

Northern Rock plc: A case study in banking policy during times of duress

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Abstract: This paper explores the events that engulfed Northern Rock plc, a UK publicly listed company, during the latter part of 2007. The background to those events that took place is illustrated together with their consequences for Northern Rock. A model of the Northern Rock liquidity situation is produced and tested using the System Dynamics paradigm and methodology. The resultant model is verified and validated with reference to known behaviour and data. Hypotheses were constructed that resulted in a set of conclusions which centred on the need for co-operation between the central bank and Northern Rock together with a need for active management and co-ordinated action. Within the limitations of the model different means of coping with banking credit problems are illustrated and remedied postulated.

The model presented could be further developed to produce recommendations for automatic triggering of interventions. This is an area for further work.

From a methodological viewpoint it is the aim of this paper to present an understanding of the events that took place during the second half of 2007, to produce a working model of those events and construct the model in such a fashion that it may assist those who teach or are studying in the finance and banking sector.

Keywords: Northern Rock, System Dynamics, Systems Thinking, Finance, Banking, Simulation

Introduction and background

International and UK national environments

There has been increased turbulence in financial markets around the world for the past year and more. From a previously favourable environment for international financial trading the early part of 2007 revealed, with hindsight, the precursors of a less benign financial climate (FSA, 2008, pp9-12), Figure 1. Through this lens of hindsight it has been observed that the ripple effect that emanated from decreasing confidence in and default rates for US sub-prime lending (Figure 2) led to a global tightening in money markets which then trickled down to UK housing markets in the middle and latter parts of 2007 and this effect continues into 2008 (FSA, 2007).

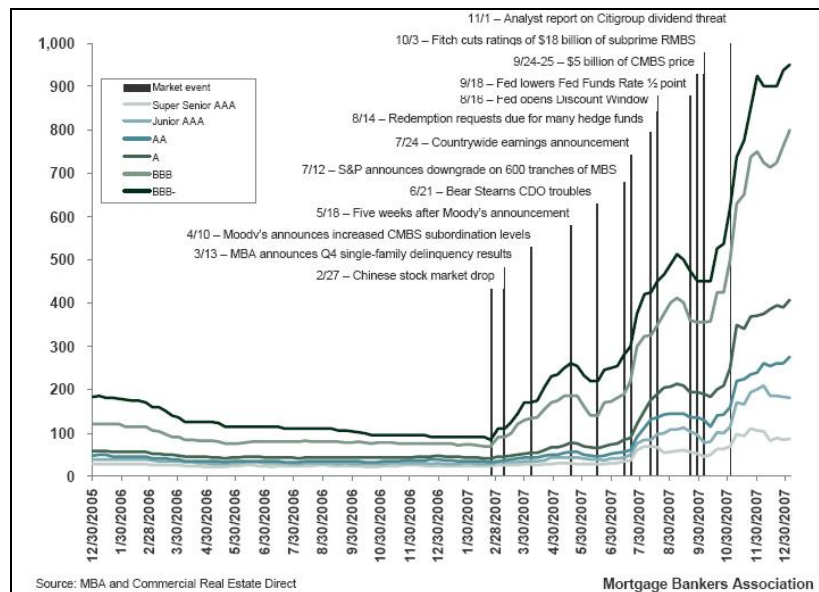


Figure 1: Signalling the crunch – Events/CMBS spreads to swaps in basis points

In effect we had a US consumer derived phenomenon having an effect on UK consumers in the same market segment; US home buyers had an indirect but definite effect on UK homebuyers; through their lenders (figure 2).

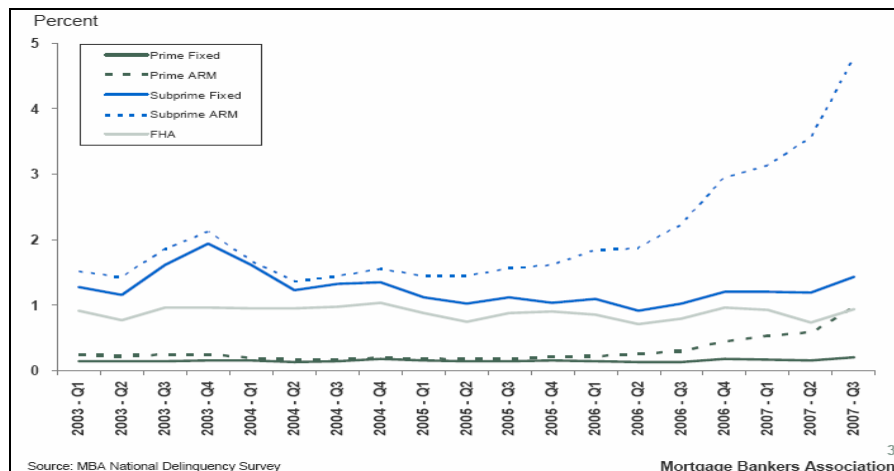


Figure 2: The crunch on consumption - US foreclosures started by loan type

| | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---------|---------|---------|----------------|----------------|
| House price growth, Q4, year on year % change | 15 | 5 | 10 | 7 (7) | 1 (5) |
| Property sales, England and Wales (Land Registry), millions | 1.29 | 1.07 | 1.25 | 1.17 (1.19) | 1.01 (1.13) |
| Gross advances, £bn | 291 | 288 | 345 | 360 (360) | 340 (360) |
| Net lending, £bn | 101 | 91 | 111 | 105 (120) | 90 (115) |
| Arrears, over 3 months, number at end period | 103,400 | 124,900 | 120,500 | 145,000 | 170,000 |
| Arrears, over 3 months, % of all mortgages at end period | 0.90 | 1.08 | 1.03 | 1.22 | 1.42 |
| Possessions, number in period | 8,000 | 15,100 | 22,700 | 30,000 | 45,000 |
| Possessions in period, % of all mortgages | 0.07 | 0.13 | 0.19 | 0.25 | 0.38 |
| GDP, % | 3.3 | 1.9 | 2.7 | 3.0 (3.0) | 2.25 (2.8) |
| Bank rate, end year, % | 4.75 | 4.5 | 5.0 | 5.5 (5.25) | 5.0 (5.0) |

Source: Bank of England, National Statistics, HM Land Registry, HBOS, CML
Notes: (1) Figures for arrears and possessions are estimates and relate only to first charge lenders who are members of the CML. They do not include arrears and possessions relating to other secured lending or to firms that are not CML members. (2) December 2006 forecast shown in brackets. December 2006 arrears and possessions forecasts are no longer comparable due to changes in methodology.

Figure 3: The picture in the UK – forecast summary statistics – CML

The statistics and forecasts from figure 3 reveal that some sources look upon the UK market as heading for a clear downturn with consequent rises in arrears and repossessions. Though if we take figure 3 as our guide then it looks more like an orderly retreat than any kind of full scale rout.

Having set the national and international scene we can now focus in on the main subject matter of this paper the stakeholders of a UK bank; Northern Rock.

Historical and current background of Northern Rock

The Northern Rock Building Society was formed on 1st July 1965 but can trace its origins back to 1850 when the Northern Counties Permanent Building Society (established in 1850) and Rock Building Society (established in 1865) merged. Northern Rock Building Society then went on to merge with a number of small local building societies and, prior to its conversion to a public limited company in October 1997, was an amalgamation of 53 societies (Northern Rock, 2008), (Datamonitor, 2008).

A building society is the approximate UK equivalent of the US savings and loan association, building societies are described as mutual societies which exist to further the interests of their members; usually in the form of arranging loans (mortgages) to purchase land or property with any surplus directed back to the members. Building societies do not have shareholders they are owned by their members.

“A significant development in the recent history of Northern Rock was its conversion on 1 October 1997 from a building society to a public limited company, listed on the London Stock Exchange and authorised under the Banking Act 1987. The conversion also resulted in the establishment of The Northern Rock Foundation, a charitable body

which is entitled to receive approximately 5% of the annual consolidated profit before tax of Northern Rock plc” (Northern Rock, 2008).

Northern Rock is a substantial corporation within the UK having been a member of the FTSE 100, which “comprises the 100 most highly capitalised blue chip companies, representing approximately 81% of the UK market”(FTSE International, 2008), since September 2001 until its removal to the FTSE 250 in December of 2007.

Northern Rock though now a bank and not a building society still has its roots in the same market segments – on the lending side at least see figure 4 for a breakdown.

| £ millions | Residential | Buy to Let | Total Residential | Commercial | Unsecured | Total |
|---|-------------|---------------|----------------------|------------|-----------|--------|
| 2007 1st Half | | | | | | |
| Gross | 15,979 | 1,455 | 17,434 | 188 | 1,704 | 19,326 |
| Net | 9,170 | 899 | 10,069 | 91 | 554 | 10,714 |
| Closing balances | 81,212 | 6,181 | 87,393 | 818 | 7,829 | 96,040 |
| 2006 1st Half | | | | | | |
| Gross | 11,515 | 1,196 | 12,711 | 259 | 1,837 | 14,807 |
| Net | 5,427 | 924 | 6,351 | 72 | 853 | 7,276 |
| Closing balances | 63,912 | 4,704 | 68,616 | 1,594 | 6,638 | 76,848 |
| Note: Net flows represent net cashflows excluding fair value adjustments and excluding asset disposals. Closing balances are stated including fair value adjustments. | | | | | | |

Figure 4: Northern Rock lending profile (Northern Rock, 2007)

Whilst the lending profile may have remained similar in that it is still based primarily on lending for purchase of property with a small component relating to unsecured loans (8.15% of the closing balance in June 2007 down from 8.64% at the comparable point in 2006) the borrowing profile has undergone some changes. Instead of funding lending from retail deposits it now, as at June 2007, relies much more heavily on borrowing from sources other than retail depositors to finance its lending activities.

| £ millions | Retail | Non-Retail | Securitisation | Covered Bonds |
|---|--------|------------|----------------|---------------|
| 2007 1st Half | | | | |
| Net flow | 1,734 | 2,509 | 5,632 | 2,194 |
| Closing balances | 24,350 | 26,710 | 45,698 | 8,105 |
| 2006 1st Half | | | | |
| Net flow | 1,666 | (2,329) | 5,834 | 1,382 |
| Closing balances | 21,773 | 19,570 | 36,334 | 4,965 |
| Note: Net flows represent net cashflows excluding fair value adjustments. Closing balances are stated including fair value adjustments. | | | | |

Figure 5: Northern Rock funding profile (Northern Rock, 2007)

The retail deposit funding amounted to some 23.1% of total funding in June 2007 and 26.3% at the comparable point in 2006.

Research framework

It is the aim of this paper to present a brief analysis of the issues that faced Northern Rock during 2007 and which continue at the time of writing. The analysis is

comprised of a review of the overall background, see above, resulting in a lack of funds in the wholesale credit markets, 'the credit crunch', and the effects of the reduction in retail confidence in Northern Rock which in turn led to a run on that bank (BBC, 2007).

The approach to the analysis is centred on the use of System Dynamics (SD) and the de facto standard within that discipline which was outlined by Sterman (Sterman, 2000). A description of that methodology is presented in Annex C to this paper.

Within the framework set out in the preceding paragraph the design tenets applied to this simulation were to keep it simple and where factors could be removed without compromise to the viability of the overall simulation this was done. The management simulator or interface was kept as simple as possible to enable this model to be used as a teaching aid both for SD and in financial systems.

The remainder of this section focuses on the process of applying the research framework.

Phase 1

The problem scenario is to devise a model that incorporates the major factors which influenced the state of the UK based Northern Rock bank to the extent that there is significant doubt about its survival in its current incarnation (Foley, 2007),(Griffiths, 2007).

Two particular aspects of the problem are identified; the lack of wholesale credit 'the credit crunch' and the loss of retail investor confidence. Possible levers which may affect a solution to either or both of these factors are examined. These levers have been identified as being of two broad types.

The first set are the internal levers that are available to the bank and its management without recourse to outside bodies and are the ability of the bank to 'shut up shop' closing its branches and shutting down its ATM network, the second internal lever is the ability of management to stop issuing new loans to its lender base thereby hoarding that liquidity rather than investing it (Croft, 2007b). Though there is some evidence that mortgage lending is dropping anyway as a result of general unease about the state of the bank (Croft, 2007a). The exact cause of this reduction in mortgage lending is not yet clear and could be internally driven, see model description for how this could be achieved.

The second set are the external levers available to those who have a stake in the business for purposes beyond that of just maintaining Northern Rock as a going concern. These could be labelled the regulators who wish both to stop the loss of confidence in the economy on a wider scale that could result from a banking failure and to forestall the possibility of contaminating the remainder of the UK banking sector; the so called 'contagion risk'. The regulators in this case are composed of Her Majesty's Treasury, the Bank of England which is the UK's central bank and 'lender of last resort' and finally the Financial Services Authority who are given responsibility for regulating the UK financial services industry. A description of the roles of each of these players, who are collectively referred to as the tripartite

authority, is given in Memorandum of Understanding between HM Treasury, the Bank of England and the Financial Services Authority (HM Treasury, 2006). There are two levers that have been identified as being available to the tripartite authorities; they are the issuance of guarantees to Northern Rock depositors to back their deposits with Northern Rock by government funds (a practical nationalisation of retail deposit accounts) and secondly a loan facility to enable Northern Rock to continue to fund its borrowing requirements.

This paper is centred on the financial environment surrounding Northern Rock plc the tools it has to cope with that environment and the tools available to the tripartite authorities to influence the financial environment of Northern Rock. It is beyond the scope of this paper to model the structure or behaviour of the 'credit crunch' in any detail, see following paragraph, the internal machinations or philosophical determinants of why it might be worth saving a failing business or the internal details and processes of the tripartite authorities. The overall view of the tripartite authorities can be summed up by their position statement that it "must be noted, however, that it is neither possible nor desirable to design a regulatory system that removes the possibility of a bank ever failing" (HM Treasury, 2008).

The 'credit crunch' is widely reported as being rooted in the rise of sub-prime mortgages in the US; see glossary for definition. Sub-prime lending by Northern Rock is not seen as a significant factor in their performance, as at the reference date of June 2006, with figures for residential lending being reported as 0.47% of total loans which is significantly below the industry average. Though there is some acknowledgement that this position is likely to worsen even a doubling in substantial arrears would still only have moved Northern Rock up to the UK average (Northern Rock, 2007). However this situation may be worth monitoring in the medium to long term, 2-10 years, and including in any longer term analysis.

There has been widespread reporting of the Northern Rock business model, lend long term borrow short term, as being a significant factor in their 'failure' (Hill, 2007), (Hill and Betts, 2007), (Wolf, 2007). The simulation needs to cope with this business model and does so partly by the use of data to determine the flow of funds that are sourced either through the wholesale credit markets and where this is not available to those measures taken by the tripartite authorities to replace that lack of commercial funding with state backed funding (Farrell, 2007).

The role of interest rates in general and their effect on Northern Rock policy was examined. When short term rates differed from longer term rates this did have an effect on Northern Rock but not a significant one. Interest rates variations were not therefore considered relevant to this model. A sample of historic rates is included in Annex B for information.

The time frame for this analysis is the six month period commencing July 2007 and within that overall time frame to allow analysis at both daily and monthly intervals. Choosing this time frame allows the modelling of events that occurred rapidly, over a period of days, 'the run on the bank', those that took place over a slightly longer period, 'liquidity drain', policy formation within the bank and tripartite authorities, and finally understanding the effects of applied policy in the slightly longer term.

Typical behaviour for this scenario is defined here as that which existed in the six month period leading up to end June 2007 (Northern Rock plc, 2007), (FSA, 2007 and 2008).

Phase 2

Given the results of phase 1 it has been possible to devise an overall causal map of the scenario described therein. Figure 6 illustrates the overall result of this analysis. Beginning with the hypothesis that the key to understanding the effects that the credit crunch had on Northern Rock rests on a liquidity crisis within the bank this becomes central to the initial modelling process. This hypothesis is motivated by the assertion that liquidity is necessary for survival and other business objectives can only be realised if the business survives.

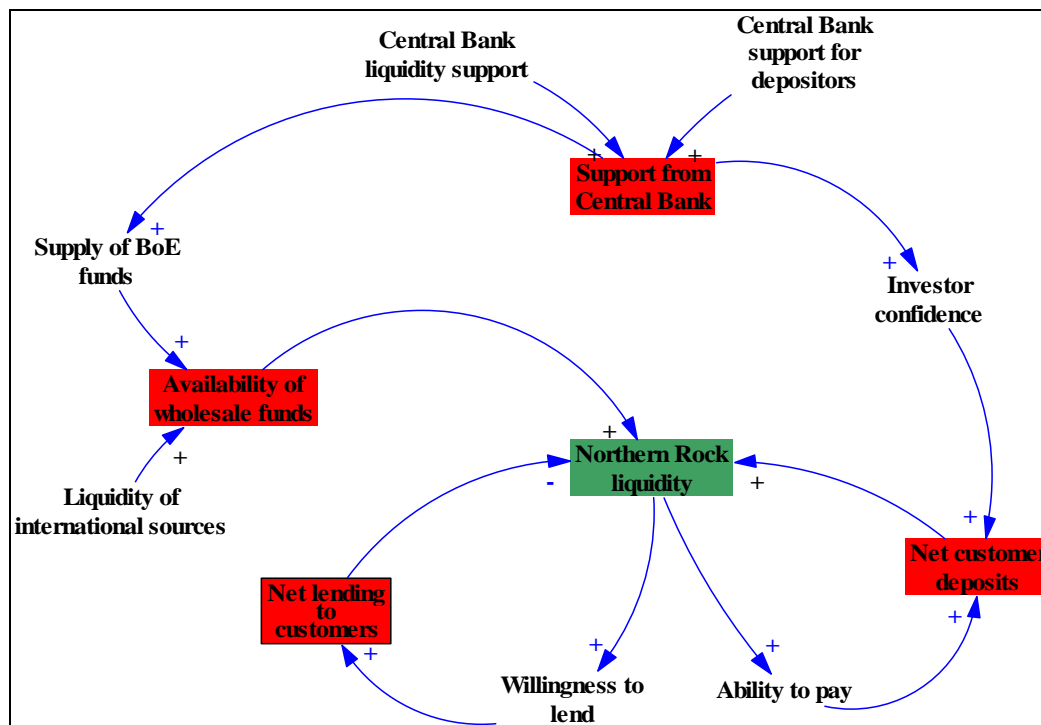


Figure 6: Causal map of Northern Rock situation

From the literature it has become obvious that although there is a loop between Northern Rock and the 'credit crunch' (availability of wholesale credit in figure 6) in general the effect that Northern Rock has on the wider lack of credit is not significant this effect is acknowledged here but removed from the causal map. If this paper were to examine the effect of the UK banking sector as a whole then this would have a significant effect on wholesale credit and would be a viable loop on that causal model.

Business model risk (or policy) within Northern Rock has a direct influence on that banks liquidity and it has been determined that this needs to be included in the overall structural view of the system; this is indicated in figure 6.

Net retail and non-retail deposits have an effect on bank liquidity and in particular the lack of confidence which spread rapidly within Northern Rock's customer base

leading to a run on the bank (Walsh, 2007). This process becomes a reinforcing loop with lower confidence leading to decreasing net deposits (withdrawals) leading to decreased liquidity. As with the previous two factors this aspect of the model is accounted for in figure 6.

The fourth major factor to play a role in the Northern Rock scenario is support from the tripartite authorities – represented as the ‘National Central Bank’ in figure 6. The reason why the authorities are represented as a bank is that it is the Bank of England that implements many of the policies that are agreed between the other members of the triumvirate and given that the workings of the tripartite authority are beyond the scope of this paper the Central Bank seems the most appropriate representation. There has been some criticism of the authorities handling of their regulatory responsibilities (Brown, 2008)

Distilling the four aspects above it is possible to determine that from the point of view of maintaining Northern Rock’s liquidity the ‘credit crunch’ is to be a given and not explained further other than that its existence or otherwise is a prime motivator for the entire crisis.

Apart from the ‘credit crunch’ in order to explain the dynamic behaviour of the system and its potential solutions it emerged that the motivating factors and those offering a potential solution are; Internal management policy, Central Bank policy and Depositor confidence. If we treat these as the hypothetical keys to the solution box then these are the aspects which it is necessary to turn to in order to provide solutions. Much of the dynamic behaviour of the system is governed by the application of policy inputs and in the absence of these the liquidity levels of Northern Rock would be expected to continue growing, as was the case up until June 2007. Additionally as much of the reference mode behaviour is defined using actual data at a point in time then it would be assumed that growth would be linear.

If actual data were not used for net flows then a generic causal loop of a net flow would look something like figure 7 below.

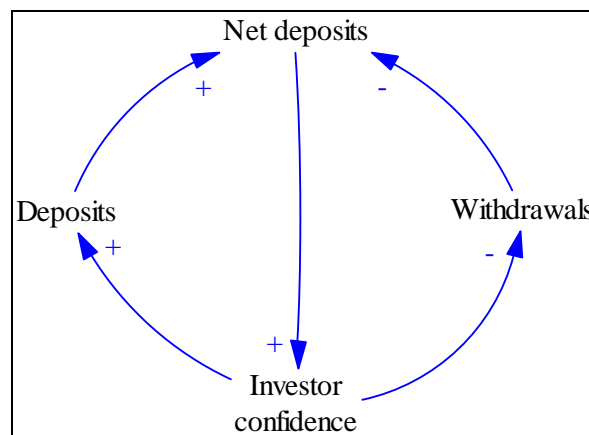


Figure 7: Causal map of net deposits

Phase 3

This phase involves the construction of stock and flow models which are in line with the previous analysis. The graphical representation of the computer model is illustrated in figure 8 below.

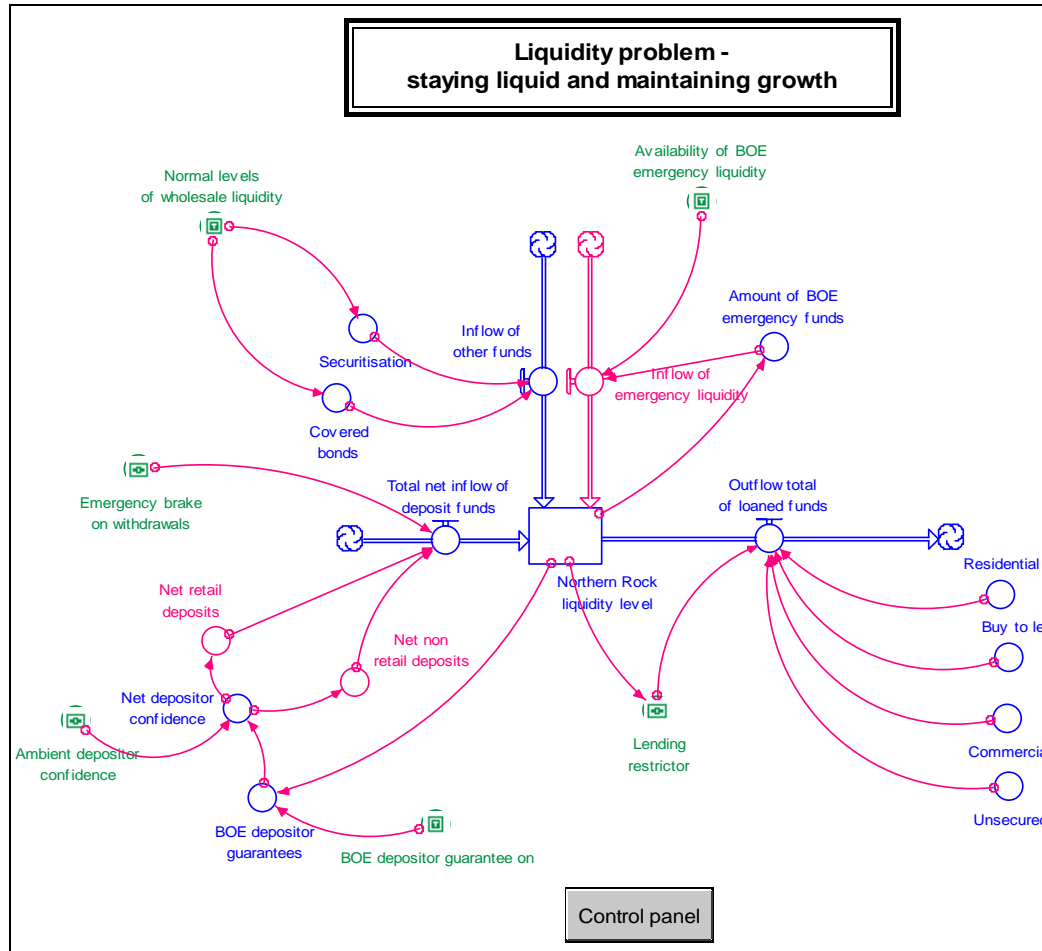


Figure 8: Stock and flow model of Northern Rock liquidity influences

The equations for this model are reproduced in Annex D and the interface level in Annex E, the causal model for this paper (figure 6) was developed in Vensim PLE and the Stock and Flow model (figure 8, Annex D and E) in Stella 8.1.1.

Parameter values have been calibrated from existing data where possible (Northern Rock, 2006, 2007) and where unavailable were estimated from other sources (Bank of England, 2007), (FSA 2007, 2008).

The model has been tested using sensitivity analysis, via the interface at annex E, and has been found capable of generating results close to those occurring in the real world. Although it is true that any model is a simplification of reality and constraints of time and resource do not enable a full description of all possible variables or their relationships; no significant factor appears to be absent.

Phase 4

The model conforms with the reference mode and produces a good approximation of what would have occurred had the reference mode continued to be the systemic behaviour over the period modelled. Figure 9 below illustrates this.

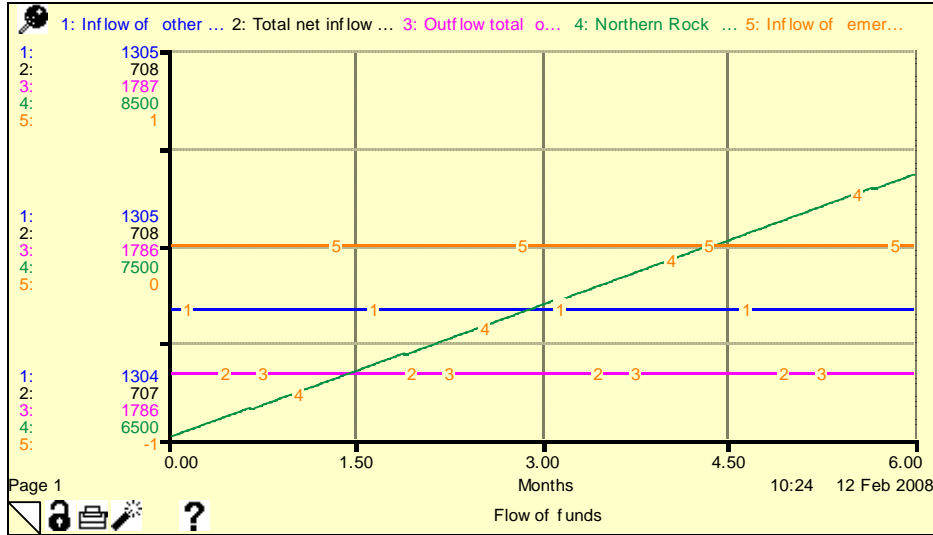


Figure 9: Reference mode modelled over the period

Figure 10 below illustrates the effect of a wholesale market 'credit crunch' with no attempt to correct for it over the six months being modelled. Northern Rock is effectively insolvent at the end of the simulation having approximately £34m in cash and cash equivalents remaining which is roughly half of one percent of the starting liquidity level.

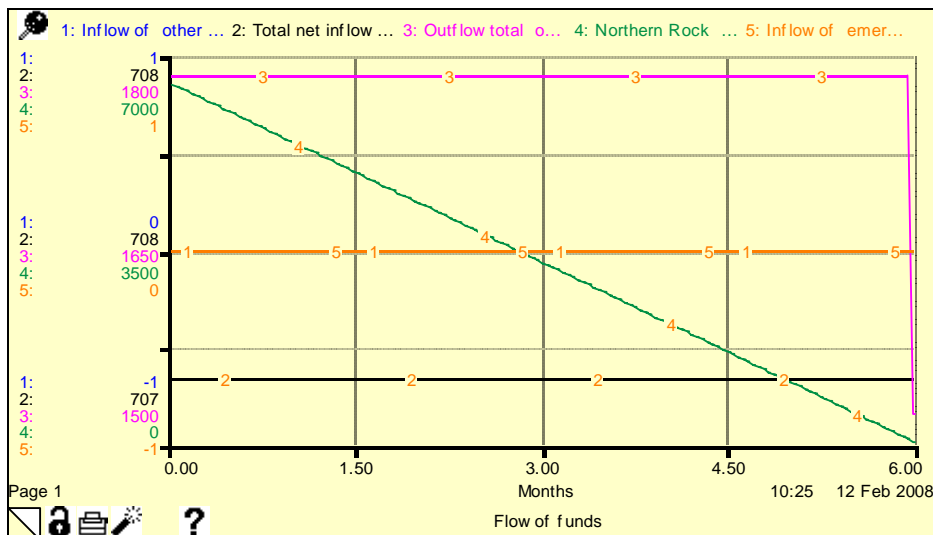


Figure 10: Performance of Northern Rock in an unmitigated 'credit crunch'

Figure 11 below illustrates the effect of a credit crunch and a run on the retail bank; Northern Rock becomes entirely insolvent after approximately at simulation time 3.67 which is after approximately 3 months and 3 weeks into the simulation.

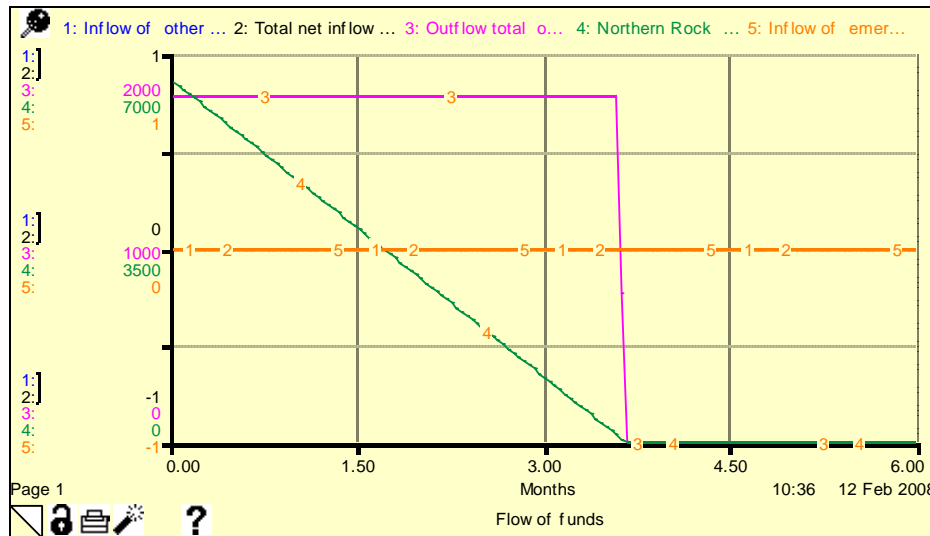


Figure 10: Performance of Northern Rock in an unmitigated 'credit crunch' and with an unaddressed 'run on the bank'

From the two scenarios presented immediately above (figures 10 and 11) it can be seen that the model produces realistic results in the case of unaddressed problems.

Figure 12 below illustrates the effect of the restricted wholesale credit and the loss of depositor confidence with in addition all possible measures to address those problems taken. The bank has effectively 'shut up shop' and is in equilibrium though whether this is a practical reality is open to question.

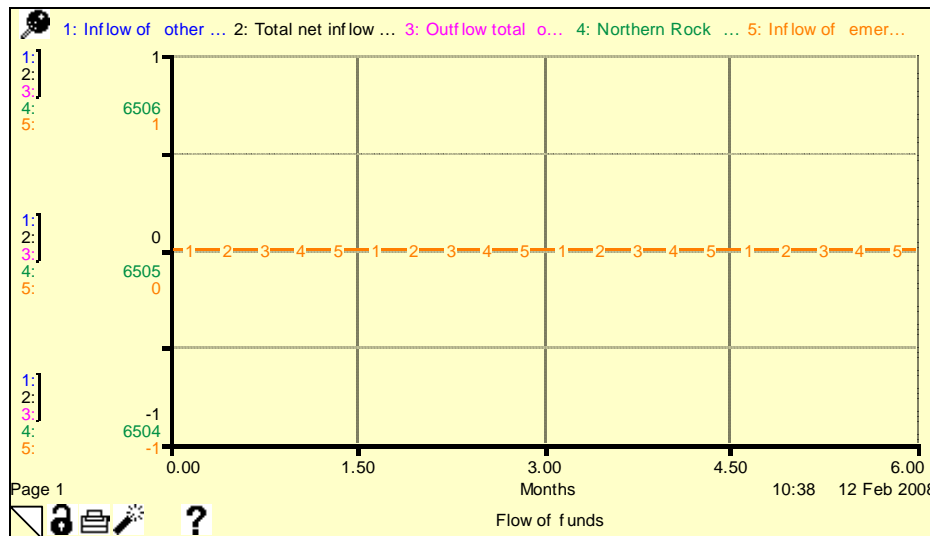


Figure 12: Performance of Northern Rock in a 'credit crunch' with a 'run on the bank' and all emergency measures in place

It can be seen from figures 9, 10, 11 and 12 that the model, though straightforward, is sensitive to parameters and is capable of a wide range of behavioural simulation.

Phase 5

The model was tested to evaluate several possible hypotheses, these are:

H0: That in the absence of any policy or external changes Northern Rock would continue to behave as it had in the six months to June 2007.

H1: That in the presence of a 'credit crunch' Northern Rock would become insolvent if no correcting actions are taken.

H2: That in the presence of a 'credit crunch' Northern Rock could maintain solvency through the use of the internal levers available to it.

H3: That in the presence of a 'credit crunch' and total absence of investor confidence Northern Rock would become insolvent if no correcting actions are taken.

H4: That in the presence of a 'credit crunch' and total absence of investor confidence Northern Rock could maintain solvency through the use of internal levers.

H5: That in the presence of a 'credit crunch' Northern Rock could maintain solvency through the use Bank of England emergency liquidity funding.

H6: That in the presence of a 'credit crunch' Northern Rock could maintain solvency through the use of the internal levers available to it and Bank of England emergency liquidity funding.

Definitions and scope:

For the purposes of testing insolvency means that liquidity falls below 50% of the level available at the start of the simulation (£6504.9m at end June 2007 (Northern Rock, 2007, p.20)) and all hypotheses are time limited to the simulation period; start July to end December 2007.

Testing of these hypotheses was carried out and the results are shown below.

Testing H0

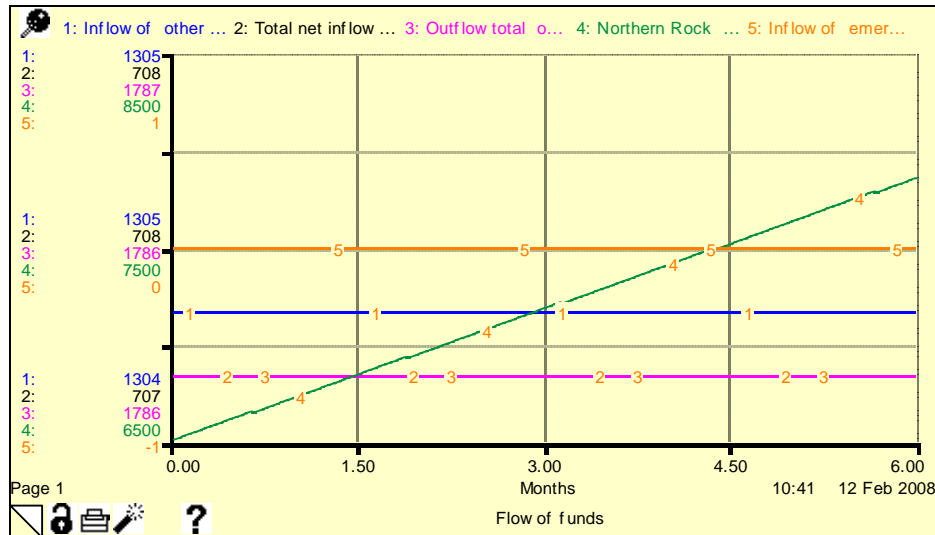


Figure 13: Results of testing under conditions of H0

As can be seen from figure 13 above Northern Rock continued to grow in a linear fashion, as would be expected, given no change in conditions from those in existence at end June 2007. The conclusion is that H0 is in accord with simulated results.

Testing H1

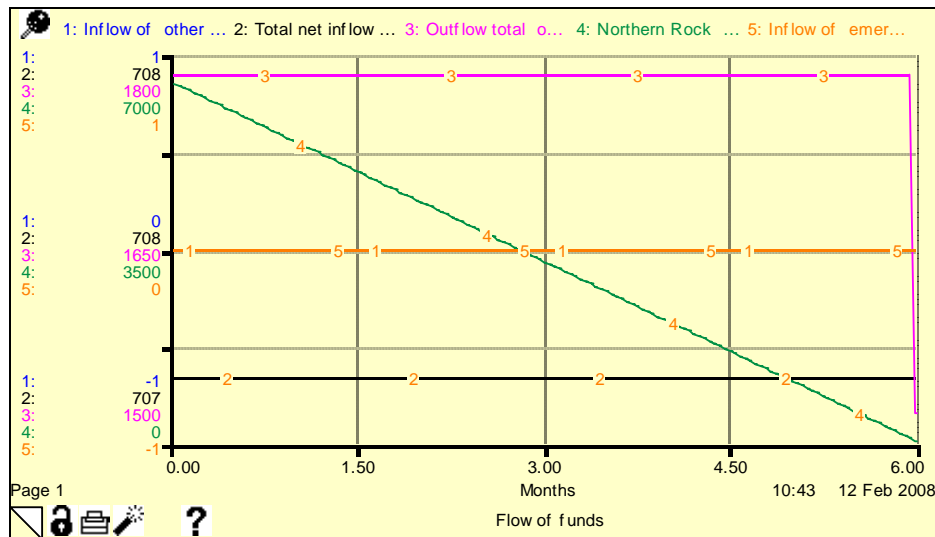


Figure 14: Results of testing under conditions of H1

As can be seen from figure 14 above Northern Rock showed a linear decline in its liquidity and although not actually entirely without liquid reserves, £34m, it was insolvent according to the assumptions given in the definitions and scope, above, at the end of the simulation. The conclusion is that H1 is in accord with simulated results.

Testing H2

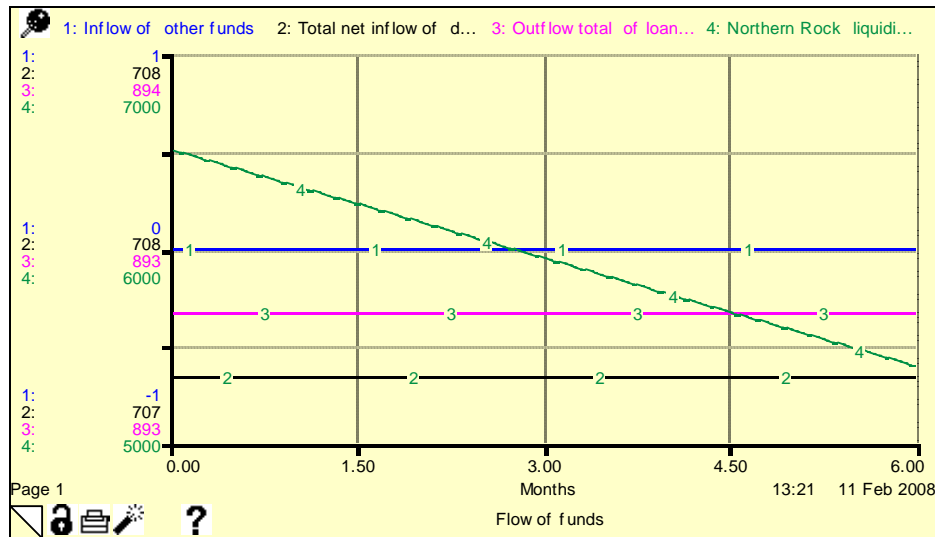


Figure 15: Results of testing under conditions of H2

Figure 14 illustrates the output from a simulation where the ‘Lending restrictor’ was applied at a 50% level and the credit crunch was in operation. The application of the ‘Lending restrictor’ simulated an effective halving of the amount lent to customers and amounted to a hoarding of liquidity. This latter point could be an important indicator of how retail credit contagion would propagate i.e. if all banks did this it would cause a credit crunch for retail customers (Haycock, 2008). At the end of the simulation period Northern Rock still retained approximately 83% of its starting liquidity level. The conclusion is that H2 is in accord with the simulated results.

Testing H3:

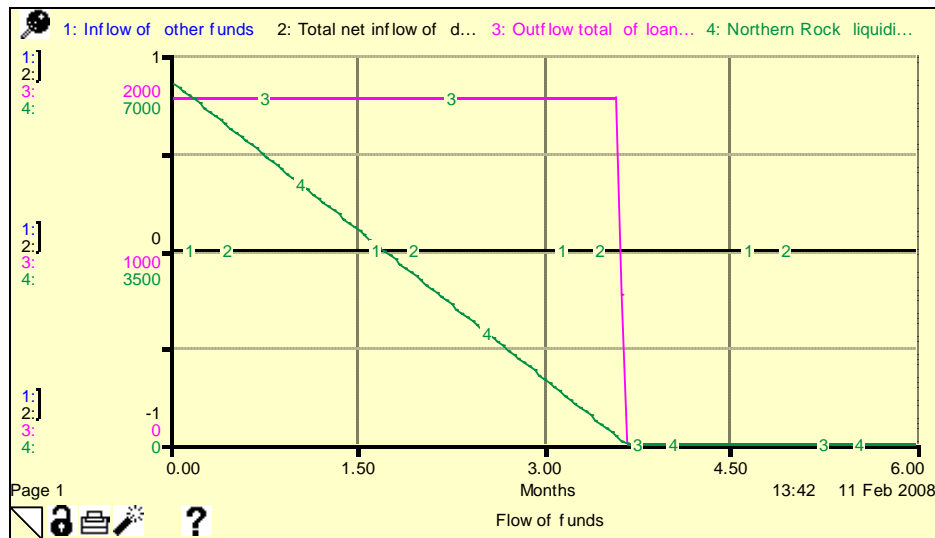


Figure 16: Results of testing under conditions of H3

Results of testing under conditions of H3 illustrate the complete absence of liquidity within Northern Rock occurring at time 3.67 in the simulation (approximately 3 months and 3 weeks) and insolvency occurring at time 1.83 in the simulation (approximately 1 month and 3½ weeks). The conclusion is that H3 is in accordance with the modelled results.

Testing H4:

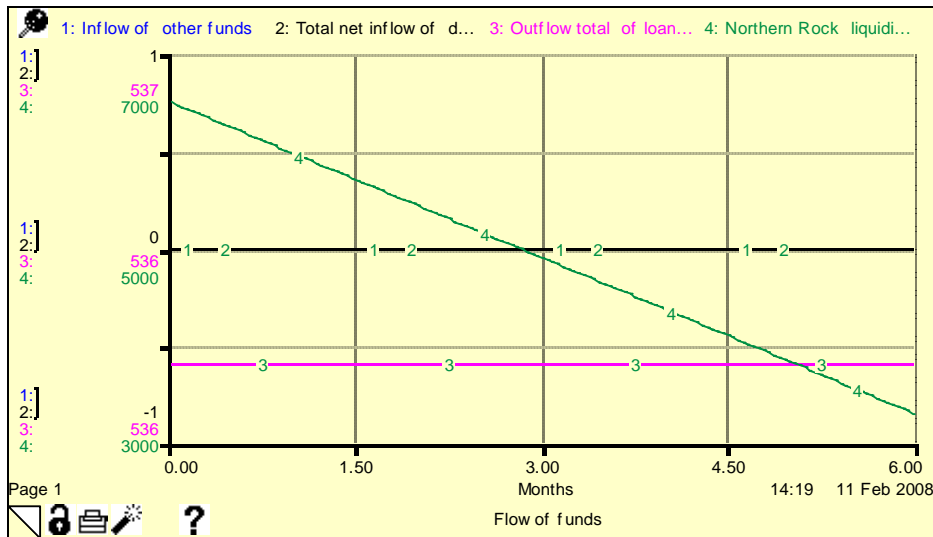


Figure 17: Results of testing under conditions of H4

Figure 17 shows the results of the Lending restrictor applied at a 30% level. The conclusion is that H4 is in accordance with the modelled results.

Testing H5:

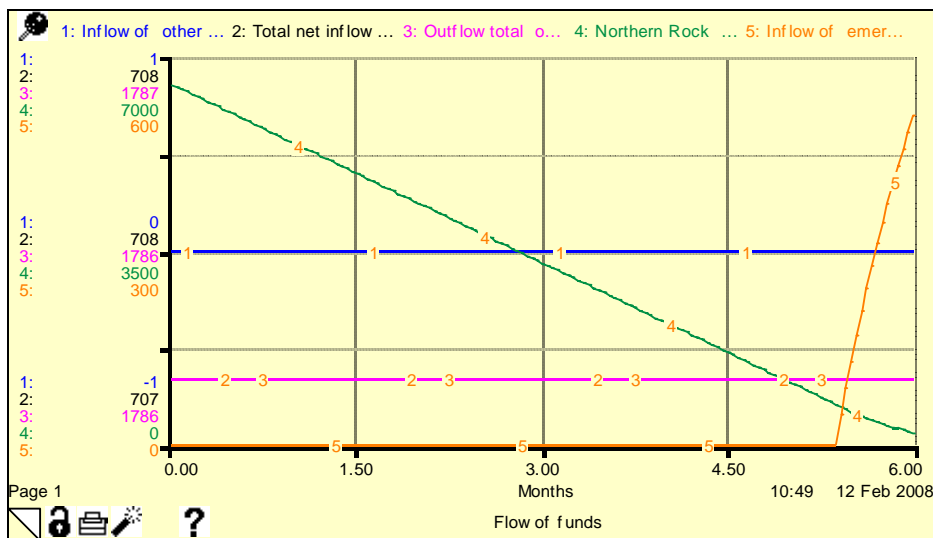


Figure 18: Results of testing under conditions of H5

Figure 18 illustrates the output graph from testing under hypothesis 5. This demonstrates the effect of the introduction of Bank of England emergency liquidity

funding. Northern Rock becomes insolvent at simulation time 3.00 (three months) into the simulation with a liquidity level of £199m remaining at the end of the simulation. The conclusion is that H5 is not in accord with the model results.

Testing H6:

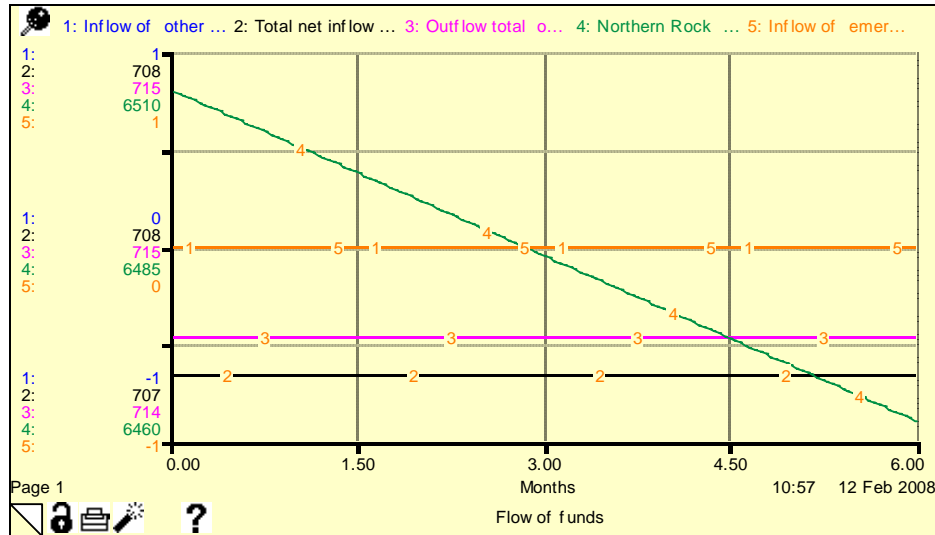


Figure 19: Results of testing under conditions of H6

Figure 19 illustrates the same outputs shown in figure 18 and is a result of testing under H6 conditions. The graph shows the outputs with the lending restrictor set to allow 40% of previous lending levels. The conclusion is that H6 is in accord with the model results.

Supplementary scenario

In the hypothesis testing carried out above management and regulators have been fairly docile setting policy at the simulation outset and letting that continue until simulation end. This supplementary scenario shows the results of a more active management approach. At the outset of the simulation the wholesale 'credit crunch' is active and the investor confidence level is set to nil. All other parameters are as per reference mode any changes are made at the end of each month. The first month is run with the set up as described above and the subsequent series of actions is taken:

Month 2:

Lending restrictor is set to 50%

Month 3:

Lending restrictor increased to 80%

Bank of England depositor guarantee is set to on

Month 4:

Lending restrictor increased to 90%

Bank of England depositor guarantee is set to on

Bank of England emergency liquidity is set to on

Month 5:

Investor confidence set to 50%

Month 6:

Lending restrictor decreased to 85%

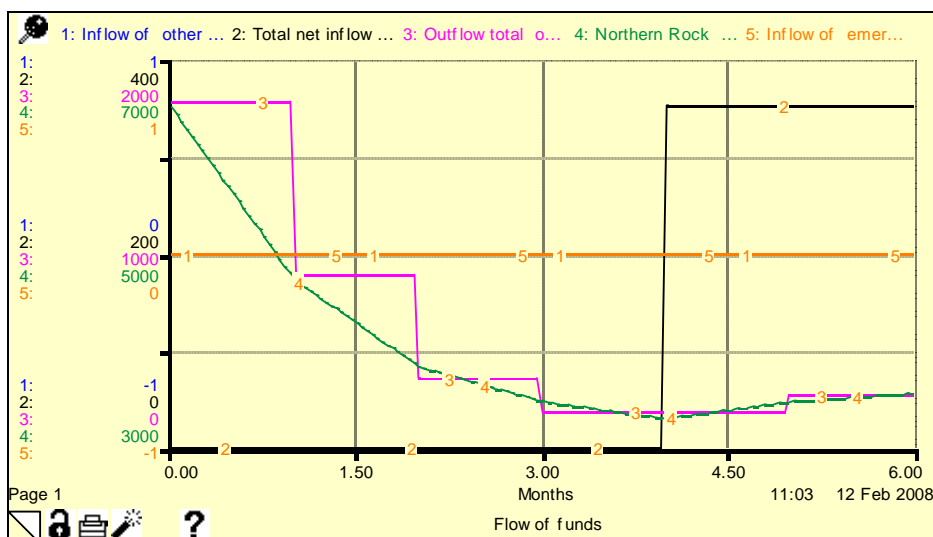


Figure 20: Results of testing under conditions supplementary scenario

Looking at the results of the actions taken in the supplementary scenario and shown in figure 20 it can be seen that we have a much more dynamic (and realistic) progression of events. This shows a manipulation of various levers at various points, implying a degree of co-operative action, by both Northern Rock and the Bank of England. The turning point for this scenario is at the start of month 5 when depositor confidence begins to return to Northern Rock.

Conclusions

General

From an analysis of the hypotheses presented in Phase 5 above it is clear that an amalgam of both internal and external levers are best used together to maintain both Northern Rock as a going concern and remove the need to restructure the entire business. Teamwork amongst the tripartite authorities and Northern Rock is desirable as the most effective solutions were achieved using co-ordinated application of both internal and external levers. Neither internal nor external levers were effective on their own for maintaining Northern Rock plc as a going concern.

An active approach as outlined in the supplementary hypothesis is recommended as this approach achieved the most responsive and solution oriented means of dealing with the problems facing Northern Rock.

Contagion risk is addressed in phase 5, H2 and a tentative explanation for its existence, individual institutions hoarding liquidity, is put forward.

Automatic triggering of state guarantees or funding could be developed within a variant of this model, here they are activated as policy decisions, which could define an overall response framework for particular scenarios. To define these as automatic within this model would have resulted in an unrealistic simulation. This is identified as an area for further work.

Methodological

Methodological conclusions drawn here are:

1. That this model is largely linear in functionality due to the presence of data informing the results, for example when defining monthly receipts and payments as a function of the flows from the previous six months. It only exhibits dynamic complexity when actively managed as illustrated by the supplementary model and graphed in figure 20; which is realistic.
2. That this simulation is quite basic with just a few controls but seems to be broadly capable of representing the actual situation of Northern Rock and the inputs to its system that determine its liquidity status.
3. That the model produced could be a useful teaching/learning tool for those involved in the teaching or study of finance.

Glossary

ABS – Asset Backed Security

Basis Points – Hundredths of a percent; usually applied to interest rates changes

CDO – Collateralised Debt Obligations

CMBS – Commercial Mortgage Backed Security

CML – Council of Mortgage Lenders

Contagion risk – The risk that a particular set of circumstance will spread within the community in which it arose. In this case a risk that the credit crunch and loss of investor confidence would spread from one bank to the UK banking sector.

Libor – London InterBank Offered Rate

RMBS – Residential Mortgage Backed Security

Sub-prime – “Less than first”; for example a sub-prime borrower in the UK is often accepted as those in ‘adverse credit’ i.e. previously had significant arrears and/or have had County Court Judgements, been bankrupt or have entered into an IVA. In the US the definition of a sub-prime borrower is wider including those with high loan to value and loan to income multiples. (Bank of England, October 2007)

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Annex A

Abridged financial history of Northern Rock

| | | 2002 | 2003 | 2004 | 2005 | 2006 |
|--|-----------|---------------|---------------|---------------|---------------|----------------|
| Net interest income | £m | 391.2 | 450.7 | 466.9 | 752.3 | 849.1 |
| Other income and charges | £m | 169.8 | 209.0 | 252.3 | 129.0 | 152.8 |
| Net hedge ineffectiveness and other unrealised fair value gains and losses | £m | - | - | - | (56.4) | 14.9 |
| Total income | £m | 561.0 | 659.7 | 719.2 | 824.9 | 1,016.8 |
| Operating expenses – ongoing | £m | 169.8 | 194.5 | 218.3 | 249.4 | 277.5 |
| Operating expenses – non-recurring ¹ | £m | 2.3 | 5.6 | - | - | - |
| Operating expenses – amortisation of goodwill | £m | 1.5 | 3.6 | - | - | - |
| Covenant to The Northern Rock Foundation | £m | 16.3 | 19.3 | 21.6 | 24.7 | 31.4 |
| Impairment losses on loans and advances | £m | 43.1 | 48.7 | 48.5 | 56.6 | 81.2 |
| Amounts written off fixed asset investments | £m | 2.6 | 1.4 | (4.5) | - | - |
| Profit before taxation | £m | 325.4 | 386.6 | 435.3 | 494.2 | 626.7 |
| Income tax expense | £m | 96.5 | 112.2 | 125.8 | 144.9 | 183.7 |
| Profit for the year | £m | 228.9 | 274.4 | 309.5 | 349.3 | 443.0 |
| Attributable to: | | | | | | |
| Appropriations | £m | - | - | - | 48.6 | 48.5 |
| Profit attributable to equity shareholders | £m | 228.9 | 274.4 | 309.5 | 300.7 | 394.5 |
| Total assets² | £m | 41,875 | 51,944 | 64,881 | 82,709 | 101,011 |
| Growth in total assets | % | 35 | 24 | 25 | 28 | 22 |
| Average interest earning assets | £m | 36,036 | 46,435 | 57,071 | 72,730 | 88,788 |
| Mean assets | £m | 36,482 | 46,909 | 58,415 | 73,710 | 91,860 |
| Retail deposits | £m | 15,336 | 16,343 | 17,290 | 20,104 | 22,631 |
| Equity shareholders' funds | £m | 1,165 | 1,340 | 1,538 | 1,576 | 2,175 |
| Total capital ratio | % | 15.5 | 14.3 | 14.0 | 12.3 | 11.6 |
| Tier 1 ratio | % | 9.1 | 9.0 | 8.7 | 7.7 | 8.5 |
| Gross lending | £m | 12,584 | 17,315 | 23,342 | 26,879 | 32,989 |
| Net lending | £m | 6,697 | 8,514 | 12,932 | 14,555 | 16,621 |
| Loan balances acquired | £m | 1,544 | - | - | - | - |
| Increase in retail balances | £m | 773 | 1,007 | 896 | 2,809 | 2,527 |
| Retail balances acquired | £m | 1,193 | - | - | - | - |
| Increase in profit after tax ³ | % | 18 | 20 | n/a | 11 | 31 |
| Net interest margin | % | 1.09 | 0.97 | 0.82 | 1.03 | 0.96 |
| Total income : mean assets | % | 1.54 | 1.41 | 1.23 | 1.12 | 1.11 |
| Operating expenses ³ : total income ⁴ | % | 30.3 | 29.8 | 30.4 | 30.2 | 27.3 |
| Operating expenses ³ : mean assets | % | 0.47 | 0.41 | 0.37 | 0.34 | 0.30 |
| Impairment charge as % of mean advances to customers | % | 0.19 | 0.19 | 0.10 | 0.09 | 0.10 |
| Post-tax return on mean equity ⁵ | % | 20.8 | 21.9 | 21.6 | 20.3 | 23.5 |
| Post-tax return on mean risk weighted assets ⁵ | % | 1.43 | 1.49 | 1.45 | 1.23 | 1.38 |
| Earnings per Ordinary Share | p | 55.4 | 66.6 | 74.9 | 72.5 | 94.6 |

1. Non-recurring costs represent
2002 – non-recurring costs incurred in relation to the acquisition of the banking subsidiaries of Legal & General
2003 – non-recurring costs incurred in relation to the closure of certain branches

2. Total assets for 2002 and 2003 represent assets under management, which comprised total balance sheet assets plus non-recourse finance. There is no difference between total assets and assets under management from 2004

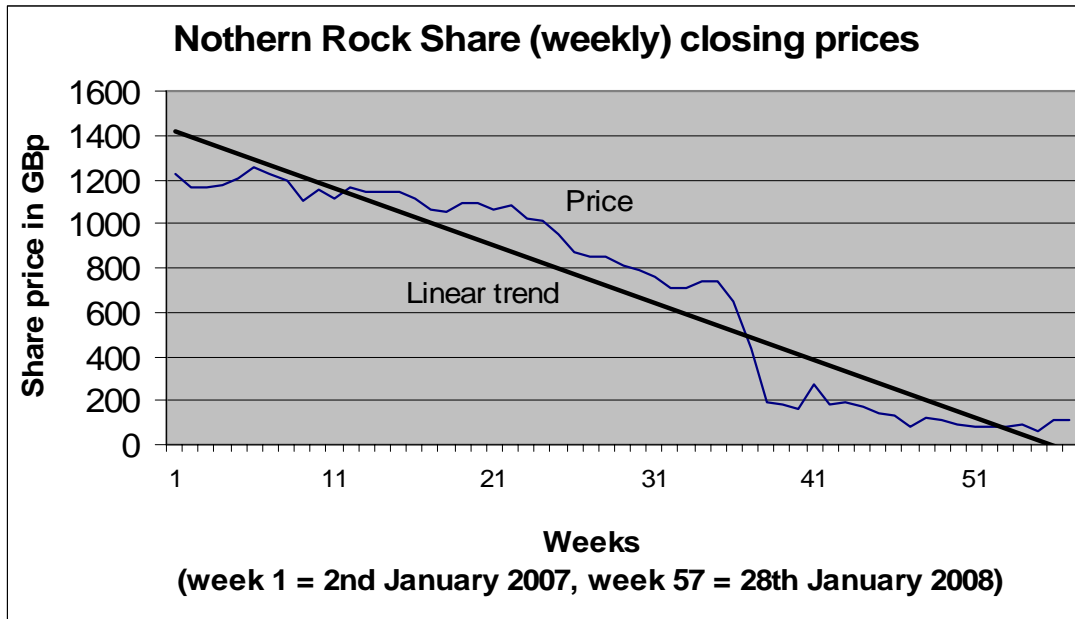
3. Before non-recurring costs

4. Before surplus on sale of credit card portfolio of £7.3 million in 2003

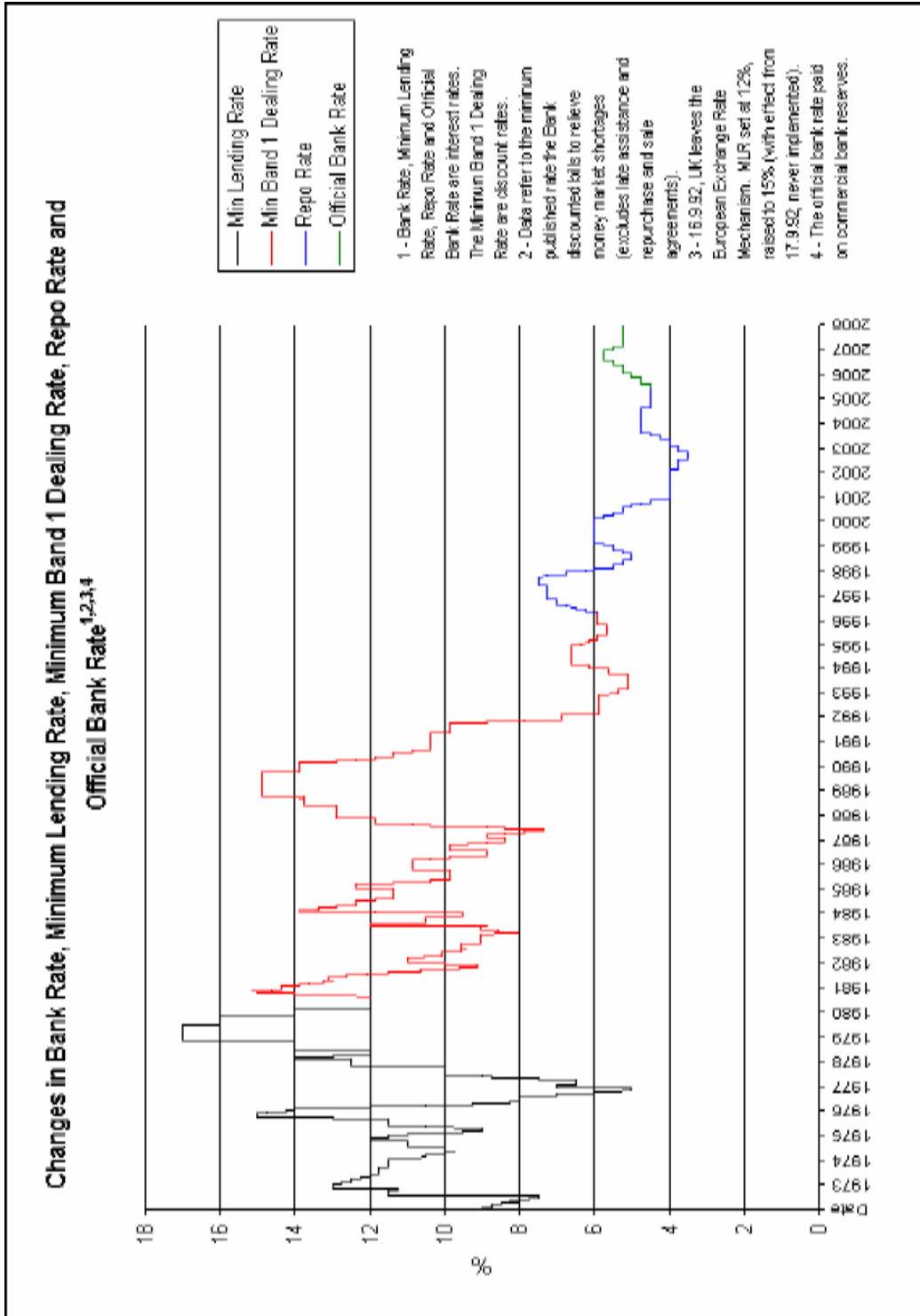
5. Post-tax returns are calculated by reference to profit attributable to equity shareholders

Source: Northern Rock Annual Report and Accounts 2006

Annex B
Share price data



Northern Rock share price January 2007 to January 2008



Historic interest rates, source Bank of England,
<http://www.bankofengland.co.uk/statistics/rates/baserate.pdf>

Annex C

Methodology

An adapted version of Sterman’s description of the Systems Dynamics modelling process is shown in the table below, this is the methodology used in this analysis.

| | |
|---|---|
| Phase 1 - Problem Articulation | Structuring the problem; determining the main variables, bounding the scope; specifying the time frame; defining the reference mode – ‘typical’ behaviour. |
| Phase 2 - Formulation of dynamic hypothesis | Develop maps/causal loop/influence diagrams of the relations between the factors; identify the main feedback structures; generate hypotheses explaining the behaviour in terms of the feedback processes. |
| Phase 3 - Formulation of simulation model | Generate a representation in terms of stocks and flows; estimate all necessary relationships and parameter values; develop a computer model and test for consistency. |
| Phase 4 – Testing and validation | Comparison with reference mode; robustness under extreme conditions; sensitivity to parameters; initial conditions. |
| Phase 5 – Using the model – Policy design and evaluation | Specify possible scenarios; develop alternative strategies and policies; do what-if analyses; check sensitivity and interaction of policies. |

Outline of a System Dynamics methodology (Sterman, 2000)

Annex D

Equations for the stock and flow model

Northern_Rock__liquidity_level(t) = Northern_Rock__liquidity_level(t - dt) +
(Total_net_inflow_of__deposit_funds + Inflow_of__other_funds +
Inflow_of__emergency_liquidity - Outflow_total__of_loaned_funds) * dt
INIT Northern_Rock__liquidity_level = 6505

INFLOWS:

Total_net_inflow_of__deposit_funds = if Emergency_brake__on_withdrawals > 0
then
Emergency_brake__on_withdrawals*Net_retail__deposits+Net_non__retail_deposits
else
Net_retail__deposits+Net_non__retail_deposits
Inflow_of__other_funds = Covered__bonds+Securitisation
Inflow_of__emergency_liquidity =
Amount_of_BOE__emergency_funds*Availability_of_BOE__emergency_liquidity

OUTFLOWS:

Outflow_total__of_loaned_funds =
(Buy_to_let+Commercial+Residential+Unsecured)*Lending__restrictor
Ambient_depositor__confidence = 1
Amount_of_BOE__emergency_funds = if Northern_Rock__liquidity_level <
(6505*0.75)
then
((1734+2509)/6) -Northern_Rock__liquidity_level {the expected level of deposit
income}
else
0
Availability_of_BOE__emergency_liquidity = 1
BOE_depositor__guarantee_on = 1
BOE_depositor__guarantees = if Northern_Rock__liquidity_level < (6505/0.5) and
BOE_depositor__guarantee_on
then
1
else
0
Buy_to_let = 899/6
Commercial = 91/6
Covered__bonds = (2194/6)*Normal_levels__of_wholesale_liquidity
Emergency_brake__on_withdrawals = 0
Lending__restrictor = if Northern_Rock__liquidity_level < (6505/0.5)
then
0
else
1
Net_depositor__confidence =
min(BOE_depositor__guarantees+Ambient_depositor__confidence,1)
Net_non__retail_deposits = (Net_depositor__confidence*(2509/6))
Net_retail__deposits = (Net_depositor__confidence*(1734/6))
Normal_levels__of_wholesale_liquidity = 1

Residential = 9170/6

Securitisation = (5632/6)*Normal_levels__of_wholesale_liquidity

Unsecured = 554/6

Annex E

Interface to the model

