

Reflections on Modern Bank Runs:
A Case Study of Northern Rock^{*}

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Abstract: The UK bank Northern Rock was the most high-profile casualty of the credit crisis of 2007 when it suffered its depositor run in September. In spite of the television images of long lines of depositors outside its branch offices, the run on Northern Rock was unlike the textbook retail depositor run caused by coordination failure. Also, contrary to received wisdom, its reliance on securitization was not an immediate factor in its failure. Rather, its problems stemmed from its high leverage coupled with reliance on institutional investors for short-term funding. When the de-leveraging in the credit markets began in August 2007, it was uniquely vulnerable to the shrinking of lender balance sheets arising from the tick-up in measured risks. Northern Rock shows that modern banking cannot be viewed separately from capital market developments.

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1. Introduction

In September 2007, television viewers around the world witnessed the spectacle of what seemed like an old-fashioned bank run – of depositors waiting in line outside the branch offices of the UK bank, Northern Rock, to withdraw their money. The current generation of economists who study bank runs in their theoretical models have had few opportunities to experience what they study, unless in was in holiday movies by Jimmy Stewart or in *Mary Poppins*.

The last bank run in the UK before Northern Rock was in 1866 (with Overend Guerney). Runs were more common in the US in the 1930s, but they have been rare since. For economists, the run on Northern Rock seemed to offer a rare opportunity to study at close quarters all the elements involved in their theoretical models – the futility of public statements of reassurance, the mutually-reinforcing anxiety of depositors, as well as the power of the media in galvanizing and channeling that anxiety through the power of television images.



(AP)

However, appearances are deceptive. Retail depositors started queuing outside the branch offices only after the Bank of England announced its emergency liquidity support for Northern Rock on the morning of Friday, September 14th. On the previous evening the BBC's evening television news broadcast first broke the news that Northern Rock had sought the Bank of England's support.

The damage had been done well before the run by its retail depositors. Even as early as July 2007, ominous signs were developing in short-term funding markets that the subprime crisis were beginning to exert stresses on the balance sheets of banks and the off-balance sheet entities they sponsored. But the demise of Northern Rock dates from August 9th, when the short-term funding market and interbank lending all but froze. The triggering event on the day was the news that BNP Paribas was closing three off-balance sheet investment vehicles with exposures to US subprime mortgage assets, but in the days leading up to the August 9th watershed, other investment vehicles that tapped short-term financing had begun experiencing difficulties in rolling over their short-term borrowing.

On August 9th, the European Central Bank intervened by injecting 94 billion Euros into Europe's banking system.¹

Northern Rock was unusual among UK mortgage banks in its heavy reliance on non-retail funding. By the summer of 2007, only 23 percent of its liabilities were in the form of retail deposits. The rest of its funding came from short-term borrowing in the capital markets, or through securitized notes and other longer-term funding sources, as we discuss in more detail below. The dating of the beginning of the credit crisis can be seen below in figure 1, which charts the weekly series on the outstanding amounts of asset-backed commercial paper (ABCP), obtained from the Federal Reserve's website. Asset-backed commercial paper was the favored means for off-balance sheet vehicles to fund their holdings of long-dated mortgage-related assets, and as such served as the barometer for the appetite for short-term lending against mortgage assets. The weekly series shows a sharp break between, August 8th to August 15th.

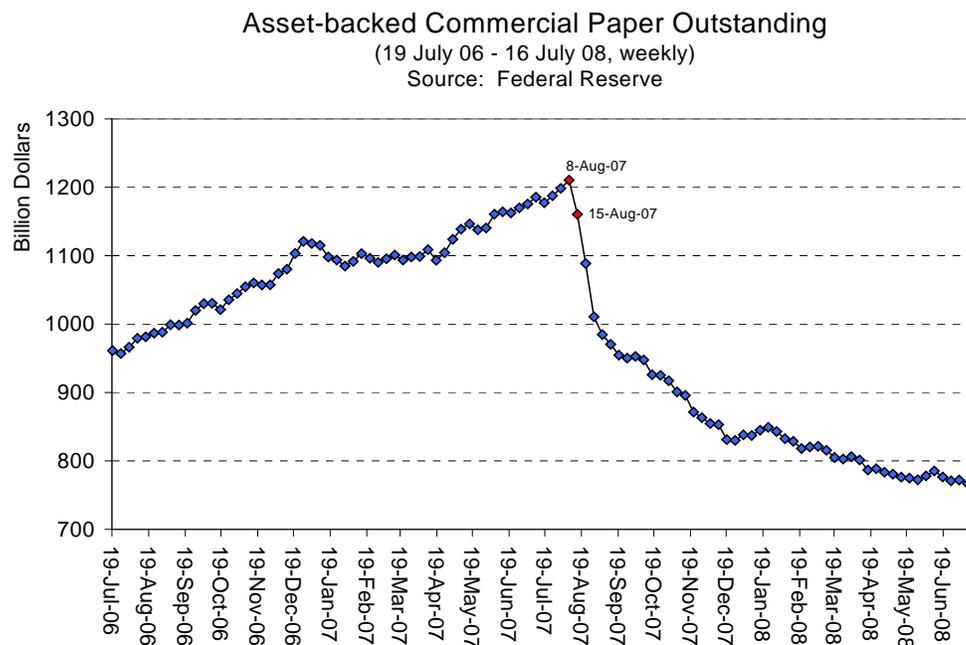


Figure 1

Although Northern Rock did not sponsor off-balance sheet vehicles that used asset backed commercial paper, it was nevertheless fishing from the same pool of short-term funding, as we will see shortly.

The managers of Northern Rock had informed its regulators, the Financial Services Authority (FSA) as early as August 13th of Northern Rock's funding problems. The Bank of England was informed on August 14th. From that time until the fateful announcement

¹ See Bank of England (2008), BIS (2008 chapter 6), IMF (2008), Dudley (2007, 2008), Brunnermeier (2008) and Greenlaw, Hatzius, Kashyap and Shin (2008) for a chronology of the credit crisis of 2007.

on September 14th that triggered the depositor run (i.e. for a full month), the FSA and Bank of England sought to resolve the crisis behind the scenes, possibly arranging a takeover by another UK bank.

However, the unfolding credit crisis was not a promising backdrop for persuading other private sector institutions to stretch their balance sheet resources in taking on a troubled bank. Having failed to find a buyer for Northern Rock, the public announcement by the Bank of England on September 14th was recognition that Northern Rock's predicament had reached the point where only central bank support could avoid bank failure. The depositor run, although dramatic on television, was an event in the *aftermath* of the liquidity crisis at Northern Rock, rather than the event that triggered its liquidity crisis. In this sense, the run on Northern Rock was not an old-fashioned bank run of the sort we see in the movies.²

The irony of the television images is that retail deposit funding is perhaps the most stable form of funding available to a bank. Although retail deposits can be withdrawn on demand, their effective duration is much longer, with bankers joking that a depositor is more likely to get divorced than switch banks. Indeed, a stable deposit base figures prominently when valuing banks in terms of their franchise value. The textbook bank run model in which retail depositors rush to the bank to withdraw their money fearing that others would therefore paints an overly pessimistic view of the fragility of the capital structure of a deposit funded bank.

So, the real question raised by the Northern Rock episode is not so much why retail depositors are so prone to running, but instead why the plentiful short-term funding that Northern Rock enjoyed before August of 2007 suddenly dried up. To turn the question around, the issue is why sophisticated lenders who operate in the capital markets and the interbank credit market chose suddenly to deny lending to another bank with an apparently solid asset book, with virtually no subprime lending.

The answers to these questions reveal much about the nature of banking in the age of securitization and capital markets. The conventional distinctions between a bank-based financial system and a market-based financial system turns out to be less relevant in the securitization era, and the most important lesson from the Northern Rock case is that modern banking cannot be viewed separately from capital market developments.

This paper is an attempt to engage with some of these questions. In what follows, I will outline the Northern Rock episode, expose the relevant facts for scrutiny, and compare the features of the Northern Rock case to the textbook bank run model of a run by its depositors, and argue that the traditional models come up short.

I will argue that a better perspective on the crisis can be gained by looking at the pressures on the *creditors* to Northern Rock. The creditors to Northern Rock were

² See Dimsdale (2008), Mayes and Wood (2008) and Milne and Wood (2008) for an account of Northern Rock and the UK institutional background. See Yorulmazer (2008) for an empirical analysis of UK banks during the run on Northern Rock.

sophisticated investors that tailor their risk-taking strategy to unfolding events. When measured risks are low – i.e. in boom times – balance sheets expand, and funding is easy to obtain. But when a crisis strikes, exposures are cut in response. Doing so is dictated by prudent risk management, and regulators have also encouraged such behavior. However, prudent cutting of exposures by the creditors of Northern Rock is a withdrawal of funding from the point of view of Northern Rock.

The Northern Rock case raises a number of important policy issues, not least how banking regulation should be formulated in the age of securitization and capital markets. There are also important issues for the theoretical analysis of banking crises and the role of the bank capital structure in welfare analysis.

2. Background

Northern Rock was a building society (i.e. a mutually owned savings and mortgage bank) until its decision to go public and float its shares on the stock market in 1997. As with other building societies in the UK, Northern Rock traced its origin to the mutual movement of the 19th century, arising out of the merger of the Northern Counties Permanent Building Society (established in 1850) and the Rock Building Society (established in 1865). Even its name, “Northern Rock” conjured up associations of dour solidity, which seemed appropriate for a savings and mortgage bank.

As with other UK building societies, Northern Rock started life as a regionally based institution, serving its local clientele. In Northern Rock’s case its base was the North East of England, around the city of Newcastle upon Tyne. Northern Rock’s successes as a bank made it emblematic of the revitalization of the North East region following the decline of traditional industries, such as coal mining and shipbuilding. Northern Rock funded a highly visible charitable trust, and becoming the main sponsor to the local football (soccer) team, Newcastle United, known for its loyal fan base. For all these reasons, Northern Rock commanded fierce loyalty in its local base.

In spite of its modest origins, Northern Rock had larger ambitions. In the nine years from June 1998 (the first year after demutualization) to June 2007 (on the eve of its crisis), Northern Rock’s total assets grew from 17.4 billion pounds to 113.5 billion pounds. This growth in assets corresponds to a constant equivalent annual growth rate of 23.2%, a very rapid rate of growth by any standards. By the eve of its crisis, Northern Rock was the fifth largest bank in the UK by mortgage assets.

Northern Rock’s liabilities reflect both the funding constraints it faced, as well as the way it overcame those constraints. Figure 2 charts the composition of Northern Rock’s liabilities from June 1998 to June 2007.

Composition of Northern Rock's Liabilities
(June 1998 - June 2007)

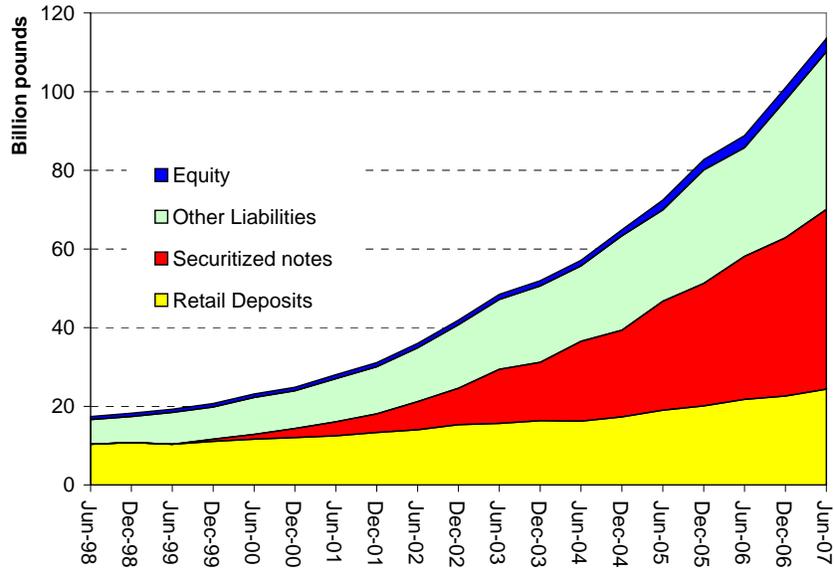


Figure 2

The first notable feature is how quickly Northern Rock's total balance sheet size outstripped its traditional funding base of retail deposits. Even as total assets grew by a factor of 6.5 in this period, retail deposits only grew from 10.4 billion pounds to 24 billion pounds. As a result, retail funding fell to 23% of total liabilities on the eve of the crisis (and much further after the run).

Northern Rock's Retail Funding
Retail deposit funding as proportion of total liabilities
June 1998 - December 2007

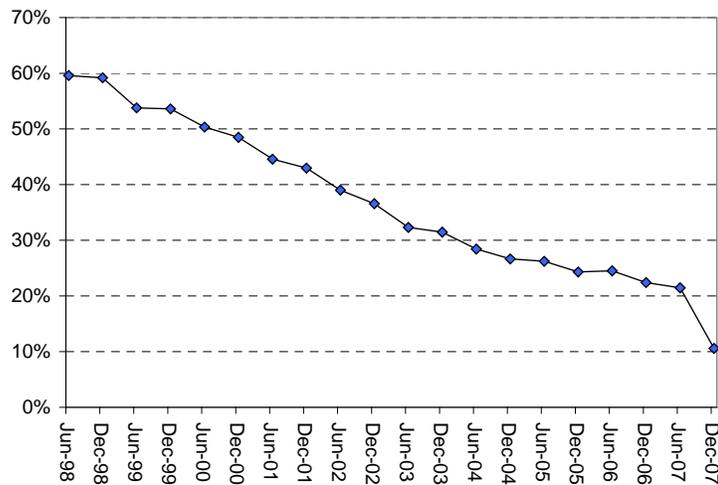


Figure 3

Even in the case of retail deposits, we will see later that only a small proportion consisted of the traditional branch-based deposits. The bulk of the retail deposits were non-branch based deposits such as postal and telephone accounts. It was these non-branch retail deposits that proved most vulnerable to withdrawal in the aftermath of the run on Northern Rock.

The gap in funding was made up by securitized notes and other forms of non-retail funding, such as interbank deposits and covered bonds. Given the importance of securitized notes for the Northern Rock story, we postpone a discussion of securitized notes until later. Covered bonds are long-term liabilities written against segregated mortgage assets. As such, they are illiquid and long-term in nature, and so were not implicated in the run. However, other short-run wholesale funding was more closely implicated in the run on Northern Rock, as we will see shortly.

Before examining the components of Northern Rock’s liabilities more closely, it is worthy of note that Northern Rock was not unique among UK banks in making growing use of non-retail funding, although the extent to which it relied on non-retail funding made it an outlier.

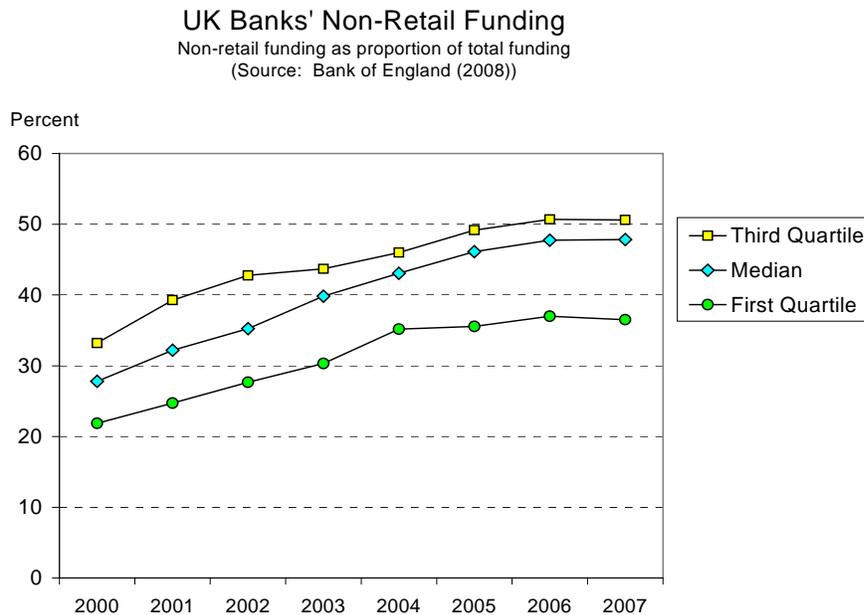


Figure 4

Figure 4, taken from the Bank of England’s *Financial Stability Report* (Bank of England, (2008)) charts the trend in the use of non-retail funding among large UK banks since 2000 as given by the time plot of the cross-section median, and the cross-section interquartile range. The median UK bank’s non-retail funding started at 27.8% in December 2000, but had almost doubled to 47.8% by December 2007. Thus, Northern

Rock was not unique among UK banks in making use of non-retail funding, but what set it aside from others was the extent to which it relied on such funding.

3. Securitization process

The role played by securitized notes has received considerable scrutiny in the Northern Rock episode. It has become the received wisdom that such securitized notes made Northern Rock’s business model unusual, its balance sheet less traditional, and that securitization was responsible somehow in Northern Rock’s downfall. However, the role of securitization seems to be more subtle than suggested by the received wisdom.

Northern Rock’s securitized notes were of medium to long-term maturity, with average maturity of over one year. It assigned portions of its mortgage assets to a trust – Granite Finance Trustees, which then entered into an agreement with special purpose entities (SPEs) called “Funding” and “Funding 2”. In turn, these SPEs entered into loan agreements with a separate note issuing company, who were the ultimate note issuers. Figure 5 is drawn from the offer documentation³ for a particular bond offering – in this case, the Granite Master Issuer series 2005-2. Appendix 1 lists the full series of offerings taken from Northern Rock’s annual reports.

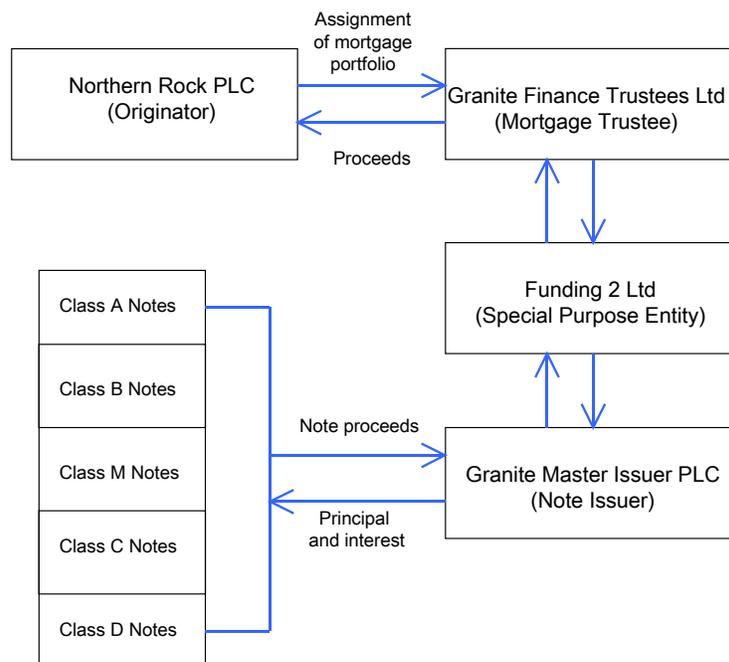


Figure 5

³ Supplement to Prospectus, dated May 23rd 2005.
<http://companyinfo.northernrock.co.uk/downloads/securitisation/prospectus%20&%20us%20supplement%2005-2.pdf>

The notes issued by Granite were floating rate “controlled amortization notes” that paid out according to set redemption dates spread over several years. The notes were ranked according to seniority, with Class A notes being more senior (paying 4 basis points above LIBOR) and Class D notes being the most junior (paying 50 basis points above LIBOR).

Unlike the US securitization process where the special purpose entities are off-balance sheet vehicles, Northern Rock kept residual interest in the securitized assets, and hence the SPEs were consolidated on Northern Rock’s main balance sheet. In this respect, the rapid growth of Northern Rock’s balance sheet reflects the accounting regime, as much as the flow of new loans originated.

There is another contrast between Northern Rock and the US and European banks caught up in the subprime crisis. The latter banks sponsored off-balance sheet entities such as conduits and SIVs (structured investment vehicles) that held subprime mortgage assets funded with very short-term liabilities such as asset-backed commercial paper (ABCPs), which were at the heart of the subprime crisis.

In contrast, the notes issued by Granite were much longer term. The relatively longer maturity of the Granite notes as compared to the notes issued by SIVs and conduits can be seen in Appendix 1, which lists the series of securitization offerings from Northern Rock’s annual reports. Take the last column. The last column lists the redemptions during 2006 as given by the difference between the amounts outstanding at the end of 2006 from the amounts outstanding at the end of 2005. The total redemptions during 2006 of notes outstanding at the beginning of the year were 7.12 billion pounds. At the end of 2005, there were 31.1 billion pounds worth of notes outstanding. So, only a small fraction (23%) of the notes outstanding were redeemed over the following year. This is in sharp contrast to the off-balance sheet vehicles that roll over their liabilities several times during the year.

There is one instance where securitization did play a role in Northern Rock’s downfall. This has to do with the Granite Master Issue 07-3, listed as the last line in Appendix 1. The notes were due to be issued in September of 2007, but the crisis intervened before the notes could be sold. None of the notes were placed with investors, and the whole issue of notes – around 5 billion pounds face value – were taken back on to Northern Rock’s balance sheet.⁴ In this instance, the problem was that the planned sale of notes did not proceed, depriving Northern Rock of cash, rather than a problem with the rolling over of existing liabilities.

Taken together, the lesson to emerge from Northern Rock’s securitization process is that the role played by Granite in Northern Rock’s downfall is somewhat more subtle than is often portrayed by financial commentators in the press. Commentators have emphasized the non-standard business model of Northern Rock as being the culprit for the run. At least for the securitized notes of Northern Rock, they were not directly culpable. The Northern Rock case was therefore different from the outwardly similar downfalls for SIVs and conduits sponsored by other European banks such as BNP Paribas or IKB, the

⁴ Northern Rock 2007 Annual Report, page 31.

German bank that suffered a liquidity crisis in August 2007. We return to this issue later in the paper.

4. The Run on Northern Rock

A snapshot of the run on Northern Rock can be gained by comparing the composition of its liabilities before the run and after the run. The comparison is given in figure 6 below, taken from the 2007 annual report of Northern Rock. The left hand bar is the snapshot of the main components of Northern Rock's liabilities as of the end of June 2007 (i.e. before the run), while the right hand bar is the snapshot at the end of the year, after its run and after the liquidity support from the Bank of England.

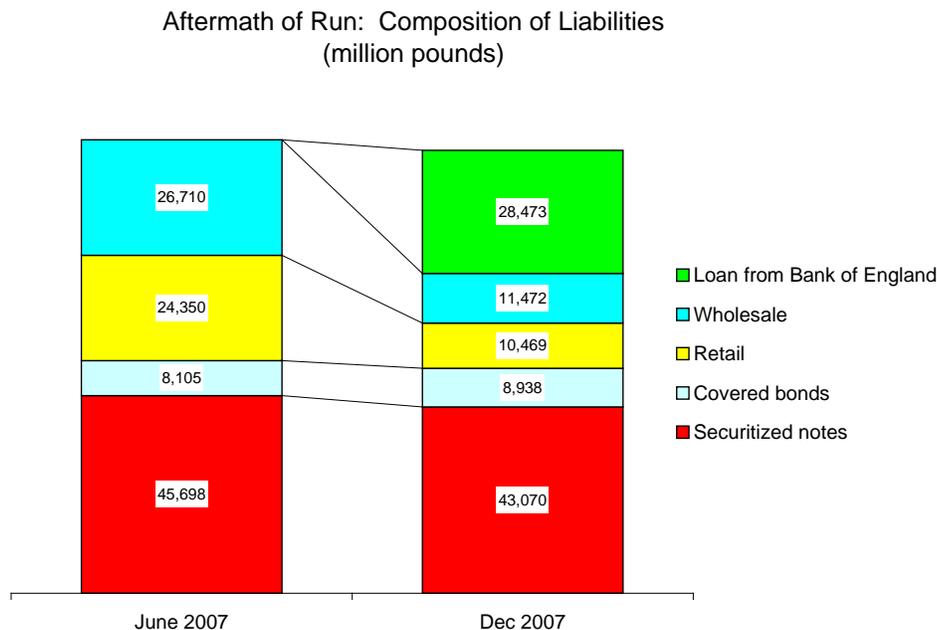


Figure 6

The most glaring difference is the liability to the Bank of England after its liquidity support to Northern Rock, which stood at 28.5 billion pounds at the end of 2007. However, covered bonds and securitized notes are seen to be relatively stable over the two dates. In fact, covered bonds increase from 8.1 billion in June to 8.9 billion in December. Securitized notes fall only slightly from 45.7 billion to 43 billion.

The largest falls are for the retail deposits, and for the wholesale liabilities, with the latter falling from 26.7 billion pounds in June to 11.5 billion pounds in December. The wholesale funding in this chart refers to the non-retail funding that does not fall under either covered bonds or securitized notes. Although a detailed breakdown of the wholesale funding is not disclosed in the annual reports, they do contain some clues on the maturity and sourcing of the funding.

The 2006 annual report (page 41) states that wholesale funding consists of a “balanced mixture of short and medium term funding with increasing diversification of our global investor”. Medium term funding refers to term funding of 6 months or longer, while short term funding has maturity less than six months. The 2006 annual report (page 41) states:

Following substantial inflows from securitisation during the first half, we repaid net £2.3 billion, mainly short term funds. In the second half we raised a net £5.2 billion, leading to a full year net funding of £2.9 billion. During the year, we raised £3.2 billion medium term wholesale funds from a variety of globally spread sources, with specific emphasis on the US, Europe, Asia and Australia. This included two transactions sold to domestic US investors totalling US\$3.5 billion. In January 2007, we raised a further US\$2.0 billion under our US MTN [medium term notes] programme. Key developments during 2006 included the establishment of an Australian debt programme, raising A\$1.2 billion from our inaugural issue. This transaction was the largest debut deal in that market for a single A rated financial institution targeted at both domestic Australian investors and the Far East.

It is clear from this description that 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, aimed at institutional investors. As such, Northern Rock was fishing from the same pool as the SIVs and conduits. This type of funding was more short-term (less than one year, frequently much shorter), and more vulnerable to the liquidity crisis that hit the capital markets in August 2007.

The 2007 annual report (page 31) states that, 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.”

This is the true run on Northern Rock. Maturing loans and deposits were not renewed by the investors in Northern Rock short- and medium-term paper. The timing coincides with kink in the ABCP series shown in figure 1 above. Thus, it was the wholesale funding that was unrelated to the securitized notes or covered bonds that was at the heart of the crisis.

A closer look at the retail deposits of Northern also reveals that there is more to the Northern Rock story than meets the eye. Figure 7 below charts the change in the composition of retail deposits of Northern Rock from December 2006 to December 2007. There is a large fall in the total, as one would expect from there having been a depositor run in the meanwhile. Total retail funding falls from 26.7 billion to 11.5 billion. However, what is noteworthy is how little of the deposit funding is attributable to the conventional, branch-based customer deposits. Branch based customer deposits fall from

5.6 billion to 3 billion. In contrast, postal account deposits, offshore deposits and telephone and internet deposits saw much more substantial falls. Evidently, not all retail deposits had the same stickiness. The irony of the television images of depositors queuing at the branch offices was that it was the branch deposits that were the most stable.

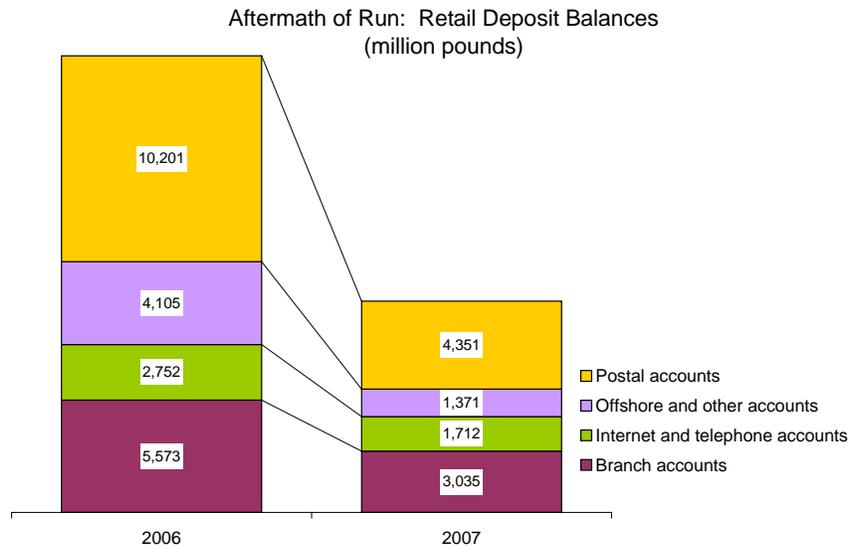


Figure 7

5. Reassessing the Run on Northern Rock

Drawing together the main strands of the discussion so far, we are faced with the following facts. First, although the television images of retail depositors outside branch offices were dramatic, they were not the proximate cause of the liquidity crisis at Northern Rock. Neither were the investors in covered bonds or in the securitized notes. Instead, it was the short-term and medium term creditors who had previously bought Northern Rock paper but who withdrew from the market that caused the liquidity crisis at Northern Rock.

Although these creditors were not retail depositors, it is still pertinent to ask whether the classic coordination failure model of bank runs could be the best description of the events. According to the coordination failure model, such as in Bryant (1980) and Diamond and Dybvig (1983), an individual depositor runs for fear that others will run, leaving no assets in place for those who do not run.

Although some element of coordination clearly played a role in the credit crisis of August 2007, the important fact to bear in mind is that the withdrawal of credit hit the whole market, not simply a subset of the institutions. Figure 1 on the evolution of the asset-backed commercial paper stock shows the dramatic nature of the withdrawal of funding from the whole market. Thus, if there was a run driven by a coordination failure, then it was a run from *all the institutions* that relied on short-term funding of this type, rather than from Northern Rock in particular.

A better perspective on the crisis can be gained by looking at the pressures on the *creditors* to Northern Rock. In the coordination failure model of bank runs, the creditors are individual consumers who rationally choose whether to run or not, based on their beliefs of what other depositors do. They are not themselves constrained in any way by other considerations.

However, many of the creditors to Northern Rock would have been sophisticated investors that tailor their risk-taking strategy to unfolding events. When measured risks are low, risk constraints on capital do not bind, and such investors will be able to expand balance sheets, meaning that they are willing to lend and are looking for borrowers. However, when a crisis strikes, risk constraints bind and lenders cut back their exposures in response. This will be the case especially if the investor is leveraged. For a leveraged institution, prudent risk management dictates the cutting back of exposures when market turmoil strikes. However, the prudent cutting of exposures by the creditors to Northern Rock will look like a run from the point of view of Northern Rock itself.

The key is to recognize that the creditors themselves face constraints in their decisions. They do not conform to the picture of the unconstrained household depositor whose only decision is whether to run or not. The constrained creditor has less discretion in the face of market developments. The run on Northern Rock may be better seen as the tightening of constraints on the creditors of Northern Rock, rather than as a coordination failure among them.

One way to illustrate the fluctuations in funding conditions is to look beyond Northern Rock to the US investment banks. Figure 8 is taken from Adrian and Shin (2007) and shows the scatter chart of the weighted average of quarterly change in assets against the quarterly change in leverage of the (then) five stand-alone US investment banks – Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley.

Although US investment banks have a very different balance sheet composition compared to a mortgage bank such as Northern Rock, the investment banks are a mirror to the market-based financial system based on securitization and marked-to-market balance sheets. As such, they serve as a good barometer of the overall funding conditions ruling in the markets.

The horizontal axis in figure 8 measures the (quarterly) change in leverage, as measured by the change in log assets minus the change in log equity. The vertical axis measures the change in log assets. Hence, the 45-degree line indicates the set of points where equity is constant. Above the 45-degree line equity is increasing, while below the 45-degree line, equity is decreasing. Any straight line with slope equal to 1 indicates constant growth of equity, with the intercept giving the growth rate of equity.

There are two noteworthy features of figure 8. First, leverage is procyclical in that leverage is high when balance sheets are large, while leverage is low when balance sheets are small. This is exactly the opposite finding compared to households, whose leverage is high when balance sheets are *small*. For instance, if a household owns a house that is

financed by a mortgage, leverage falls when the house price increases, since the equity of the household is increasing at a much faster rate than assets.

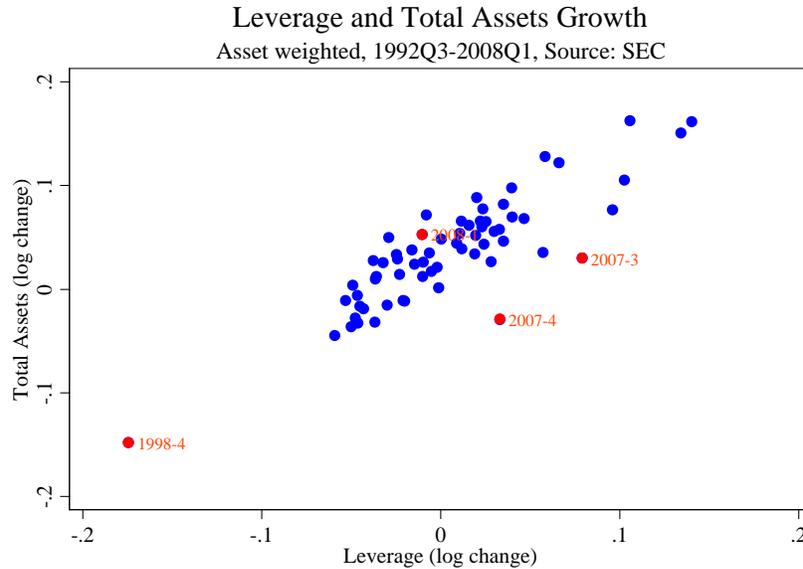


Figure 8

For investment banks, however, the relationship is reversed. Leverage is high when balance sheets are large. It is as if the householder responded to an increase in house prices by going out and getting an even bigger mortgage so that his leverage increases in spite of the increased value of his house.

The second notable feature of the scatter chart in figure 8 is that the slope of the scatter chart is close to 1, implying that equity is increasing at a constant rate on average. Thus, equity seems to play the role of the forcing variable, and all the adjustment in leverage takes place through expansions and contractions of the balance sheet. If banks aim to achieve the highest permissible leverage consistent with prevailing haircuts, then the fluctuations in leverage will closely track the fluctuations in repo haircuts.

There is another perspective on this feature of the behavior of investment banks. Banks aim to keep enough equity capital to meet its overall value at risk (VaR). If we denote by V the value at risk per dollar of assets, and A is total assets, then equity capital E must satisfy $E = V \times A$, implying that leverage L satisfies

$$L = A/E = 1/V$$

Since value at risk is low during booms and high during busts, leverage is high during booms and low during busts.

One further way we can understand the fluctuations in funding conditions is to look at the implicit maximum leverage that is permitted in collateralized borrowing transactions such as repurchase agreements (repos). The discussion of repurchase agreements is instructive in thinking about leverage and funding more generally, even though Northern Rock did not make substantial use of repos in its own funding.

In a repurchase agreement, the borrower sells a security today for a price below the current market price on the understanding that it will buy it back in the future at a pre-agreed price. The difference between the current market price of the security and the price at which it is sold is called the “haircut” in the repo, and fluctuates together with funding conditions in the market.

The fluctuations in the haircut largely determine the degree of funding available to a leveraged institution. The reason is that the haircut determines the maximum permissible leverage achieved by the borrower. If the haircut is 2%, the borrower can borrow 98 dollars for 100 dollars worth of securities pledged. Then, to hold 100 dollars worth of securities, the borrower must come up with 2 dollars of equity. Thus, if the repo haircut is 2%, the maximum permissible leverage (ratio of assets to equity) is 50.

Suppose that the borrower leverages up the maximum permitted level. Such an action would be consistent with the objective of maximizing the return on equity, since leverage magnifies return on equity. The borrower thus has a highly leveraged balance sheet with leverage of 50. If at this time, a shock to the financial system raises the market haircut, then the borrower faces a predicament. Suppose that the haircut rises to 4%. Then, the permitted leverage halves to 25, from 50. The borrower then faces a hard choice. Either it must raise new equity so that its equity doubles from its previous level, or it must sell half its assets, or some combination of both.

Times of financial stress are associated with sharply higher haircuts. The following table lists the haircuts that were being applied during the peak of the market disruptions in March 2008 compared to the haircuts prevailing during normal times.

Security	Typical haircuts	March 2008 haircuts
Treasuries	< 0.5%	0.25% ~ 3%
Corporate bonds	5%	10%
AAA ABS	3%	15%
AAA RMBS	2%	20%
AAA Jumbo Prime mortgages	5%	30%

Table 3. Haircuts during March 2008 compared to normal levels
(Source: Bloomberg)

The increase in haircuts listed above entail very substantial reductions in leverage, necessitating asset disposals or raising of new equity. For instance, a borrower holding

AAA rated residential mortgage backed securities would have seen a ten-fold increase in haircuts, meaning that its leverage must fall from 50 to just 5.

Raising new equity or cutting assets entail painful adjustments for the borrower. Raising new equity is notoriously difficult in distressed market conditions. But selling assets in a depressed market is not much better. The evidence from figure 8 is that borrowers tend to adjust leverage through adjustments in the size of the balance sheet, leaving equity unchanged, rather than through changes in equity directly. For an investment bank, whose assets are very short term and liquid (such as short-term collateralized lending), it can adjust its balance sheet size flexibly by reducing lending and repaying debt.

To the extent that the *financial system as a whole* holds long-term, illiquid assets financed by short-term liabilities, any tensions resulting from a sharp decrease in permitted leverage will show up somewhere in the system. Even if most institutions can adjust down their balance sheets flexibly in response to the greater stress, there will be some pinch points in the system that will be exposed by the deleveraging. The pinch points will be those institutions that are highly leveraged, but who hold long-term illiquid assets financed with short-term debt. When the short-term funding runs away, the financial institution holding the long-term illiquid assets will face a liquidity crisis. Arguably, this is exactly what happened to Northern Rock.

The scenario painted above becomes more compelling when we examine the leverage of Northern Rock. Leverage is defined as the ratio of total assets to equity. Figure 9 plots the leverage series from June 1998 to December 2007 according to three different measures of equity.

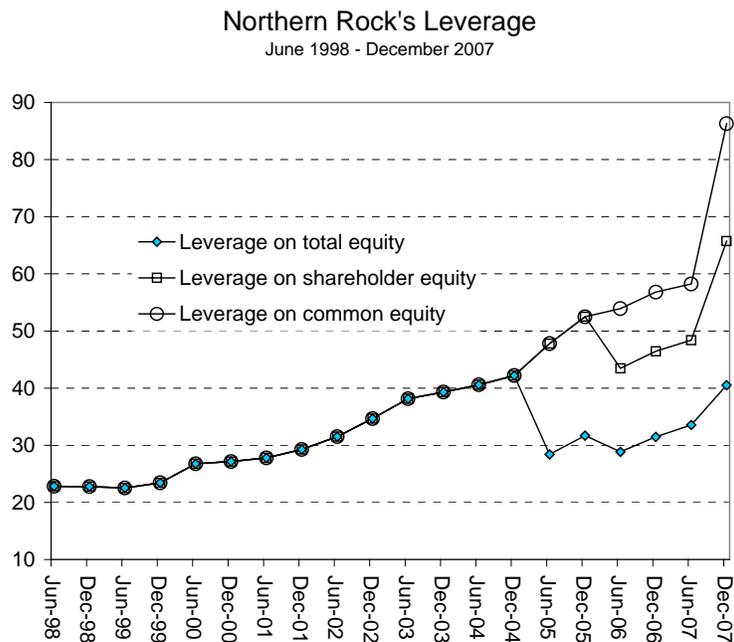


Figure 9

In the early years of Northern Rock's operation as a public limited company (PLC), there was no distinction between total equity, shareholder equity and common equity. All equity was just common equity. However, beginning in 2005, the three series starts to diverge sharply. In 2005, the total equity series included for the first time 736.5 million pounds worth of subordinated debt, as well as 299.3 million pounds worth of reserve notes⁵. Both of these items had been issued much earlier (in 2001), but they were included in the equity series in the annual report for the first time in 2005. The inclusion of these subordinated debt items introduced a jump up in the equity series for Northern Rock, and accounts for the sharp jump down in the leverage series in June 2005 in figure 9. However, as we can see also from figure 9, when the subordinated debt items are excluded, and equity is construed just as shareholder equity, the equity series continues to move up in 2005.

Subordinated debt is classed as a capital buffer under the Basel rules (as tier 2 capital), but their economic significance for the purpose of computing permitted leverage is unclear. Under the Basel rules, subordinated debt is junior debt relative to the other creditors, and so have elements of a buffer. This is the reason why it is seen as capital under the Basel rules.

However, subordinated debt holders are just another class of creditor to the bank. They do not have control of the bank's operations as the common equity holders do. For the purpose of calculating the permissible leverage in a moral hazard context, where the equity holders must have sufficient equity at stake so as to prevent them from engaging in moral hazard, it is the common equity that matters, rather than the equity enhanced by subordinated debt. This is because the common equity holders will take account of the possible losses that result from their portfolio decisions, rather than the interests of the subordinated debt holders. Adrian and Shin (2008) discuss the theoretical basis for fluctuating leverage based on such a feature.

In 2006, Northern Rock issued 396.4 million pounds worth of preference shares, which is counted as shareholder equity⁶. This issuance of new preference shares accounts for the jump down in the leverage series with respect to shareholder equity in June 2006. However, the economic meaning of preference shares for the determination of permissible leverage depends crucially on the degree to which the common equity holders who exercised control would have subscribed to the preference shares. If the preference shareholders did not exercise control, then the moral hazard argument and the necessity of the minimum stake implies that the maximum permissible leverage should be calculated on the basis of common equity alone.

When leverage is interpreted strictly as the ratio of total assets to common equity, then we can see from figure 9 that Northern Rock's leverage continued to climb throughout its history as a public company, rising from 22.8 in June 1998, just after its floatation, to 58.2 in June 2007, on the eve of its liquidity crisis. This is a very large number, even by the standards of US investment banks who hold very liquid and short-term assets. Of

⁵ Northern Rock 2005 Annual Report, page 51

⁶ Northern Rock 2006 Annual Report, page 59

course, Northern Rock's leverage jumped even higher in December 2007 after its run, following the depletion of its common equity from losses suffered in the second half of 2007. The leverage on common equity at the end of 2007 was 86.3.

When a bank is so highly leveraged, even a small increase in the implicit haircut on its borrowing will entail a withdrawal of funding from that bank. Thus, although most of the discussion above has focused on the constraints facing the leveraged creditors to Northern Rock, many of the points will apply also to non-leveraged creditors to Northern Rock – such as money market mutual funds, or insurance companies. In a contracting problem with moral hazard, the minimum incentive compatible stake in the assets that the borrower must hold will fluctuate widely as the underlying risk in the portfolio shifts (see Adrian and Shin (2008)).

When a borrower is as highly leveraged as Northern Rock, small fluctuations in implied haircuts can cause large shifts in funding. In this sense, the run on Northern Rock was just a matter of when the next pull back in funding conditions would arrive. When the tide eventually turned, institutions with balance sheet mismatches were left on the beach. Northern Rock was not the only one to find itself beached, but it lacked the liquidity support of a larger sponsor – apart from the Bank of England.

6. Economic Role of Short-Term Debt

The Northern Rock episode gives us an opportunity to revisit some of the economic principles behind the use of short-term debt to finance long-term assets. As we have argued above, when the financial system as a whole finances long-term, illiquid assets financed by short-term liabilities, not everyone can be perfectly hedged in terms of their maturity profile. Pinch points will emerge somewhere in the system. Northern Rock could be seen as precisely such a “pinch point” in the financial system where the tensions would finally be manifested.

There are well known arguments for the desirability of short-term debt in disciplining managers. Calomiris and Kahn (1991) have argued that demand deposits for banking arose naturally as a response by the bank's owners and managers to commit not to engage in actions that dissipate the value of the assets, under pain of triggering a depositor run.

Diamond and Rajan (2001) have developed this argument further, and have argued that the coordination problem inherent in a depositor run serves as a commitment device on the part of the depositors not to renegotiate in the face of opportunistic actions by the managers. When the bank has the right quantity of deposits outstanding, any attempt by the banker to extort a rent from depositors will be met by a run, which drives the banker's rents to zero. Foreseeing this, the banker will not attempt to extort rents. In a world of certainty, the bank maximizes the amount of credit it can offer by financing with a rigid and fragile all deposit capital structure.

However, in both Calomiris and Kahn (1991) and Diamond and Rajan (2001), the relationship between the bank and the depositors are seen as being self-contained. In

particular, the depositors are unconstrained. Under these conditions, the economic rationale for short-term debt is compelling. Short-term debt has desirable incentive effects, and the fragility of the balance sheet has economic rationale. However, the lesson from Northern Rock is that sometimes creditors are subject to external constraints, and may have to take actions that are the consequence of factors outside the immediate principal agent relationship with the bank.

Take the following simple example, illustrated by figure 10 below, taken from Morris and Shin (2008). Bank 1 has borrowed from Bank 2. Bank 2 has other assets, as well as its loans to Bank 1. Suppose that Bank 2 suffers credit losses on these other loans, but that the creditworthiness of Bank 1 remains unchanged. The loss suffered by Bank 2 depletes its equity capital. In the face of such a shock, a prudent course of action by Bank 2 is to reduce its overall exposure, so that its asset book is trimmed to a size that can be carried comfortably with the smaller equity capital.

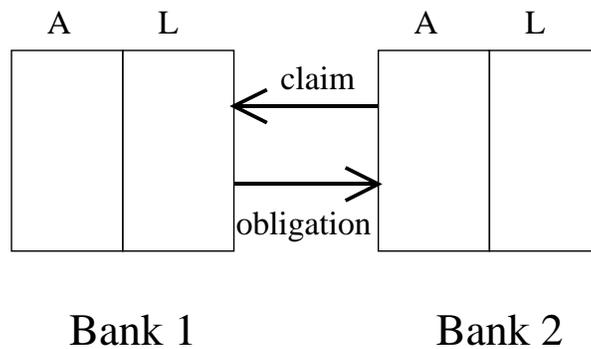


Figure 10

From the point of view of Bank 2, the imperative is to reduce its overall lending, including its lending to Bank 1. By reducing its lending, Bank 2 achieves its micro-prudential objective of reducing its risk exposure. However, from Bank 1's perspective, the reduction of lending by Bank 2 is a withdrawal of funding. Unless Bank 1 can find alternative sources of funding, it will have to reduce its own asset holdings, either by curtailing its lending, or by selling marketable assets.

In the case where we have the combination of (i) Bank 1 not having alternative sources of funding, (ii) the reduction in Bank 2's lending being severe, and (iii) Bank 1's assets being so illiquid that they can only be sold at fire sale prices, then the withdrawal of lending by Bank 2 will feel like a run from the point of view of Bank 1. In other words, a prudent shedding of exposures from the point of view of Bank 2 is a run from the point of view of Bank 1. Arguably, this type of run is one element of what happened to Northern Rock.

Questions of overall economic welfare cannot be addressed without the system perspective that incorporates all spillover effects and externalities. The example given in figure 10 above illustrates the externalities that are generated by Bank 2 on Bank 1 as the former tries to follow a prudent course of action that reduces its exposures.

When evaluated from a system perspective, maturity mismatch on the balance sheet is double-edged. In spite of the incentive effects that make a fragile balance sheet desirable from the point of view of incentives, the spillover effects from outside the principal agent relationship will generate countervailing inefficiencies. The relative strengths of the desirable and undesirable consequences of balance sheet fragility will determine the overall economic rationale for maturity mismatch on a bank's balance sheet. In the case of Northern Rock, its demise is a lesson in the possible downside costs in the overall welfare calculation.

7. Implications for Financial Regulation

Traditionally, capital requirements have been the cornerstone of the regulation of banks. The rationale for capital requirements lies in maintaining the solvency of the regulated institution. By ensuring solvency, the interests of creditors – especially the retail depositors – can be protected. A creditor who has the ability to monitor the firm can protect his interests through the enforcement of covenants and other checks on the actions of the firm's managers. However, in the case of a traditional deposit-funded bank, the creditors are the small retail depositors. Small depositors face a coordination problem in achieving the monitoring and other checks that large creditors are able to put in place. The purpose of bank regulation has been seen as the protection of the interests of depositors by putting into place through regulation the restrictions on the manager's actions that would arise in normal creditor-debtor relationships.

The traditional rationale for capital regulation leads naturally to the conclusion that the key determinant of the size of the regulatory capital buffer should be the riskiness of the assets. If the purpose of regulation is ensuring solvency, then the riskiness of assets determines the size of the regulatory capital buffer required. This is because the degree to which solvency can be ensured depends on the likelihood that the realized value of assets falls below the notional value of the creditors' claim. The original Basel capital accord of 1988 introduced coarse risk buckets into which assets could be classified, but the Basel II rules have taken the idea much further, by refining the gradations of the riskiness of the assets, and fine-tuning the regulatory capital to the risks of the assets held by the bank.

However, the fall of Northern Rock and the turmoil in the financial system more generally in the 2007/8 financial crisis poses a challenge to the traditional view of regulation. The traditional capital buffer view of financial regulation misses the importance of externalities generated by actions of one financial institution that impacts on the interests of others. In particular, the balance sheet maturity mismatch, when embedded in a system context, generates stresses that result as a consequence of unintended actions. The prudent reduction of exposures by the creditors of Northern Rock and of Bear Stearns was a run from the point of view of these institutions.

There are two specific proposals that deserve closer attention. The first is some type of liquidity regulation that imposes constraints on the composition of assets, rather than a quantitative restriction on the relative size of total assets relative to equity (which is the more traditional capital regulation). The second is a limit on the raw leverage ratio, rather than risk-weighted assets. Both ideas are discussed in more detail in Morris and Shin (2008).

The rationale for liquidity regulation is to put in place some restrictions on the composition of assets. The rationale is that a bank can survive a run if (1) it has sufficient liquid assets and cash or (2) it has sufficiently stable (i.e. illiquid) liabilities such as long-term debt. Too much illiquidity on the liabilities side of the balance sheet will undermine the incentive effects as argued by Calomiris and Kahn (1991) and Diamond and Rajan (2001). The idea would be to strike the right balance between mitigating the externalities and preserving incentives.

Moreover, the liquidity requirement may not be too onerous if the requirement is adhered to widely in the financial system. The idea is that when small liquidity buffers are distributed widely in the financial system, spillover effects can be mitigated by amplifying the buffer effects, just as the absence of liquidity buffers will tend to amplify shocks that reverberate inside the system.

The argument for a raw leverage constraint is that it can act as a binding constraint “on the way up” when banks increase leverage on the back on permissive funding conditions. The build up of excessive leverage makes the system vulnerable to a shock that raises the implicit haircuts, and hence lowers the permitted leverage. By preventing the build-up of leverage during good times, the leverage constraint could act as a dampener in the financial system.

The leverage constraint works both at the level of the debtor, as well as the creditor. Refer to the example in figure 10 again. From the point of view of Bank 1 (the debtor), the leverage constraint will prevent Bank 1 building up excessive leverage, and thereby making Bank 1 less susceptible to a tick-up in the implied haircut. From the point of view of Bank 2 (the creditor), the leverage constraint binds “on the way up”, so that when eventually the tide turns, there is slack in the balance sheet capacity of Bank 2. Hence, its lending to Bank 1 will suffer a smaller shock to any rise in implied haircuts. Thus, for both the lender and the borrower the leverage constraint binds during boom times so that the imperative to reduce leverage is less strong in the bust. Indeed, the bust may be averted altogether, as the initial boom is dampened.

The most commonly encountered criticism against a raw leverage constraint is that it does not take account of the riskiness of the assets. Basel II rules specify a very finely graduated capital requirement that depends on minute shifts in measured risks of the asset portfolio. A simple leverage ratio is seen as throwing away all the finely calibrated calculations of asset risk. However, when viewed through the lens of systemic stability, the leverage ratio constraint has desirable properties that cannot be replicated by risk-based capital ratios alone.

8. Concluding Remarks

Northern Rock was a victim of its earlier success. The rapid growth of its balance on the back on benign credit conditions propelled it to being the most innovative and celebrated bank in the UK, winning several prizes along the way from industry sponsors and generally being the toast of the UK banking industry. However, the high implied leverage that was built up during the boom times was vulnerable to a reversal in the permitted leverage implicit in the market haircuts. When, eventually the tide turned, the balance sheet maturity mismatch of Northern Rock's balance sheet proved to be its undoing.

The Northern Rock episode raises many profound questions on the economic rationale for maturity mismatch on banks' balance sheets, and the potential role of financial regulation to mitigate the inefficiencies. A liquidity requirement combined with a raw leverage ratio may have some role to play in mitigating the system-wide externalities generated by one financial institution on the interests of others. Financial regulation then has the role of imposing the appropriate Pigovian taxes that internalize the externalities as much as possible. The Pigovian tax perspective is likely to yield better insights into system stability than the traditional risk-based capital requirements under the Basel process.

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Appendix 1. Northern Rock's securitization vehicles and amounts outstanding
(Source: Northern Rock annual reports 2005, 2006 and 2007)

Securitization Vehicle	Issue Date	Outstanding End 2007 (A)	Outstanding End 2006 (B)	Outstanding End 2005 (C)	2007 Redemptions (B – A)	2006 Redemptions (C – B)
Granite Mortgages 00-1 plc 1	Mar-00	0.00	170.60	213.10	170.60	42.50
Granite Mortgages 00-2 plc 25	Sep-00	0.00	265.90	375.50	265.90	109.60
Granite Mortgages 01-1 plc 26	Mar-01	424.10	507.90	641.10	83.80	133.20
Granite Mortgages 01-2 plc 28	Sep-01	0.00	0.00	713.20	0.00	713.20
Granite Mortgages 02-1 plc 20	Mar-02	0.00	1123.60	1366.30	1123.60	242.70
Granite Mortgages 02-2 plc 23	Sep-02	1068.60	1302.60	1677.60	234.00	375.00
Granite Mortgages 03-1 plc 27	Jan-03	1644.90	1718.80	1981.30	73.90	262.50
Granite Mortgages 03-2 plc 21	May-03	962.70	1129.00	1468.90	166.30	339.90
Granite Mortgages 03-3 plc 24	Sep-03	876.90	1058.90	1372.30	182.00	313.40
Granite Mortgages 04-1 plc 28	Jan-04	1485.80	1802.50	2364.80	316.70	562.30
Granite Mortgages 04-2 plc 26	May-04	1694.90	2044.60	2587.10	349.70	542.50
Granite Mortgages 04-3 plc 22	Sep-04	1962.10	2378.10	3112.70	416.00	734.60
Granite Master Issuer plc – Series 05-1	Jan-05	2795.10	3254.60	4000.40	459.50	745.80
Granite Master Issuer plc – Series 05-2	May-05	2413.60	2880.10	3762.10	466.50	882.00
Granite Master Issuer plc – Series 05-3	Aug-05	503.80	511.10	582.20	7.30	71.10
Granite Master Issuer plc – Series 05-4	Sep-05	2383.30	2840.60	3891.30	457.30	1050.70
Granite Master Issuer plc – Series 06-1	Jan-06	4423.80	5048.10		624.30	
Granite Master Issuer plc – Series 06-2	May-06	2460.40	2786.10		325.70	
Granite Master Issuer plc – Series 06-3	Sep-06	4761.50	5400.30		638.80	
Granite Master Issuer plc – Series 06-4	Nov-06	2787.30	3206.20		418.90	
Granite Master Issuer plc – Series 07-1	Jan-07	5607.00				
Granite Master Issuer plc – Series 07-2	May-07	4570.80				
Granite Master Issuer plc – Series 07-3	Sep-07 ⁷	5074.10				
Total (million pounds)					6,780.80	7,121.00

⁷ The securitized issue in September 2007 was not taken up by investors and was taken back on to Northern Rock's balance sheet.

3 Bank Runs Northern Rock Bank In September of 2007, Northern Rock bank closed its doors for one day and asked the Bank of England to cover its deposits. The brief scare started a chain reaction. Long lines formed outside many branches as people attempted to withdraw their money. Photo by Dominic, Flickr. 4 Bank Runs Withdrawers knew their actions were unreasonable. These bank runs are examples of hyperdyadic spread. Millions of pounds were withdrawn causing a financial crisis that effected not only Northern Rock Bank but the entire banking and investing community. Photo by Christopher Elison. 5 Photo by Lilly, Flickr Individual rational behavior led to communally irrational behavior. Case 3 Auric Bank. Case 4 Acquiring Metrot. Case 5 Angel Investments. Description: Modern hotel; 68 rooms Location: On the seafront in the Bay of Arcachon; Bordeaux 60 km; airport 50 km; railway station 1.5 km Restaurant: International cuisine. Vegetarian menu available Price: 150 per room per night. Cost of meals per day: 80.No discount for groups Conference facilities: 2 large rooms, 2 smaller rooms. Their head office is in Paris, and they have two factories in northern France. Reasons for Cornerstone's acquisition 1. Cornerstone will expand sales of Metrot products in Europe. 2. It will use Metrot as a base for launching its own products in Europe. The dreams might reflect the brain's attempt to find associations for the memories that could make them more useful in the future. Every day we are gathering and encountering tremendous amounts of information and new experiences. The scientists say there may be ways to take advantage of this phenomenon for improving learning and memory. For example, students might be better studying hard before bedtime, or taking a nap after a period of afternoon study. Speaker C The sessions, run by the charity Sleep Scotland, aim to teach pupils tips such as the importance of a bed-time routine and avoiding... won't enter the university unless you study hard. The job you've got is fine as it's only ten. hours a week.