1 individual only consume in period t_1 and thus interrupt the investment, and the type 2 individual only consume in period t_2 .

In order to maximize the utility of individuals, we consider the expected utility at period t_0 :

$$EU = ku(c_1) + (1 - k)\rho u(c_2) \quad \text{with } \rho = 1$$

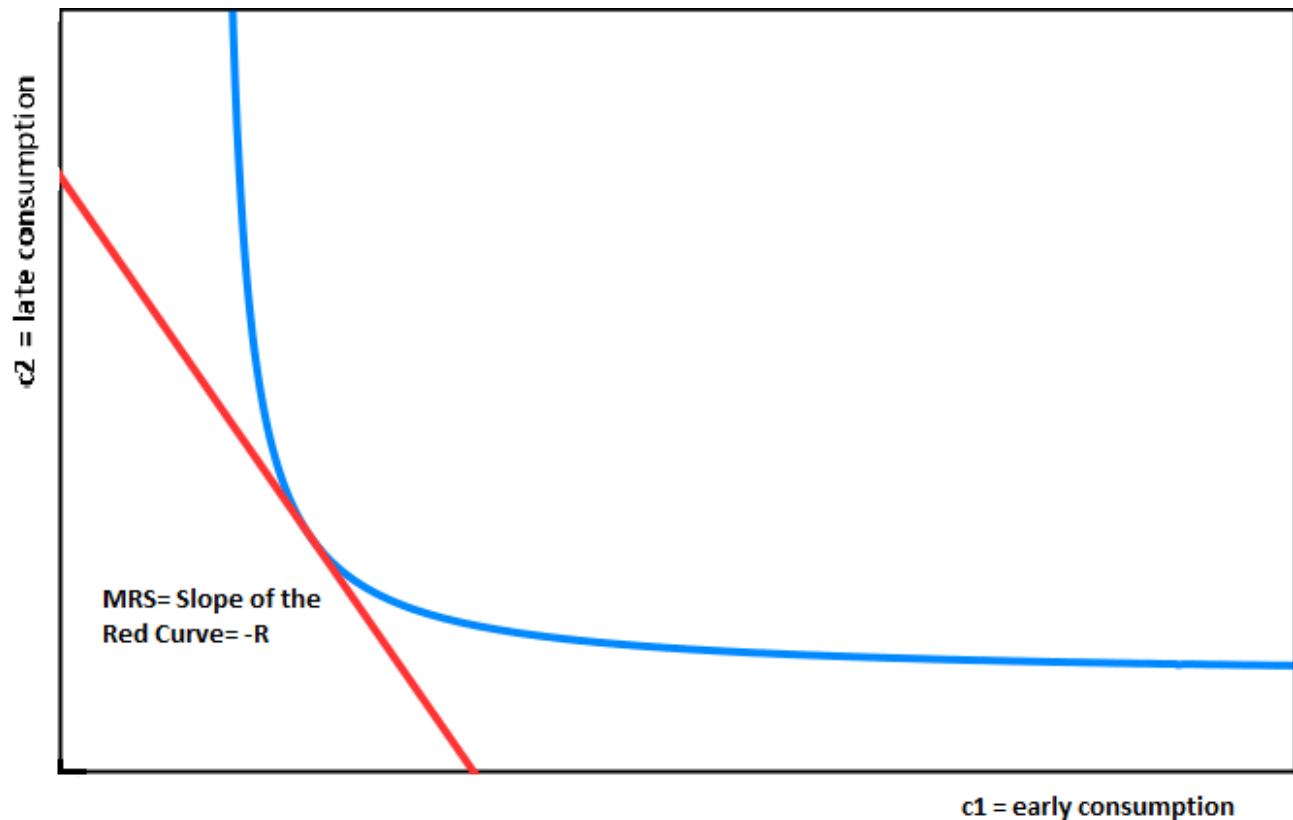
and the constraints, which are the expected consumptions:

$$kc_1 + \frac{(1-k)c_2}{R} = 1$$

Solving the Lagrangian yields:

$$\frac{u'(c_1^*)}{u'(c_2^*)} = R$$

This result means that the rate of substitution between consumption at period t_1 and period t_2 is R .



DD model adds further special restrictions (already summarized at the beginning of the model's analysis): $R^{-1} < \rho$, which implies that it is more desirable to be type 2 individual than type 1 individual, and $\frac{-cu''(c)}{u'(c)} > 1$, which implies that individuals are risk averse. These restrictions are imposed in order to guarantee that the Lagrangian solution satisfies:

$$1 < c_1^{1*} < c_2^{2*} < R$$

The restriction $R^{-1} < \rho$ brings the need for an insurance market (the banking industry in our case), in which type 2 individual compensates for type 1 individual's bad luck. If left without an insurance market, individuals would directly invest in the production process which would yield at period t_1 $c_1=1$ and at period t_2 $c_2=R$. This "autarky" solution is not optimal, since it doesn't satisfy the above first-order condition under the special restrictions.

The model now introduces the banking industry (by assumption formed by one bank only). The role of the bank is to turn illiquid assets in liquid assets, providing insurance that allows individuals to consume when they need it the most (specifically in our model, it means that the role of the bank is to give insurance to the individuals who turn out to be type 1). The model also assumes that the demand deposit contract gives each individual who wants to withdraw in period t_1 a fixed claim of r_1 per unit deposit in period t_0 . Furthermore, the demand deposit contract satisfies a sequential service constrain, which is that the bank uses a "first come, first served" policy for individuals who want to withdraw their investment. Theoretically speaking, as the model clearly specifies, *this policy specifies that a bank's payoff to any agent can depend only on the agent's place in line and not on future information about agents behind him in line*. We assumed from the beginning that the bank is mutually owned (a "mutual") and will be fully liquidated in period t_2 , so that individuals who do not withdraw their investment in period t_1 will get a share of the bank's assets in period t_2 . We now introduce the payoff functions for type 1 individual (V_1) for each unit deposit withdrawn in period t_1 ; and for type 2 individual (V_2) for each unit deposit not withdrawn in period t_1 . V_1 and V_2 can be written as:

$$V_1 = \begin{cases} r_1 & \text{if } f_j \leq r_1^{-1} \\ 0 & \text{if } f_j > r_1^{-1} \end{cases} \quad V_2 = \max \left\{ \frac{R(1-r_1f)}{(1-f)}, 0 \right\}$$

where f_j is the number of withdrawer's deposits serviced before the individual j as a fraction of total demand deposit; f is the fraction of total demand deposit withdrawn at period t_2 . This means that when $f_j > r_1^{-1}$ the bank is out of assets. Let now w_j be the fraction of deposit that an individual tries to withdraw at period t_1 . We now have that the consumption of a type 1 individual is $w_j V_1$ and the consumption of type 2 individual is $w_j V_1 + (1-w_j)V_2$. Note that we assumed an individual can store the good for free.

1.1.1 Equilibrium Decision

The Diamond-Dyvig model states that the demand deposit contract can achieve the full-information risk sharing as an equilibrium (a pure Nash Equilibrium). This equilibrium, called the “good” equilibrium, occurs when $r_1 = c_1^{1*}$. In this equilibrium, type 1 individuals will withdraw at period t_1 and type 2 individuals will not withdraw and wait period t_2 ; mathematically speaking it means that $f = k$.

The second equilibrium (the bank run one) assumes that individuals are panicked and try to withdraw at period t_1 . This will cause that everyone will prefer to withdraw at period t_1 because there is a much greater chance that $r_1 > V_2$. There can be a “bank run” equilibrium only if $r_1 > 1$ because if $r_1 = 1$, $V_1 < V_2$ for every value of $0 \leq f_j \leq f$. In the case $r_1 = 1$, the bank will act as a simple holder of assets and therefore there will be no improvement in the market and the result will be the same as in a competitive and autarky condition in which an interruption of the production in period t_1 will yield the salvage value of 1. The bank run equilibrium provides allocations that are worse for all individuals than they would have obtained without the bank. In fact bank run equilibrium harm efficiency of production because it stops all production at period t_1 when it would be optimal for some to continue till period t_2 .

1.2 Improvement to the demand deposit contract

The Diamond-Dyvig model analysis two policies that can improve demand deposit contract, *suspension of convertibility* and *government deposit insurance*.

1.2.1 Suspension of convertibility

A bank may choose to suspend the withdrawal of deposit, in other words the convertibility of deposits into cash, to defend itself from a bank run. The explanation is straightforward: if the bank can suspend convertibility if the number of withdrawals at period t_1 is too high, adoption of this policy can prevent panic and eliminate the incentive for type 2 individuals to run to the bank. The new contract with the suspension of convertibility will be identical to the previous one except for the fact that now at period t_1 the individual will get 0 after $\hat{f} < r_1^{-1}$, in which \hat{f} represents the highest number of f after which the bank stops paying out deposits. So the new payoff function are redefined as:

$$V_1 = \begin{cases} r_1 & \text{if } f_j \leq \hat{f} \\ 0 & \text{if } f_j > \hat{f} \end{cases} \quad V_2 = \max \left\{ \frac{R(1-r_1f)}{(1-f)}, \frac{R(1-r_1\hat{f})}{(1-\hat{f})} \right\}$$

Convertibility is suspended when $f_j = \hat{f}$, de facto not allowing individuals still “in line” to withdraw their deposits at period t_1 . This demand deposit contract type can achieve optimal allocation and it is easy to demonstrate. We consider the equilibrium condition $r_1 = c_1^{1*}$ and any value of $\hat{f} \in \left\{ t, \left[\frac{(R-r_1)}{r_1(R-1)} \right] \right\}$. As we said before, with this contract no type 2 individual will have an incentive to withdraw at period t_2 because no matter the number of withdrawers that he (the type 2 individual) expects, he is going to receive a higher payoff by waiting period t_2 . Instead, the type 1 individuals, will obviously only consume in period t_1 , as for them consumption in period t_2 is worthless to them. Therefore the unique Nash Equilibrium is $f = k$, a dominant strategy equilibrium because each individual will choose his equilibrium action even if he anticipates that other individuals will choose non-equilibrium or even irrational actions. This equilibrium is

therefore very stable but not the most efficient one because some of type 1 individuals will not be able to withdraw and as a result not able to consume at period t_1 (Therefore their overall utility will be 0). Another fault of this type of demand deposit contract is that it only works if k is known ex ante and not a random variable.

1.2.2 Government Deposit Insurance

The second policy treated in the model is the most common government deposit insurance policy (backed by the government itself or the central bank). This is because a private institution may experience liquidity problem itself. To finance this policy, the government uses its tax authority to levy a tax on all period t_1 wealth, which is imposed whether or not the bank fails. We consider the proportionate tax as a function of f :

$$\tau(f) = 1 - \frac{c_1^{1*}(f)}{r_1} \quad \tau \in [0,1]$$

So the after tax outcome for withdrawers in period t_1 is:

$$V_1 = r_1[1 - \tau(f)] = r_1 \left[1 - \left(1 - \frac{c_1^{1*}(f)}{r_1} \right) \right] = c_1^{1*}$$

In extend, for the case of a deposit insurance policy V_1 and V_2 can be defined as:

$$V_1 = \begin{cases} c_1^{1*} & \text{if } f \leq k \\ 1 & \text{if } f > k \end{cases} \quad V_2 = \begin{cases} \frac{R\{1-[c_1^{1*}(f)f]\}}{1-f} = c_2^{2*} & \text{if } f \leq k \\ \frac{R(1-f)}{1-f} = R & \text{if } f > k \end{cases}$$

Note that for any value f , the fraction of withdrawers in period t_1 , $V_2 > V_1$. This means that type 2 individual will always wait for period t_2 , no matter what is his forecast on the fraction of withdrawers in period t_1 . Furthermore, type 1 individual will have his optimal consumption level always satisfied, because $V_1 > 0$ for any k . So $f = t$ and thus the deposit insurance policy can achieve the optimum equilibrium which is $V_1 = c_1^{1*}$ and $V_2 = c_2^{2*}$.

The deposit insurance policy is thus the best policy that the Diamond-Dybvig model analyses; it can prevent bank run even if k is random (the deposit insurance policy still achieves to prevent bank runs with a stochastic k) and without the suboptimal outcome of the suspension of convertibility policy in which some of type 1 individuals will not be able to withdraw and as a result not able to consume at period t_1 .

1.3 Extensions to the Diamond-Dybvig model

We now present four extensions to the above discussed model that can help to better implement those ideas to real world policies and situations. The first two extensions deal with actual forms of deposit insurance used nowadays, with the first one limiting the amount insured by a percentage and the second one by a fixed amount. The third one introduces the concept of an even more illiquid long-term assets; while the fourth one further examines the sequential service constrain.

1.3.1 Deposit Insurance as a Percentage of the Total Deposit

Before the financial crisis hit the UK, British depositors were only guaranteed for 90% of the amount up to £35,000. We now analyze this type of situation using the framework of the Diamond-Dybvig model. Let d be the fraction of deposit insured by the government, where $0 < d < 1$. With this policy enacted, V_1 and V_2 can be defined as:

$$V_1 = \begin{cases} r_1 & \text{if } f_j \leq r_1^{-1} \\ d & \text{if } f_j > r_1^{-1} \end{cases} \quad V_2 = \max \left\{ \frac{R(1-r_1f)}{(1-f)}, dR \right\}$$

In the good equilibrium $r_1 = c_1^{1*}$ and $f = k$, and thus $V_1 = c_1^{1*}$ and $V_2 = c_2^{2*}$, as in the original model. There is a difference in the panicked equilibrium, although. Again, the question is if there is an incentive for type 2 individuals to withdraw at period t_1 . Obviously, for type 1 individuals, there is always an incentive to withdraw at period t_1 because they care only on the consumption at period t_1 and their payoff is always strictly larger than zero for any f , $V_1 > 0$. Instead, for type 2

individuals, their willingness to withdraw depends on the inequality $r_1 > dR$. In fact, if type 2 individuals forecast that the bank will fail, they will run on the bank if their payoff of the insured percentage of R (dR) at period t_2 is going to be lower than the payoff that they would have gotten if they had withdrawn at period t_1 (r_1). So the condition to avoid a bank run is $r_1 > dR$; if this inequality holds, type 2 individuals will not withdraw at period t_1 . This extensions clearly shows that, holding the other variables fixed, an increase in d will decrease the probability that a type 2 individual withdraws and, hence, decreasing the possibility of a bank run.

1.3.2 Deposit Insurance as a Fixed Limit

Most countries nowadays adopt a maximum amount for which deposits are insured against bank failures. FDIC's (Federal Deposit Insurance Corporation) insurance limits rose from \$2,500 to the current \$250,000, while the European Union has started the harmonization process in 1994 with the Directive (94/19/EC) that has now reached the limit of €100,000. Those limits have increased for most countries after the financial crisis.

We now try to model this policy with the framework of the Diamond-Dybvig model. Let us set D , a limit on the deposit insurance. Furthermore, we differentiate from the original model by setting two different initial levels of endowment, i.e. E_b and E_a . In our model, E_b is below the limit of deposit insurance and E_a is above the limit of deposit insurance. In mathematical term, $E_b < D < E_a$.

Also, e is the probability for an individual to be endowed with E_a , with $0 < e < 1$. Again this policy doesn't change anything for the good equilibrium where $V_1 = c_1^{1*}$ and $V_2 = c_2^{2*}$. The new payoff functions V_1 and V_2 with E_a are:

$$V_1 = \begin{cases} r_1 & \text{if } f_j \leq r_1^{-1} \\ \frac{D}{E_a} & \text{if } f_j > r_1^{-1} \end{cases} \quad V_2 = \max \left\{ \frac{R(1-r_1f)}{(1-f)}, \frac{D}{E_a} \right\}$$

As for the previous extension, type 1 individuals will always withdraw in period t_1 because $V_1 > 0$ for any f . Instead, for type 2 individuals, the situation is more complicated. Type 2 individuals with an above endowment (E_a) are indifferent between withdrawing at period t_1 and period t_2 when the

bank is already out of assets because their payoff is the same, $\frac{D}{E_a}$. But if type 2 individuals forecast in period t_1 a high value of f (which means that the bank is going to be insolvent), they will try to withdraw at period t_1 to get r_1 ; which is strictly higher than $\frac{D}{E_a}$. ($r_1 > \frac{D}{E_a}$)

For type 2 individuals with a below endowment (E_b) the outcome is the same as in the original Diamond-Dybvig model with deposit insurance, where type 2 individuals will not participate in a bank run. This result is achievable only if the total amount of the initial endowment plus the interest that the individual would get in return for waiting for period t_2 is smaller than the limit deposit, in mathematical term, $RE_b < D$. In case this inequality doesn't hold and so $RE_b > D$, there are two possible cases. Similarly for type 2 individuals with an above endowment, type 2 individuals with a below endowment and with $RE_b > D$ will care only about maximizing their utility between the two periods, and so if $r_1 > \frac{D}{E_b}$ they will try to withdraw at period t_1 .

This extension displays that a higher value of e will increase the likelihood of a bank run.

Furthermore there is a negative correlation between e and D , meaning that an increase in the limit amount of insured deposits will decrease e and thus decreasing the probability of a bank run.

1.3.3 Diamond-Dybvig Model with more Illiquid Assets

When long-term assets are even more illiquid, there is an additional way in which the banking industry can help improve utility of individuals. Let us assume the same asset as the original model, only with a return of $r_1 = 1 - \varphi$, with $\varphi > 0$, representing the cost of liquidating the asset at period t_1 . We now introduce a short-term asset that has a return of 1 per each unit invested, thus having a higher return at period t_1 than the long-term asset. However, because a bank knows that a fraction t of depositors needs to withdraw at period t_1 , it can obtain the same set of payoffs as before: $\frac{R(1-r_1f)}{(1-f)}$.

The bank can achieve that by investing in enough short-term assets to cover all withdrawals at period t_1 : investing a fraction of value $r_1 f$ in short-term assets and a fraction of value $1 - r_1 f$ in long-term assets. (Note that we assume in this case $k = f$). This is called asset management of liquidity.

The individuals holding directly the assets (without depositing his liquidity in a bank) cannot obtain the same payoff of the bank. The bank's advantage over the single individual is that the bank doesn't need all of its liquidity at one period, because it knows that only a fraction t of depositors will need liquidity at period t_1 , while the individual holding directly the assets needs all or none of his liquidity at a precise period (t_1 or t_2).

Let us assume, for instance, that bank offers to individuals $r_1 = 1$ and $r_2 = R$ ($R > 1$). A single individual has to directly hold a short term asset to match the return offered by the bank at period t_1 . If he turns out to be a type 1 individual, he will consume at period t_1 and get the same payoff as he would get with the bank; but if he turns out to be a type 2 individual he will get a payoff of 1 at period t_1 , not consume and reinvest still at period t_1 in the short-term asset and get a payoff of 1 at period t_2 , which is lower than R , the payoff that he would get with the bank. The same reasoning applies if he was to match the return offered by the bank at period t_2 , $r_2 = R$. In order to achieve that, he will invest in the long-term asset, getting the same payoff as with the bank if he turns out to be a type 2 individuals (R) and, if he turns out to be a type 1 individual, receiving a payoff of $1 - \varphi$, which is lower than the payoff offered by the bank, $r_1 = 1$. Therefore, it is clear that the payoffs that the bank returns offered to individuals create a strategy that strictly dominates the strategy of an individual who directly holds both type of assets. (Note that this happens only if $0 < k < 1$, or differently, the probability of being a type 1 individual is neither one or zero; the individual at period t_0 does not know if he will need liquidity at period t_1). In the following matrix it is shown that the aggregate payoff (the sum of expected payoffs for period t_1 and for period t_2) that an individual holding directly the assets is going to obtain is strictly dominated by the strategy of investing in the bank, both for short-term assets and long-term assets.

Individual	Short-term	Long-Term
With Bank	$1 + R$	$1 + R$
No Bank	$1 + 1$	$(1 - \varphi) + R$

Hence the banking industry, when long-term asset are even more illiquid ($\varphi > 0$), not only it helps at sharing the risk of liquidating an illiquid asset but also at lowering the opportunity cost of creating an another payoff date, in our case the payoff r_1 , at period t_1 .

1.3.4 Diamond-Dybvig Model with sequential service constrain taken seriously

In 1988, Neil Wallace presented a paper where he claimed that “*Although Diamond and Dybvig seemed aware of the importance of the sequential service constraint, they were vague about why it arises, what in the environment forces banks to deal with their customers sequentially instead of, for example, being able to cumulate withdrawal requests and make payments contingent on the total.*” Wallace goes on demonstrating that if sequential service was “taken seriously”, optimal consumption for type 1 individual at period t_1 would be different depending on their place in line. The paper concludes stating that the Diamond-Dybvig’s kind of deposit insurance is not feasible and it does not work if sequential service constrain is considered, as Wallace does, a fundamental restriction on the economy, assuming that when an individual finds out that he is type 1, he must consume immediately or not at all. Unfortunately, Wallace’s paper has been criticized for the strong assumption that “*during period 1, people are isolated from each other, although each contacts a central location at some instant during the period.*” (McCulloch & Yu, 1998)

1.4 Issues and real-world problematic of the DD model

In the Diamond-Dybvig model, the key variable that incentivize depositors to withdraw depends on exogenous factors, not taken into account in the model. In fact, the decision to withdraw is entirely made on the individual's type and the exogenous forecast that is made by each individual (f). If the forecast is low enough, no bank run will happen, even in the case without a deposit insurance. This idea has been strongly rejected by a following paper by Postlewaite and Vives (1987), in which the authors crafted a demand deposit contract based on the idea that a bank run can always happen occur without the need of an exogenous variable. In their paper, Postlewaite and Vives associated the bank run with a Prisoner's Dilemma type situation, in which the individuals withdraw their money not for consumption purposes but for self-interest reasons. The result are that indeed that there are no endogenous events conditioning individuals' behavior and, secondly, there are no equilibria without the possibility of a bank run.

Furthermore, the DD model imposes some restrictions that may neglect real world facts. The model assumes rationality and risk aversion among individuals, two elements that clearly are not fully implemented by people. The informatization of finance (online banking) and the deregulation of the banking industry at the end of the XX century have made the opportunity cost of switching deposit account into another bank quite low, increasing the incentive to run on the bank. Furthermore, internet makes news spread faster and with a bigger impact and, because not everyone has a degree in economics, people could not fully understand government policies or action taken by the central bank, making them eager to withdraw due to panic and low cost of deposit account switching. Additionally, the model does not consider the moral hazard that may be created by a deposit insurance scheme.

1.5 Policies to prevent bank panic

This section describes the main policies adopted by governments in order to prevent banking failures and bank runs. The first one is *Lender of Last Resort* (LLR), which ought to give confidence to depositor (and households in general) that illiquid banks will be rescued by giving liquidity. The second one is *Deposit Insurance*, which should remove the incentive from depositors to withdraw, guaranteeing their deposit accounts.

1.5.1 Lender of Last Resort

In his influential book, *Lombard Street: A Description of the Money Market*, Walter Bagehot was the first, along with Henry Thornton, to develop the concept of a Lender of Last Resort. Bagehot's advice (sometimes referred to as "Bagehot's dictum") for the lender of last resort during a credit crunch has been summarized by Paul Tucker as follows: *"to avert panic, central banks should lend early and freely (i.e. without limit), to solvent firms, against good collateral, and at 'high rates'".*

The aim of this policy is to protect the money stock and ensure stability in the financial system and, in the classical theory view, it should also follow some restrictive rules: rescue solvent institutions only; let insolvent institutions default; charge penalty rates; require good collateral. These additional rules have remained controversial nowadays and yet not fully implemented in the 2007-2008 financial crisis. It is accepted by scholars, as we will see later in the Overend & Gurney case study, that the Bank of England strictly followed these rules in the last third of the 19th century.

Since the beginning of the concept of a Lender of Last Resort, moral hazard has been a major concern of policy makers and scholars. Guaranteeing illiquid financial institution by allowing them to borrow from the central bank would incentivize bankers and top executive to take excessive risks. It also lowers the motivation of investors (depositors) to monitor their bank. Then, even if Lender of Last Resort may alleviate present financial panic, it may as well increase the probability of a future financial panic due to risk taking induced by moral hazard. Quoting Bagehot, *"If the banks are bad, they will certainly continue bad and will probably become worse if the Government*

sustains and encourages them. The cardinal maxim is, that any aid to a present bad bank is the surest mode of preventing the establishment of a future good bank.”

Therefore, Thornton and Bagehot suggested that, in order to reduce moral hazard, the central bank should let fail “bad” banks and lend only to creditworthy institutions. Nowadays, most central banks act as Lender as Last Resort mainly to give liquidity to illiquid but solvent financial institutions.

1.5.2 Deposit Insurance

Deposit insurance is a measure implemented by several countries in order to protect depositors from potential losses caused by the inability of the bank to pay back its liabilities. The oldest system of national bank deposit insurance is the U.S. system (Federal Deposit Insurance Corporation), established in 1934. It was only after the WWII that deposit insurance schemes started to spread around the world and, during the 1980’s, it saw an acceleration of its diffusion. As we observe in part 1.2.2, the Diamond-Dybvig model recognizes that deposit insurance is the best policy to prevent bank runs; it negates the incentives of depositors to withdraw when all the amount of their deposits is insured. Also, when deposit insurance is with a fixed limit or/and a percentage it may help to prevent bank runs.

As the previous topic discussed of the Lender of Last Resort, the downside brought by deposit insurance is the creation of moral hazard. When banks acknowledge that a government agency will insure the deposits of its creditor in case of bankruptcy, bank’s managers are encourage into taking more risks. In other words, citing the empirical study of Demirgüç-Kunt, Asli, and Detragiache (2002), *as their ability to attract deposits no longer reflects the risk of their asset portfolio, banks are encouraged to finance high-risk, high-return projects.* This is particularly true in highly competitive markets, in which there is a strong correlation between risk and return. A perfect example of the dangers of moral hazard is the Saving & Loan crises of the 1980’s. By a

combination of generous deposit insurance scheme, financial liberalization, and regulatory failure more than one thousand financial institution during 1986 to 1995 have failed due to excessive risk-taking.

So the question we pose ourselves is if deposit insurance has an overall positive effect, thus preventing self-fulfilling bank runs; or if the creation of moral hazard nullifies those positive effect and actually worsening the financial stability by giving an incentive to bankers to take excessive risks. Demirgüç-Kunt, Asli, and Detragiache tried to answer this question with an empirical study which analyzes the deposit insurance scheme of 61 countries over the period of 1980-1997. Using a simple explicit/implicit dummy as the deposit insurance variable, the authors found that it has a positive correlation with the banking crisis dummy variable at the 8 percent confidence level, suggesting that explicit deposit insurance increases banking system vulnerability.

They also found that, replacing the binary deposit insurance variable with a non-binary dummy variable that takes into account the level of institution and financial regulation, the positive correlation effect is even more significant (at one percent confidence level) than the previous binary variable. This result suggests that moral hazard due to deposit insurance may be more severe in liberalized banking systems where interest rates are deregulated. (The rationale behind this conjecture is that control on bank interest rates limit the ability of banks to benefit from high-risk, high-return investment projects). Furthermore, the authors found that, using institutional indexes, that good institution (assumed to be proxy for better banking regulation and supervision) can limit the negative effect of deposit insurance due to moral hazard on bank stability. Even more interesting, in a number of cases, with high values of the institutional indexes, the effect of deposit insurance on the banking system fragility variable was no longer significant; suggesting that only for countries with good institution and regulation deposit insurance may not be harmful and actually be beneficial for the financial system.

In the following part (part 2), we will discuss the run on Northern Rock of 2007. In this case, the deposit insurance scheme used in the UK, called the Financial Services Compensation Scheme, may

have been one of the explanations for the run that the bank suffered. In fact, in 2007, the FSCS guaranteed only 100% for the first 2000 pounds and then 90% for the next 33000 pounds; effectively guaranteeing 31700 for the first 35000 pounds. This policy was far from best, and it might have incentivize depositors to withdraw their accounts.

1.6 Numerical illustration & Appendix

We now present a brief numerical example to clarify the model and its rationale.

We assume: $R = 2$; $k = 1/5$; $u(c_{1,2}) = -\frac{1}{c}$

In order to maximize:

$$\begin{cases} ku'(c_1) + \lambda k = 0 & (i) \\ (1-k)u'(c_2) + \frac{\lambda(1-k)}{R} = 0 & (ii) \\ kc_1 + \frac{(1-k)c_2}{R} - 1 = 0 & (iii) \end{cases}$$

$$\begin{cases} 0.2 \frac{1}{c_1^2} + \lambda 0.2 = 0 \\ 0.2 \frac{1}{c_2^2} + \frac{\lambda 0.8}{2} = 0 \\ 0.2c_1 + \frac{0.8c_2}{2} - 1 = 0 \end{cases}$$

Which yields:

$$\frac{u'(c_1^*)}{u'(c_2^*)} = R \quad \rightarrow \quad \frac{c_2^2}{c_1^2} = 2$$

$$\text{To find the optimal level of } c_1 = r_1: \begin{cases} c_2 = c_1\sqrt{2} \\ 0.2c_1 + \frac{0.8c_2}{2} = 1 \end{cases} \rightarrow r_1 \cong 1.3$$

To find the optimal amount of r_2 (the return on each unit invested at period t_0 and withdrawn at period t_2) we just consider how much is left to pay depositors who wait until period t_2 to withdraw if a fraction f of initial depositors withdraw at period t_1 . (Please note that we consider a non-stochastic k , which it means $k = f$).

$$r_2(k = f = 1/5) = \frac{R(1 - r_1f)}{(1 - f)} = \frac{2(1 - 1.30 * 0.20)}{(1 - 0.20)} = 1.85$$

It easy to see that $r_2 = 1.85 > r_1 = 1.30$, so type 2 individual will always wait for period t_2 to withdraw because of the higher payoff. This is an example of a good equilibrium, where each type of individual reaches his optimal consumption.

Let us check if the optimal outcome is better than the autarky solution:

$$EU(\text{optimal solution}) > EU(\text{autarky solution}) \rightarrow -\frac{0.2}{1.3} - \frac{0.8}{1.85} > -\frac{0.2}{1} - \frac{0.8}{2} \rightarrow$$

$$-0.5863 > -0.6$$

Consider now a situation in which all depositor forecast that all other depositor will withdraw at period t_1 , (i.e. $f \geq 0.99$). In this case the bank will fail before period t_2 . To find the tipping point in which the bank runs out assets:

$$f * r_1 = 1 \quad f = \frac{1}{1.30} = 0.7692$$

This means that if 77 depositors (if we assume a total of 100 depositors) withdraw at period t_1 the bank will run out of assets and fail. But this is not the turning point for a bank run to happen. In fact type 2 individuals only care if $r_2 > r_1$, if this inequality doesn't hold, and $r_2 < r_1$, type 2 individuals will run on the bank. So the condition is:

$$1.30 > \frac{2(1-1.30f)}{(1-f)} \quad 1.30 - 1.30f < 2 - 2.6f \quad f > 0.53846$$

So if a depositor forecasts that more than 53 depositors will withdraw in period t_1 , he will withdraw at period t_1 too.

We demonstrate now that for every f , in case of a deposit insurance policy, type 2 individual will always wait for period t_2 and not run on the bank. Let us consider the extreme case where the type 2 individual forecasts that the bank will fail, hence $f = 0.77$. In this case type 2 individual's payoff will be

$$\frac{R(1-f)}{1-f} = \frac{2(1-0.77)}{(1-0.77)} = 2 = R.$$

So, even if a bank run is forecasted by a type 2 individual, he will not run on the bank due the fact that $V_2 > V_1$ for any value of f .

Let us consider the extension 1.3.3. We now demonstrate that the individual's opportunity set is dominated by the bank's opportunity set. Let us assume $k = f = \frac{1}{4}$, $\varphi = \frac{1}{2}$, $R = 2$.

An individual can, if he does not use the bank, can put a fraction α of his endowment in short-term assets and the remainder in long-term assets, giving him the following returns:

$$r_1 = \alpha + (1 - \alpha)(1 - \varphi) \text{ and } r_2 = \alpha + (1 - \alpha)R$$

To get the individual's tradeoff between r_1 and r_2 we just substitute for α .

$$r_2 = 1 + (1 - r_1) \frac{(R-1)}{\varphi} \quad \text{While the bank's tradeoff is:} \quad r_2 = \frac{R(1-r_1f)}{(1-f)}$$

Now if we assume that the individual will split his endowment equally between short-term and long-term assets ($\alpha = \frac{1}{2}$), his return at period t_1 is going to be $r_1 = \frac{1}{2} + \left(1 - \frac{1}{2}\right)\left(1 - \frac{1}{2}\right) = 0.75$.

Hence, period t_2 's return, is going to be $r_2 = 1 + (1 - 0.75) \frac{(2-1)}{0.5} = 1.5$. However, if the bank sets the same return at period t_1 ($r_1 = 0.75$), it (the bank) can offer a return of period t_2 of

$$r_2 = \frac{2(1-0.75*0.25)}{(1-0.25)} = 2.167, \text{ which is strictly higher than the return obtained by the single individual}$$

who directly holds the assets.

Part 2: The Northern Rock case and Bank of England's response

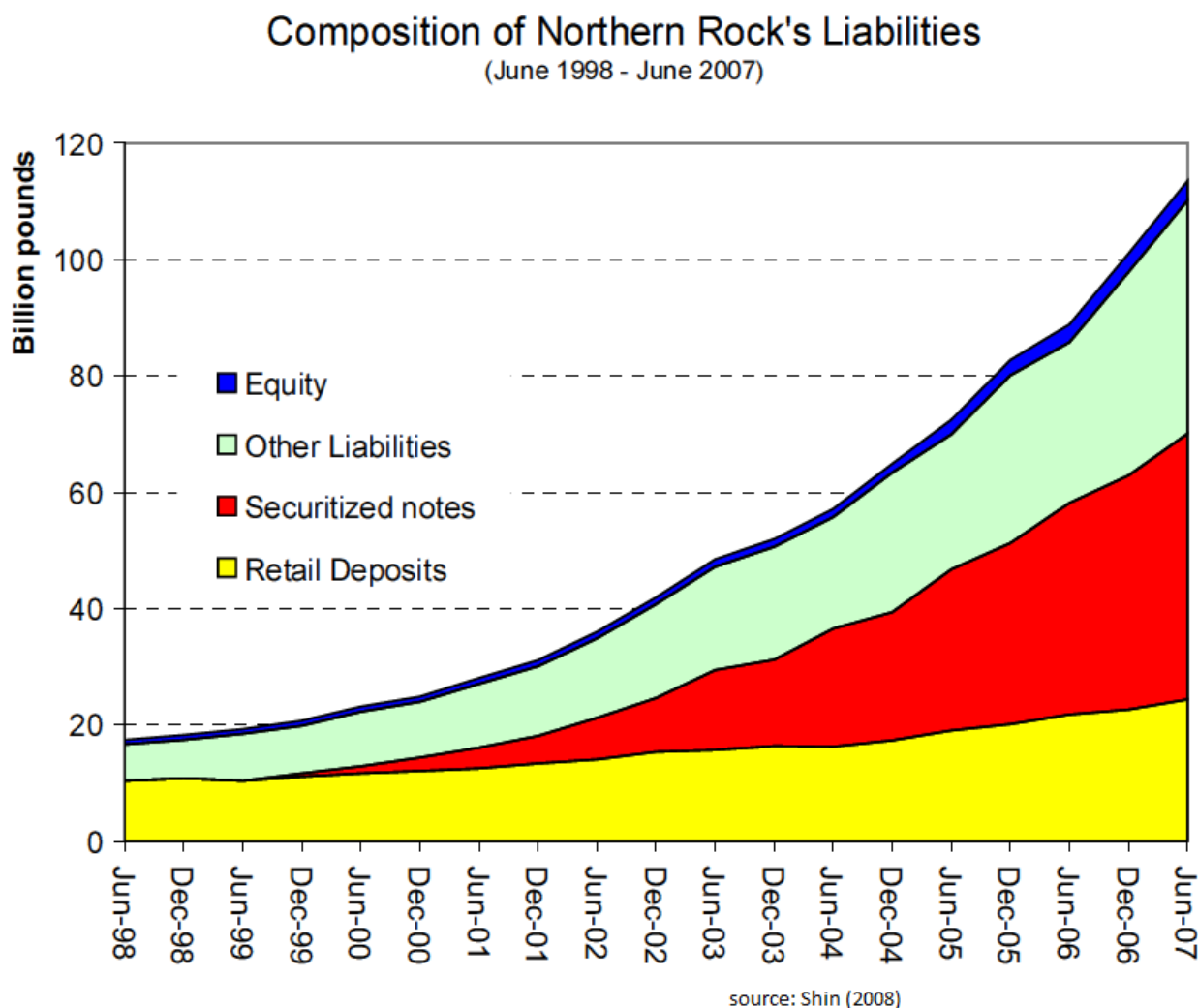
2.1 Historical Background of Northern Rock

Northern Rock Building Society was formed in 1965 as a result of the merger of two North East English building societies (a building society is a mutually owned saving bank); the Northern Counties Permanent Building Society and the Rock Building Society.

During the subsequent 30 years, Northern Rock expanded with the acquisition of 53 smaller building societies. Throughout the 1990's, Northern Rock chose to demutualise (join the stock market) in order to expand their business more easily. In 1997 it successfully did so, and in the 2000 Northern Rock was included in the FTSE 100 index, a share index of the 100 most highly capitalized companies listed on the London Stock Exchange. During the financial crisis of 2007-2008 the bank went under severe financial trouble that resulted in the liquidity support facility aid from the Bank of England and, subsequently, the bank was hit by a bank run on September 14th 2007. At 00:01 on the 22nd of February 2008, Northern Rock was nationalized by the British government.

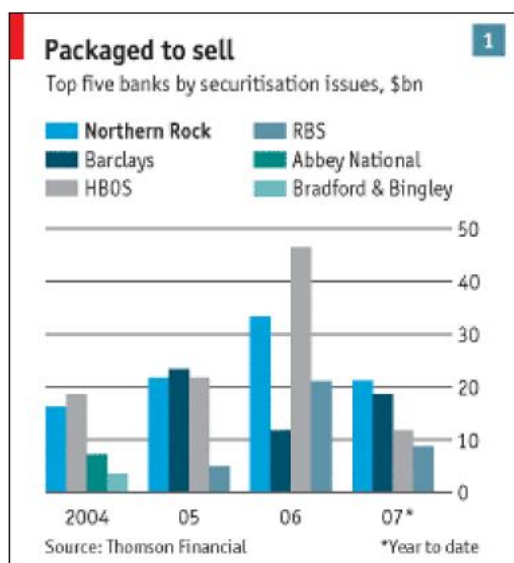
In 2012 Virgin Money completed their purchase of Northern Rock from UK Financial Investments for approximately £1 billion and by October of that year the high street bank operated under the Virgin Money brand.

2.2 Northern Rock's operations and policy: why it failed



Since the entry in the London Stock Exchange, Northern Rock's assets grew from 17.4 billion pounds to 113.5 billion pounds. However, as the figure clearly shows, the share of retail deposits dropped from 60% to 20% during the same period. Furthermore, the leverage rose from 22.8 in June 1998, just after its floatation, to 58.2 in June 2007, two months before of its liquidity crisis. At the eve of the bank run, Northern Rock was the fifth largest bank in the United Kingdom. Since its quotation on the stock exchange, Northern Rock changed its business model moving away from retail deposits to rely more heavily on the wholesale market and securitized notes in order to finance its assets expansion of the first decade of the new millennium. It is worth noting, though, that Northern Rock was not unique among UK banks in making growing use of non-retail funding, but

what set it aside from others was the extent to which it relied on such non-ordinary funding. In 2007, Northern Rock was the biggest player in the securitization market of the United Kingdom. Northern Rock, aggressively using this business model, bundling and packaging its loans and selling them as bonds to investors around the world, could raise money more cheaply than its competitor and thus offer its mortgages at a lower price. This made a huge impact in the bank's rapid growth.

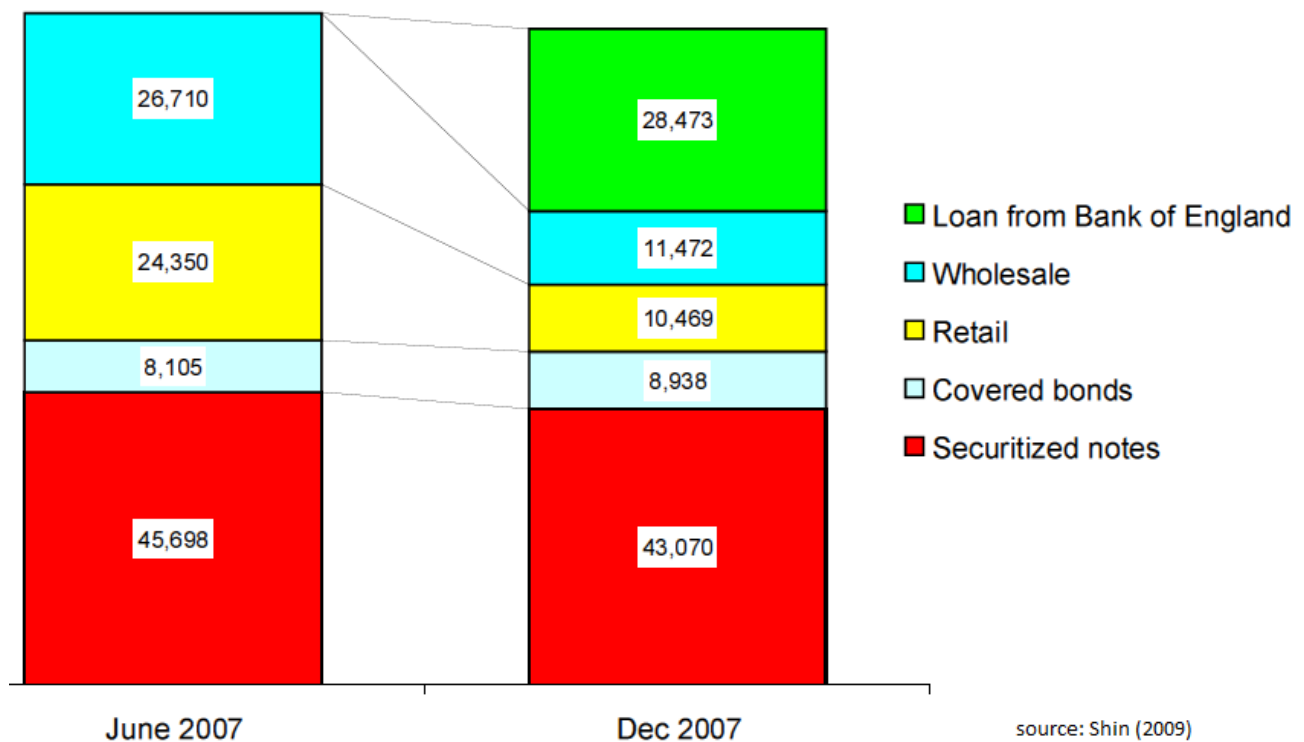


2.2.1 Securitized Notes

Although commentators mostly pointed at the securitized notes way of funding as the main source of Northern Rock's financial catastrophe, as we will now discuss, the role played by Granite Finance Trustees Ltd (the mortgage trustee that Northern Rock assigned portion of its mortgage assets to and subsequently channeled into special purpose entities (SPEs) for the securitization process) in Northern Rock's downfall is somewhat more subtle. In fact, differently from the US securitization process where SPEs are off-balance sheet vehicles, Northern Rock kept residual interest in the securitized assets, hence consolidated in its balance sheet, reflecting Northern Rock's balance sheet's rapid growth. Moreover, the US and European banks caught up in the subprime crisis supported off-balance sheet entities that heavily relied on very short-term liabilities such as asset-backed commercial paper (ABCPs). Instead, notes issued by Granite were of much longer

maturity. Taken together, these two differences made the effect of the subprime crisis on securitized notes much more subtle for Northern Rock and hence was therefore different from the outwardly similar downfalls for structured investment vehicle (SIVs) and conduits sponsored by other European banks. So what caused the financial turmoil of Northern Rock of 2007? The following figure helps us understand.

**Aftermath of Run: Composition of Liabilities
(million pounds)**



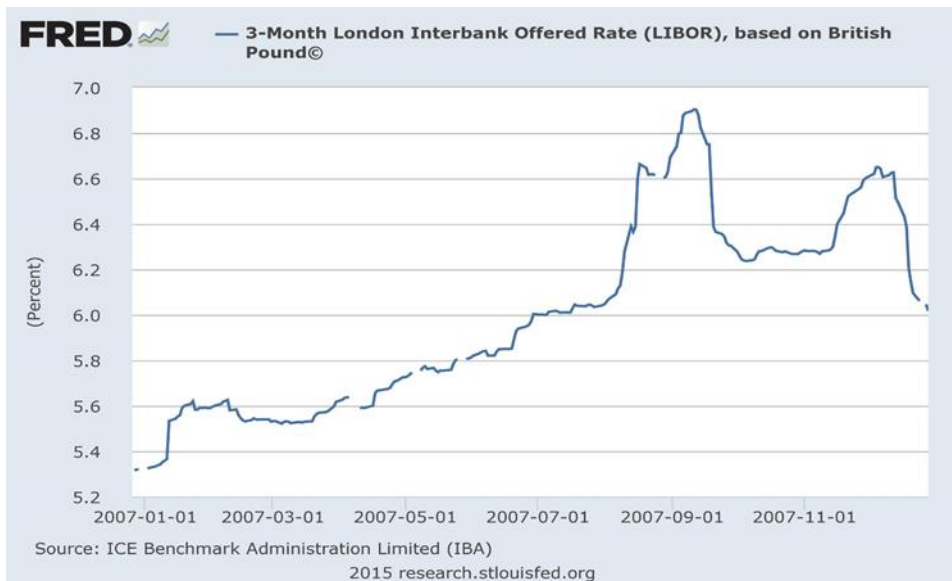
2.2.2 Wholesale Funding

The figure shows a snapshot of Northern Rock's liabilities before and after the bank run. As we may have expected, the amount of retail deposit experienced a sharp drop of 57%, from 24.3 billion to 10.5 billion. Moreover, reflecting the conclusion of part 2.2.1, securitized notes fell only slightly

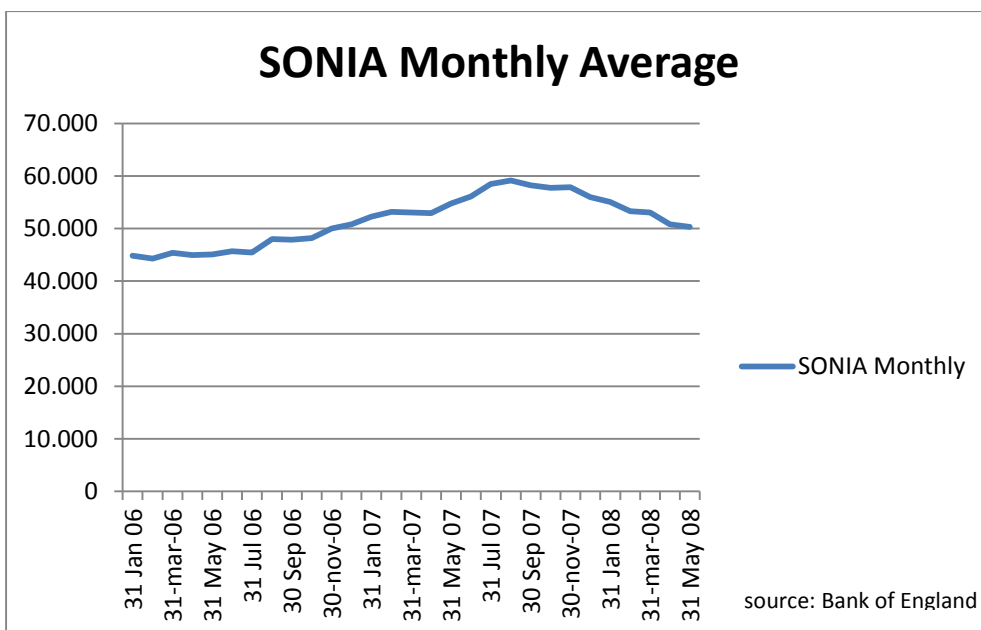
from 45.7 billion to 43 billion. The largest drop, with the retail deposits, is the wholesale funding falling from 26.7 billion pounds in June to 11.5 billion pounds in December. Northern Rock's short-term wholesale funding shared many similarities with the short-term funding raised by off balance sheet vehicles such as SIVs and conduits, suggesting that Northern Rock's source of wholesale funding was the same of said SIVs and conduits of other Europeans banks. The 2007 Northern Rock's financial statement indicates where the true run happened: although Northern Rock managed to raise a net 2.5 billion pounds of wholesale funding in the first half of the year, the second half saw "substantial outflows of wholesale funds, as maturing loans and deposits were not renewed. This resulted in a full year net outflow of £11.7 billion." Maturing loans and deposits were not renewed by the investors in Northern Rock short- and medium-term paper, thus it was the wholesale funding that caused the financial trouble of Northern Rock. This is comparable with a bank run in which depositors try to withdraw their stake. What caused this?

2.2.3 The financial Crisis of 2007-2008

In 2007 US housing prices sharply declined (the Real estate bubble burst), and many poor homeowners could not repay their mortgage. Because most mortgages were bundled together (part of the securitization process called pooling) and resold many times, it was difficult to recognize which asset packages were "clean" or "toxic". This panicked investors and thus dried up the wholesale market, raising perceived risk and interest rates. Confidence between financial institutions dropped, raising interbank lending rate. A good indication of the liquidity in the interbank lending market is the London Interbank Offered Rate (LIBOR) index.



The figure shows that the LIBOR since the end of 2006 till the beginning 2008 was really high and reached a record high of 6.88 in September 2007, when Northern Rock bank run happened. Another useful indicator is the Sterling Over-Night Index Average (SONIA). Calculated on a daily basis, SONIA indicates how much it will cost a bank to borrow in the market. As for the LIBOR, this index shows that during the financial turmoil of Northern Rock, interest rates reached very high level, reflecting the illiquidity of the wholesale market.



A more specific indicator of the financial situation of Northern Rock is the share price index, a good gauge about the future expectation of investors about the soundness of a firm. Northern Rock share price went down about 40% within 6 months, while the rest of the banking sector experienced a smaller drop in the share price of 10%.



2.3 FSA and Bank of England Responses

We now analyze the responses of the Financial Services Authority (FSA), designated to supervise individual banks in the United Kingdom, and of the Bank of England to the Northern Rock case financial insolvency.

2.3.1 An Unknown Unknown

In 1997 Gordon Brown, at that time chancellor of the exchequer, decided to hand bank supervision from the Bank of England to the new FSA. This new government agency was to look at individual banks while the Bank of England remained responsible for the stability of the financial system as a whole. During the months leading to the bank run, the FSA missed clear signs of the fragility of Northern Rock. A falling share price, the heavy reliance on the risky wholesale market and a profit warning (in June when Northern Rock trimmed the year's expected profits growth from 17% to

15%), did not warn the FSA about the fragility of Northern Rock. FSA's regulatory chairman and Northern Rock's CEO stated that the event that felled the bank (a complete failure of the funding-source of Northern Rock) could not have been foreseen; an unknown unknown. Besides missing clear signs, though, the FSA's stress test was faulty and incomplete because it did not incorporate extreme scenarios, in which markets were very illiquid.

2.3.2 Rescue and Nationalization of Northern Rock

On Monday August 13th, two days after the markets completely dried up, Northern Rock informed the FSA that it was in trouble. When the situation was assessed and passed to the Bank of England and the Treasury, the idea that the Bank of England would have to act as a "lender of last resort" to Northern Rock had been brought up. However, all the three institutions agreed that it would have been preferable for another private bank to take over the troubled bank. After some initial contacts, it looked like Lloyds TSB, a British bank, could indeed take over Northern Rock but the deal sunk on September 10th. Lloyds TSB was ready to take over but it requested a loan of £30 billion from the Bank of England. The three institution deliberated that it would have been inappropriate to help finance a bid by a private bank. This reflected the policy undertaken by the Bank of England: while the ECB and the FED injected extra cash into the money markets and accepting a wider range of collateral than usual, the Bank of England did neither until September. The aim was to send a message to bankers and players in the financial markets in general that, if excessive risks were taken, the Bank of England would not bail them out. The Bank of England wanted to avoid moral hazard creation.

However, when the deal with Lloyds TSB foundered, only the Bank of England could rescue Northern Rock. Mr. King, the Governor of the Bank of England, wanted to do this behind the scenes. On the 14th of September the bank sought and received a liquidity support from the Bank of England but the news of the impending rescue leaked out prematurely. This caused panic among depositors and alerted to trouble, they raced to get their cash out before everyone else did. The bank run was stopped only on September 17th, when Mr. Darling, the Chancellor of the Exchequer during

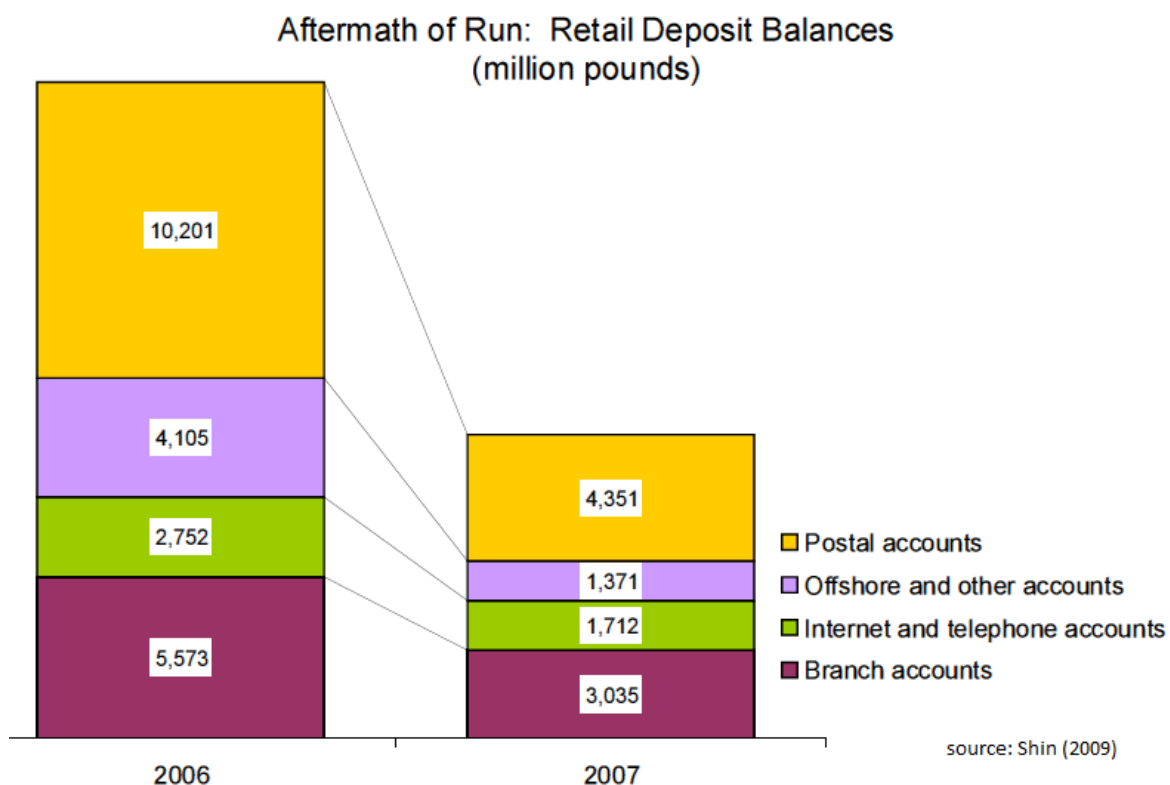
the crisis, issued an unprecedented guarantee for all existing deposits at Northern Rock.

By January 2008, Northern Rock's loan from the Bank of England had grown to £26 billion.

On 6 February, the Office for National Statistics announced that it was treating Northern Rock as a public corporation, similar to the BBC and Royal Mail for accounting purposes, causing the loans (approximately £25 billion) and guarantees (approximately £30 billion) extended by the Bank of England and the value of the company's mortgage book (approximately £55 billion), provisionally estimated to total around £100 billion, to be added to the National Debt.

2.4 Irrational Depositors and Rational Investors?

On September 14th 2007 and many days after, the evening news were flooded with images of depositors queuing and forming long lines at the branch offices of Northern Rock. Almost “ironically”, though, the conventional branch-based customer deposits turned out to be the most stable during the run. The following figure reflects this statement.



As we seen before, we see a large drop in the retail funding, from 26.7 billion to 11.5 billion.

However, the figure tells us that conventional branch accounts, at least for the case of Northern Rock, proved to be more “sticky”, dropping “only” 45% from the initial pre-run level. Instead, non-conventional deposits (postal accounts, offshore and other accounts, internet and telephone accounts) experienced a drop of 57% from the initial pre-run level of 2006.

Nathalie Janson analyzed the effect of non-conventional deposits and internet in general in a paper of 2009. The author identifies two main issues for which bank runs may be affected by internet banking. Firstly, thanks to online banking, it is much easier, faster and cheaper to switch bank account for depositors, lowering the opportunity cost of withdrawing money. Secondly, due to the internet, news (good and/or bad) spread much faster among depositors, and this may increase the probability of a bank run. The author continues saying that for these reasons, the central bank (the Bank of England in our case) should respond quickly and if needed act as a “Lender of Last Resort”. Janson in her paper claims that if the Bank of England would have responded promptly to the liquidity problem of Northern Rock with an immediate temporary loan, the bank run probably would not have happen. The paper concludes analyzing the reactions of depositors. In fact, for the author, depositors did not use all available public information from the stock market, and relied, instead, more on the news from television and newspaper. This claim is strongly backed by the fact that bank run happened only when the news of the Bank of England’s aid (which in theory is a good news, meaning that the government would not let a big bank fail) leaked, and not when Northern Rock’s share price declined sharply in the first half of 2007.

If the depositors did not act fully rational to the news of the implicit bailout of Northern Rock, the financial markets did. Tanju Yorulmazer (2008) analyzed the spill-over effect of Northern Rock’s financial trouble on the banking sector and markets in general. On the days prior to the complete and actual bailout from the Bank of England (18th September), the British banking sector experienced abnormal negative returns, while after that date, when the Bank of England bailed out Northern Rock, the banking sector experienced abnormal positive returns in the stock market. This

reflects the above statement that financial markets reacted rationally. In fact, investors acted rationally and, when the Bank of England made clear that it would not let a large bank fail on the 18th September, they started reinvesting in the banking sectors. This thesis is also strongly backed by the fact that this results were stronger for banks that had a similar balance sheet to Northern Rock (heavy reliance on the wholesale funding market), showing a larger drop in the days prior to the bailout and a larger raise in the days after. In conclusion, the Bank of England, even if it reacted slowly, not preventing the bank run of September 14th, did avoid a widespread banking panic by bailing out Northern Rock and, doing so, it restored confidence in the financial market.

2.5 Overend, Gurney & Company: The Panic of 1866

We now present another bank run that happened during The Panic of 1866 in the UK. We will discuss the reaction of the Bank of England to the crisis at that time and, in the last section, we will make a comparison with the Northern Rock liquidity crisis of 2007 discussed above.

2.5.1 Overend, Gurney & Company's History

The business was founded in 1800 as Richardson, Overend and Company in Nottingham and in 1807 Samuel Gurney joined the firm and took control of Overend, Gurney & Co. in 1809. The core business of the bank was the buying and selling of bills of exchange (the most common money market instrument at that time) at a discount. Overend, Gurney & Co expanded rapidly throughout the first half of the 19th century and earned the respect of the banking industry during the crisis of 1825, when the firm was able to make short loans to many other bankers. After that event, it became known as “the bankers' banker”.

After the retirement of Samuel Gurney, the bank expanded its portfolio and, still financing itself with short-term loans, started investing in long-term investment with high-risk such as railways, ships and shipyards. As one investment after the other failed, the bank ended up with non-performing assets and its liquidity declined. In order to recover from that and attract fresh new

capital, the partnership was turned into a limited liability company and floated on the stock exchange in 1865. This move may have delayed the inevitable fall of Overend, Gurney & Co, but on the other hand the losses of the bank became public knowledge and its reputation got irremediably tarnished. When the stock market collapsed, the Bank of England was approached by the newly limited liability company which sought a temporary loan in order to meet its mismatch of liquidity. The Bank of England refused. Desperate calls to other bankers were unsuccessful and on May 10th 1866 Overend Gurney & Co. suspended payment. The result was the “wildest panic”: contemporaries compared the event with an “earthquake”, and King (1936) writes that it is “impossible to describe the terror and anxiety which took possession of men’s minds for the remainder of that and the whole of the succeeding day”.

2.5.2 The Bank of England’s Response of 1866

How did the Bank of England reacted to the panic? Even if it let Overend Gurney & Co fail, rebutting the principle of “too big to fail”, Bank of England met all “legitimate” demands, lent over £4 million in one day while its reserve fell by close to £3 million. Lending literally exploded on May 11th and, as a result, the crisis month (May 1866) was characterized by much larger amounts of cash supplied compared to the normal month. Moreover, the share of rejected bills was also reduced in May 1866 compared to its 1865 counterpart. This is suggestive of an extensive role of the Bank of England to support the market. Basically, the Bank of England followed the Bagehot's dictum discussed in part 1.5.1: rescue solvent institutions only; let insolvent institutions default; charge penalty rates; require good collateral. In fact, the Bank let the insolvent institution fail (Overend Gurney & Co) no matter the size of the firm, while it increased the monetary base by increasing lending (at a penalty rate) to protect the money stock.

2.5.3 A Comparison Through Time

The Bank of England's responses to the two financial crisis of 2007 and of 1866 were substantially different. In the case of Northern Rock, the Bank, in the end, actually acted as a "Lender of Last Resort" and implicitly stated that it would have not let a big bank as Northern Rock fail, bailing out the troubled bank with taxpayers money. Instead, for the case of Overend Gurney & Co, the Bank followed the Bagehot's dictum and let the insolvent bank fail. Obviously the two responses are not completely comparable, because of how much financial markets are integrated across countries and the speed at which information travels nowadays in respect to the 19th century; but we may draw some hypothesis and describe pros and cons of each response.

Letting one of the biggest player in the money market fail created an unprecedented panic among investors of the City during the 1866, causing huge financial distress and repercussion to the economy. Doing so, though, the Bank clearly sent a message to all bankers that the Bank would not bail out insolvent institutions, refraining excessive risk-taking actions, hence decreasing moral hazard. We may claim that the decision of 1866 worked conceivably well, being the bank run on Northern Rock the first in 150 years since the Overend Gurney & Co run in the United Kingdom history. Instead, in 2007, the Bank, after an initial slow response and a failed bid from a private institution, bailed out Northern Rock and ended up nationalizing the bank. Even if the depositors ran on the bank, panic among depositors and investors was quickly brought down by the announcement of the bailing out of Northern Rock and the full guarantee of its deposits. This action gave confidence back to the market, the bank run stopped, banking panic was averted and the stock market recovered. An immediate cons of this response is that it increased the national debt of the British government by £100 billion, a net increase of 7.3% of the budget-deficit ratio. The figure is the equivalent of £3,000 additional borrowing for every family in Britain, in other words a direct hit for each taxpayer in the UK. Moreover, in the long-run, the bail out of Northern Rock under the principle of "too big to fail" may lead to an increase in the moral hazard and thus more bankers will engage in more excessive-risk investments.

Conclusion

This thesis described liquidity crisis and banking panics by extensively using the influential Diamond-Dybvig model and its extensions. Moreover, the second part analyzed the bank run that Northern Rock suffered in 2007 and the reactions of the FSA and the Bank of England to the crisis. From our findings we learned that the Northern Rock liquidity crisis was due the collapse of the US mortgage market that caused a loss of confidence between financial institutions, making the market very illiquid. Unfortunately so, Northern Rock heavily relied on the wholesale funding market to finance its investments. This was the true bank run on Northern Rock, where maturing loans and deposits in the short-term wholesale market were not renewed by the investors in Northern Rock short- and medium-term paper. This is why in the introduction we described the run on Northern Rock to be a “reversed bank run”; the bank first went into a liquidity crisis and only then depositors tried to withdraw their money.

The Diamond-Dybvig model cannot capture this aspect of a bank run. As discussed in part 1.4, the main problem of the DD model is that it neglects the reason of panicking, making it an exogenous variable, which may be a fundamental aspect of a bank run.

The public agencies responsible of financial regulation and supervision (namely the FSA and the Bank of England) played a huge role in the bank run. The deposit insurance scheme of the UK, as discussed in part 1.5.2, was far from best and gave an incentive to withdraw. Furthermore, the FSA completely missed its supervisory task and it built a stress test that was not able to catch extreme cases of very illiquid markets. Moreover, the Bank of England’s response was slow and it did not provide Northern Rock with a quick loan that could have prevented the bank run.

In part 2.5.3 we discussed the different approaches that the Bank of England implemented into two different liquidity crises (the Panic of 1866 and the Financial Crisis of 2007-2008). Both banks (Northern Rock and Overend Gurney & Co) experienced huge growth rates, thanks to a business model that was unconventional but more competitive. However, the mismatch of liquidity between

long-term assets and short-term liabilities and high leverage, creates fragility and a high sensitivity to market condition. Hence, in both cases the liquidity problems of the two banks were created by excessive risk taking decisions. In 1866 deposit insurance did not exist but for the Northern Rock case of 2007, even if the Financial Services Compensation Scheme has been active since 2000, it did not prevented the bank run. After the Northern Rock bank run, the flawed deposit insurance scheme has been improved (as it happened for many countries after the financial crisis), and now depositors are guaranteed for 100% of the first £85,000. However, it is critical to remember that more generous deposit insurance and the implicit guarantee from the Bank of England of a bailout in case of insolvency for big financial institutions, even if they may help stabilize the financial markets in the short run, lead to moral hazard. Therefore, to an increase in the “generosity” of those kind of policies should correspond an increase in the intensity of financial regulation and supervision.

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