The IMF's stress testing of the Norwegian financial sector

Jan Hagen, Arild Lund, Kjell Bjørn Nordal and Emil Steffensen[1]

Following a thorough examination of the Norwegian financial system, the IMF concluded in summer 2005 that the system is sound and well managed.[2] Shorter-term vulnerabilities are low. This conclusion is based partly on the results of stress tests of the financial system that were performed by the IMF in cooperation with Norges Bank and Kredittilsynet (The Financial Supervisory Authority of Norway). In this article we provide a more detailed description of these stress tests. We also discuss stress tests and their use more generally.

1. Introduction

The International Monetary Fund (IMF) monitors the economic policy of member countries and promotes dialogue among the countries on the national and global consequences of their economic policy. Exchange rate policy, monetary policy and fiscal policy have long held a central place in the IMF's surveillance work. However, the series of banking and financial crises in the 1990s, in both developing and industrialised countries, prompted the IMF to pay increasing attention to issues relating to financial markets and the state of the countries' financial sectors.

The financial crises of the 1990s showed that unstable financial markets could lead to substantial economic costs. Great importance was once again attached to financial stability, as it had been in the interwar years. Financial stability was moved up on the agenda in international organisations such as the IMF, the World Bank and the ECB. The increased weight attached to financial stability formed the background to the establishment of the Financial Stability Forum, in which central banks and supervisory authorities participate. Financial stability was also in focus on the national level, among central banks, supervisory authorities and ministries of finance.

In the IMF's work to prevent financial market instability through surveillance of the economic policy of member countries, special emphasis was placed on the situation in the financial sector. In addition, the IMF, in collaboration with the World Bank, established a Financial Sector Assessment Programme (FSAP) in 1999. Most IMF member countries have had an FSAP assessment of their financial sectors, including the Nordic countries: Iceland and Finland in 2001, Sweden in 2002 and Norway in 2005. Denmark's assessment will be completed in 2006. No FSAP has yet been carried out for countries like China and the US.

The purpose of an FSAP is to assess the strengths and weaknesses of member country financial sectors and to assess the challenges facing their financial systems. The IMF's primary focus is on the financial system as a whole, and not on individual institutions. All aspects of the financial system are assessed: markets, financial institutions and financial infrastructure (including payment and settlement systems). The most important sources of risk associated with the macroeconomic situation and the financial situation of households and enterprises are assessed. The resilience of financial institutions to any macroeconomic shocks is of central importance to financial stability, and stress tests play a key part in these assessments. Important structural aspects of the financial system are examined, and great emphasis is placed on an assessment of institutional factors, including responsibilities, cooperation and the framework for oversight of financial stability, regulation and supervision of the financial sector, crisis management and a safety net for the financial sector. Measures that in the view of the IMF will contribute to strengthening the financial system are recommended to the authorities.

Norway's FSAP assessment was carried out during autumn 2004 and spring 2005. Meetings were held with Norwegian authorities (the Ministry of Finance, Norges Bank and Kredittilsynet) and a number of financial institutions and trade organisations. An important part of an FSAP consists of evaluating the country's compliance with international standards for supervision and regulation of various parts of the financial sector. In Norway's case, supervision and regulation of banks, insurance and payment systems were examined. The IMF's assessment is summarised in an FSSA (Financial System Stability Assessment), which also covers Norway's compliance with these international standards. The report was published in June 2005. In addition, Financial Action Task Force (FATF) conducted an examination in January 2005 of Norway's observance of recommendations for combating money-laundering and the funding of terrorism.

The assessments of Norway were generally positive. It was concluded that "Norway's financial system appears sound, well managed and competitive and shorter-term vulnerabilities appear low overall". Recommendations were provided in various areas associated with stability, structural issues and institutional conditions (see box).

Main recommendations following the IMF FSAP assessment of Norway[1]

Key short-term stability-related issues:
- Continue carefully monitoring the evolution of household debt and the housing market; and examine whether banks have concentrations of exposures to more vulnerable sub-groups of household borrowers.
- Given the reduced risk weighting of mortgages under Basel II, carefully consider whether additional capital requirements should be required for banks under "Pillar 2".
- Continue to carefully monitor the risk of spillovers, in extreme events, resulting from the two-tier payments arrangements, and examine the scope for increasing the use of collateral in interbank market exposures.
- In the securities settlement system (VPO), ensure that measures are taken to reduce market and liquidity risk in the event of a key bank failing to settle. In addition, in the retail payments system, examine the scope for shifting more payments from NICS Retail (Norwegian Interbank Clearing System) to Norges Bank's real time gross settlement system (NBO), and/or introducing more settlement cycles in NICS Retail during the day.
- Continue working with other Nordic authorities on the evolving framework for cross-border crisis management and coordination of last resort lending; and domestically, ensure appropriately coordinated contingency plans in the unlikely event of a major problem at the largest, partly state-owned bank.
- Formalise more regular high-level meetings between Kredittilsynet, Ministry of Finance and Norges Bank on financial stability issues, and consider establishing a formal tripartite financial stability Memorandum of Understanding on respective roles and responsibilities.

Key structural and longer-term issues
- Reexamine key aspects of the deposit guarantee arrangements, including whether and how to achieve greater international comparability in coverage levels.
- Examine whether the clearing of medium and smaller interbank payments in NICS SWIFT net could be phased out.
- Review the continued desirability of state ownership in DnB NOR. In the interim, consider further entrenching commercial autonomy and accountability for the bank through clearly specifying – in law, regulation or at least in a public policy statement – the principles that will be followed with respect to the government's relationship with DnB NOR.

Refinements to supervisory arrangements and other technical recommendations
- Increase the level of powers delegated to Kredittilsynet in respect of licensing and similar authorisations, and for issuing prudential regulations and supervisory decisions; strengthen and make more explicit some aspects of the regulations relating to, e.g., connected lending, treatment of insiders and enforcement measures; and complete the development of risk management guidelines for various other types of risk.
- Formalise and publish supervisory requirements and standards for payments and securities settlement systems, and formalise monitoring, in Norges Bank's Payment System Department, of NBO's compliance with standards.
- Further strengthen Norges Bank's risk management arrangements in relation to the collateral it accepts from banks.

[1] The recommendations are published on page 6 of IMF (2005).

2. Stress tests

It is usual to conduct stress tests in connection with an FSAP. The financial crises of the last few decades have shown how important it is to be aware of the financial system's vulnerability to different types of economic disturbances, or shocks. A stress test is a method that has been developed to identify this vulnerability. *Its purpose is to estimate the effect on the result and solidity of a portfolio (for example one or more financial institutions) of extreme - but not implausible - economic shocks*. Stress tests were originally developed to gauge market risk, i.e. changes in the value of a portfolio as a result of major changes in market prices for securities or in exchange rates. They were gradually developed to identify all types of risk in a portfolio. Today stress tests are used both in individual financial institutions and, as in FSAPs, to measure the vulnerability of the financial sector as a whole.

Stress tests are also increasingly used in the authorities' oversight of financial institutions. The supervisory authorities impose increasingly stringent requirements on financial instutions to conduct quantitative tests of the risk associated with their activities. The new Basel rules on banks' capital adequacy emphasises the use of stress tests to identify their vulnerability to various extreme events (see box).

Stress tests may be designed to examine the isolated effect of an unexpected, major change in a single economic variable, or the effect of an economic shock scenario where account is also taken of the second-round effects of the original shock on the economy. Both types of tests were carried out in connection with the FSAP.

Basel II and stress testing

Basel II, which is expected to apply from 1 January 2007, introduces the use of stress testing in banks (some of the rules will not apply until 1 January 2008). In accordance with "Pillar 1", institutions that use an internal model for measuring credit risk (internal rating-based method - IRB) will be subject to a minimum capital requirement based on expected losses given a modelled economic downturn. In order to be allowed to use an IRB method, an institution must have a stress testing system that complies with certain rules, and the results of the stress testing must be integrated into the institution's ordinary reporting. The stress tests must also be included in an assessment of the institution's total capital requirements according to Pillar 2. The use of stress tests for IRB institutions is comparable to today's market risk capital requirements, according to which an institution that uses internal models must also have a stress testing programme and use the results of the testing to estimate the need for capital over and above that implied by the models.

Current regulations for insurance companies and pension funds require that the institutions regularly carry out stress testing to cover the risk of loss in the event of a slide in asset values in financial markets. The impending EEA regulations (Solvency II) will probably contain stress test requirements similar to the Basel II requirements for banks.

2.1 Norwegian authorities' use of stress tests

Both Kredittilsynet and Norges Bank have been carrying out stress tests for several years. Kredittilsynet has used a method for assessing the vulnerability of life insurance companies to adverse changes in securities market prices. Tests of institutions' vulnerability to changes in important economic variables are also used in the oversight of banks and other financial institutions. At the same time, the results of the companies' own stress tests are evaluated, including insurance companies' assessment of the effect that a fall in equity and fixed income markets would have for the value of their securities portfolios and their financial strength.

Norges Bank has presented macroeconomic stress tests in its *Financial Stability* reports. Shocks of various types have been used, but a sharp rise in interest rates and a sharp fall in asset prices have been important ingredients. The loss increase resulting from the shocks has been estimated and compared with banks' ability to absorb losses, i.e. their capital over and above the statutory minimum requirement. Norges Bank has also used stress tests to show how it may be necessary in monetary policy to strike a balance between the objective of attaining the inflation target and the objective of financial stability (see Evjen et al. 2005).

2.2 Evolution of stress tests over time

As the use of stress tests has been extended to take account of ever new risk types, both the execution of the tests and the interpretation of the results have become increasingly complex. It is relatively simple to assess the change in value of an equity portfolio as a result of a sharp fall in share prices. It is considerably more complicated to design a consistent negative macroeconomic scenario and then calculate the effect it will have on the whole financial sector, including the effects of the adjustments that financial institutions will make in response to the shock. In the next round, these adjustments will influence both the macroeconomic situation and the situation of other financial institutions. However, this is the direction in which stress tests have evolved.

3. Stress tests in the Norwegian FSAP

The stress tests looked at both the short-term effect of changes in individual factors, such as house prices, and at scenarios in which the full impact of a shock is taken into account. The individual factors usually considered are share prices, interest rates, exchange rates and property prices. In Norway, both the banks and the insurance companies in the survey were asked to estimate the impact of single-factor shocks. However, much of the work was spent on designing and conducting the scenario stress test. We will consider this first and return to the effects of individual factors.

The work in a stress test based on a macroeconomic scenario can normally be divided into the following four activities:

1. Identifying vulnerabilities in the financial system (Are there any asset price bubbles? Do any particular sectors have very high debt levels?)
2. Designing a consistent macroeconomic scenario that sheds light on the vulnerabilities.
3. Estimating the losses suffered by financial institutions as a result of the macroeconomic developments. This also entails establishing a relationship between developments in financial institutions' balance sheets or profit and loss accounts and macroeconomic variables.
4. Summarising and evaluating the results.

Steps 1 and 2 were carried out in a close collaboration between Norwegian authorities and the IMF. Step 3 was carried out partly by financial institutions and partly by Norges Bank and Kredittilsynet.

In Step 4, Norges Bank and Kredittilsynet contributed to summarising the results, but the actual assessment was carried out by the IMF. Two approaches were used: direct estimation of financial sector losses (top down approach) and an analysis based on individual institutions' own loss estimates (bottom up approach)

3.1 The macroscenarios

The vulnerability of some areas and sectors of the economy will vary both across countries and within individual countries over time. The IMF has no standard regarding the sort of vulnerability and accordingly the sort of shock whose impact they should be investigating in their FSAPs. Through their ongoing monitoring of factors with a bearing on financial stability, Norwegian authorities have a good picture of current vulnerabilities in the financial system[3]. First, system risk is primarily associated with banks, because of their dominant position, though insurance companies are also of significance, both because they are important players in securities markets and because they form substantial parts of financial conglomerates. Second, banks have little exposure to the securities market. Therefore, the credit risk associated with their lending to households and enterprises is of most importance. Third, in recent years there has been strong growth in household debt and in house prices, which has increased banks' exposure to the household sector and to housing markets.

There is a close connection between household financial developments and enterprise profitability developments. A sharp adjustment in the household sector, for example as a result of an interest rate rise, a fall in house prices or increased unemployment will reduce demand for services from the enterprise sector. When enterprises default on their loans in consequence, financial institutions incur losses. Financial institutions may also incur substantial direct losses on their loans to households. The strong growth in household debt and rise in house prices therefore means increased vulnerability for the financial system.

At the outset, four different initial shocks to the economy were considered: domestic cost shock, reduced domestic demand as a result of severely weakened confidence in the future, improved terms of trade and weakened terms of trade[4]. Scenarios with a domestic cost shock and weakened terms of trade were finally chosen.

The scenarios were developed using Norges Bank's models and the new core model (see Husebø et al. 2004). In addition to the core model, the partial relationships for household debt and house prices were used (see Jacobsen and Naug 2004a and 2004b). These relationships had no repercussions for the core model. Nor was any attempt made to estimate second round effects in the banking sector. In designing the scenarios, emphasis was placed on achieving an impact on macroeconomic variables that are important to financial stability.

The economic shocks were assumed to occur at the beginning of 2005. As it takes time for adverse economic developments to be reflected in loan losses, a horizon of 3 years was used. Projections from Norges Bank's *Inflation Report* 3/04 were used as a baseline scenario.

The scenarios are described in detail in a separate box.

3.2 Direct estimation of overall losses (top down)

The approach used in direct assessment of losses is described in Frøyland and Larsen (2001) and Evjen et al. (2005). The main points of the method are as follows: The point of departure for the calculations is a macroeconomic scenario defined by a number of key economic variables such as unemployment, interest rate, GDP growth etc. (see Chart 1).

Chart 1. Schematic overview of the method for direct estimation of bank losses
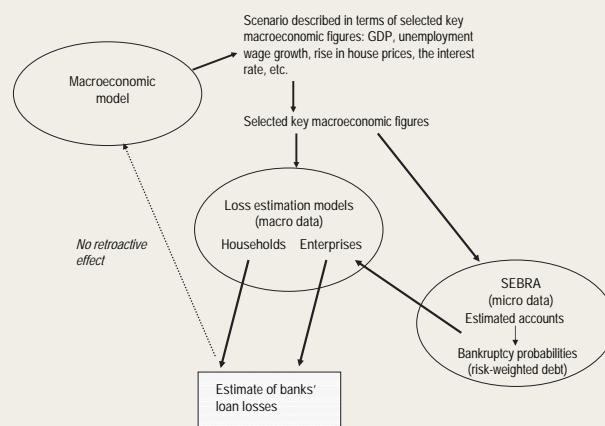
For the household sector, variables from the macroeconomic scenario are applied directly. The equation for assessing losses in the household sector is (t-values for coefficients in brackets):

$$\tag{1}$$

$$lossrel_t = \begin{array}{l} 1.5 \\ (0.5) \end{array} \quad \begin{array}{l} + 3.6\ dburd_t \\ (4.4) \end{array} \quad \begin{array}{l} - 1.7\ rhous_t \\ (-4.2) \end{array}$$

$$\begin{array}{l} + 10.4\ R_t \\ (3.2) \end{array} \quad \begin{array}{l} + 28.6\ UMP_t \\ (4.0) \end{array} \quad \begin{array}{l} - 7.1\ DUM97 \\ (-21.4) \end{array}$$

The equation is based on data for the period 1978-2003. Losses relative to debt (*lossrel*) increase with increasing debt burden (*dburd*), falling housing wealth (*rhous*), increasing interest rate (*R*) and increasing unemployment (*UMP*). The equation also includes a dummy variable that is equal to 1 for 1997 and 0 otherwise (*DUM97*). This dummy variable is included to correct for especially low losses in 1997. Small letters indicate that the logarithm of the variable is being used.

For the enterprise sector, figures for mainland GDP growth, wage growth, debt growth and interest rate

---

[3] In Norway, systematic work on oversight of financial stability started in the mid-1990s. Today, systematic assessments of financial stability are published by Norges Bank in the semi-annual publication *Financial Stability* (www.norges-bank.no/english/publications/) and by Kredittilsynet in the annual report The Financial Market in Norway (www.kredittilsynet.no), while the Ministry of Finance assesses financial stability in the Credit Report (www.odin.dep.no/fin/norsk/dok/regpubl/stmeld/bn.html - Norwegian text). In addition, Kredittilsynet publishes quarterly analyses of financial institutions' accounts.

[4] Terms of trade is the ratio between export and import prices.

Summary of the macroeconomic scenarios[1]

Baseline scenario

The baseline scenario is based on *Inflation Report* 3/04 from Norges Bank and represents a modelled path for the development of the Norwegian economy in the absence of macroeconomic disturbances.

Table A. Baseline scenario. Percentage change on previous year unless otherwise specified

	2004	2005	2006	2007
GPD, real value	2.7	3.2	2.8	2.0
Household consumption, real value	5.0	4.6	3.9	2.6
Unemployment level. Per cent	4.4	4.1	3.8	3.8
Consumer prices[1]	0.3	1.4	1.7	2.2
Interest rate (level)[2]	2.0	2.3	3.2	4.0
House prices	11.6	3.5	1.9	3.1

[1] Adjusted for tax changes and excluding energy products.
[2] 3-month nominal money market rate.

Scenario 1: Domestic cost shock

Background: Domestic inflation rises as a result of higher domestic labour costs. The central bank responds by increasing the interest rate by 5 percentage points in the course of 2005 and 2006. This dampens the rise in inflation.

The rise in interest rates causes the Norwegian krone to appreciate. This, coupled with the higher costs, reduces the competitiveness of Norwegian manufacturers. The consequence is a decline in domestic production, continued weak investment developments and a rise in unemployment. Households' financial situation deteriorates as a result of both higher unemployment and higher interest rates. This cools down the housing market, and house prices fall. Prices for commercial property follow the same trend as house prices.

Table B. Scenario 1. Percentage change on previous year unless otherwise specified. Deviation from the baseline scenario in percentage points in brackets[1]

	2005		2006		2007	
GPD, real value	2.4	(-0.8)	1.6	(-1.2)	1.9	(-0.1)
Household consumption, real value	2.9	(-1.7)	0.6	(-3.3)	0.0	(-2.6)
Unemployment level. Per cent	4.5	(0.4)	4.9	(1.1)	5.0	(1.2)
Consumer prices[2]	1.8	(0.4)	2.2	(0.5)	2.7	(0.5)
Interest rate (level)[3]	5.3	(3.0)	6.9	(3.7)	6.2	(2.2)
House prices	-6.7	(-10.2)	-6.4	(-8.3)	2.8	(-0.3)

[1] The baseline scenario is specified above.
[2] Adjusted for tax changes and excluding energy products.
[3] 3-month nominal money market rate.

Scenario 2: Depreciation of the Norwegian krone as a result of the fall in oil prices

Background: As a result of a substantial increase in the global oil supply, oil prices are halved and remain at a low level for a long time. The Norwegian krone depreciates and prices on the Oslo Stock Exchange slide. Prices for imported goods increase, and the central bank raises the interest rate to counteract the higher inflation pressures. This dampens the depreciation, but NOK has still depreciated by about 20 per cent in relation to other currencies.

Despite the fact that the depreciation improves the competitiveness of Norwegian internationally exposed enterprises, the fall in oil and equity prices makes both households and enterprises more pessimistic. Both consumption and investment fall in consequence, and the market for homes and commercial property cools appreciably. Again, prices for commercial property are assumed to follow the same trend as house prices.

Table C. Scenario 2. Percentage change on previous year unless otherwise specified. Deviation from the baseline scenario in percentage points in brackets[1]

	2005		2006		2007	
GPD, real value	-0.3	(-3.5)	-0.7	(-3.5)	2.4	(0.4)
Household consumption, real value	0.4	(-4.2)	-2.6	(-6.5)	-2.2	(-4.8)
Unemployment level. Per cent	6.0	(1.9)	7.7	(3.9)	7.8	(4.0)
Consumer prices[2]	1.8	(0.4)	2.8	(1.1)	2.5	(0.3)
Interest rate (level)[3]	7.3	(5.0)	5.4	(2.2)	3.1	(-0.9)
House prices	-20.2	(-23.7)	-14.7	(-16.6)	-2.1	(-5.2)

[1] The baseline scenario is specified above.
[2] Adjusted for tax changes and excluding energy products.
[3] 3-month nominal money market rate.

[1] More details are provided in Jacobsen, Berge and Lindquist (2005).

developments are used to estimate the future profit/loss and balance sheet developments of limited companies. This is done for each company in Norges Bank's accounts database, which contains the accounts of limited companies in Norway. On the basis of the projected profit and loss accounts, bankruptcy probabilities are then calculated for the companies using the SEBRA bankruptcy prediction model. This model is described in more detail in Bernhardsen (2001) and in Eklund, Larsen and Bernhardsen (2001). The debt of each company is then multiplied by the associated bankruptcy probability to find "risk-weighted debt". The aggregate risk-weighted debt expresses expected losses to financial institutions due to bankruptcy if the whole amount owed by the enterprises affected is lost (loss given default is 100 per cent). Risk-weighted debt for all limited companies is included in the loss equation together with a variable that reflects changes in asset values. The loss equation for the enterprises is:

$$(2)$$

$$loss_t = \begin{array}{cccc} -28.5 & +4.4 rwd_{t-1} & -6.2 \Delta rph_t & -2.5 DUM95 \\ (-6.8) & (8.6) & (-6.2) & (-5.9) \end{array}$$

Financial sector losses on loans to the enterprise sector (*loss*) increase with risk-weighted debt (*rwd*) and falling asset prices (Δrph). The last variable is closely related to the collateral posted for the amounts borrowed. Note that falling asset prices have an immediate effect on losses, whereas a rise in risk-weighted debt affects losses with a time lag of one year.

3.3 Institutions' assessments (bottom up)

The eight largest banks in Norway estimated the loan losses that would arise in each of the two macroscenarios. The specified variables in the scenarios do not provide a foundation for direct calculation of losses, but together they provide a description of developments that will impact banks through a deterioration in credit quality and ensuing losses in the lending portfolio. The losses are calculated by means of internal models such as credit management models, regression analyses of historical losses and/or qualitative assessments. Banks' estimates of the macroscenarios show the effect on loan losses and thus describe only banks' credit risk.

Regression analyses of historical losses may yield distorted estimates if the credit quality of the current lending portfolio is different from the quality during the regression period. A number of banks point out that improved credit management has resulted in portfolios today having a higher credit quality than in the past, and that estimates based on historical losses therefore overestimate future losses. Some banks, but not all, corrected for this by making qualitative downward revisions to estimated expected losses.

None of the banks have used models that include all variables in the scenarios. The variables unemployment and private consumption have proved particularly difficult to include in the models. The results of the individual banks are therefore based on simplified assumptions, differing choices of method and qualitative assessments. This makes it somewhat difficult to compare the results of individual banks.

3.4 Scenario results

Table 1 presents the estimated effect of the macroeconomic scenarios on the capital adequacy of Norwegian banks. The loss estimates of the two methods have been scaled up in the table so that the figures may be compared.[5] The table shows the capital adequacy of Norwegian banks assuming no change in any variable other than losses. Therefore, expected profits (pre-loss) are not taken into account and the listed capital adequacy (especially at the three-year horizon) is therefore lower than what might be expected if the scenarios should actually occur.

As expected, the effect of cumulative losses at the three-year horizon is considerably larger than at the one-year horizon. This is a reflection of period lengths but also of the time it takes before adverse economic developments result in considerable loan losses. On the whole, capital adequacy is above the statutory minimum requirement of 8 per cent in both scenarios.

Scenario 2 involves a more negative economic development than scenario 1 and therefore also results in higher loan losses and lower capital adequacy than scenario 1. In scenario 2, GDP growth is negative in the first two years. The interest rate is also high in the first year. In addition, asset values fall during the entire period. This fall is especially sharp during the first two years. Unemployment rises sharply to just below 8 per cent. All of this contributes to a sharp increase in losses. With the direct calculation for scenario 2, losses on loans to the household sector are higher than losses on loans to the enterprise sector (the household sector accounts for roughly 55 per cent of losses). The increase in losses on loans to households is primarily a result of the rise in unemployment and the fall in house prices. Losses on loans to enterprises increase first as a result of a fall in asset values, i.e. collateral for loans deteriorates. After that, a higher risk of bankruptcy and default contributes to a substantial increase in risk-weighted debt.

In scenario 1, GDP growth is positive for all years, even though growth is lower than in the baseline scenario. Therefore, increased losses are primarily a result of a fall in asset values and higher interest rates. The directly calculated losses show that the enterprise sector accounts for the largest share of losses (approximately 55 per cent). Again it is the fall in asset values that first contributes to higher losses. In the next two years, it is an increase in risk-weighted debt that contributes to a high

[5] The eight banks represent 65 per cent of total assets in the banking sector. Total loss estimates for these banks have therefore been scaled up by a factor of 1/0.65. Using the direct method, losses in the banking sector only are estimated at 65 per cent of losses on loans to the household sector and 70.5 per cent of losses on loans to the enterprise sector. Using the direct method, the equation that determines financial institutions' losses on loans to the household sector is calculated on the data for the period 1978-2003. In the period 1978-2002, banks' losses accounted for 65 per cent of total losses. Financial institutions' losses on loans to the enterprise sector were calculated on data for the period 1989-2003. In the period 1989-2002, banks' losses accounted for 70.5 per cent of total losses on loans to the enterprise sector.

loss level. In the household sector, higher interest rates and a higher debt burden are the first factors that contribute to higher losses. The high loss level is subsequently sustained by increased unemployment.

Banks did not report losses by household and enterprise sector. However, they did report that scenario 2 results in heavier losses in the enterprise sector than scenario 1. More specifically, losses increase in the sheltered sector as a result of a decline in private consumption. Banks reported, however, that the effect on the exposed sector is dampened by an exchange rate that is lower in scenario 2 than in scenario 1. According to banks, in scenario 2 loan losses occur in the household market as a result of high unemployment and a substantial fall in house prices, whereas in scenario 1, losses occur in the household market due to a persistently high interest rate level.

The developments described by scenario 2 resemble developments during the banking crisis. In both periods, GDP fell. House prices fall more in scenario 2 than they did during the banking crisis, and the real interest rate increases and is high in both periods. Nevertheless, the increase in losses and thus the decline in capital adequacy are considerably less pronounced in scenario 2 than during the banking crisis. One reason for this is that the share of bank lending to the household market has increased from 45 per cent to nearly 60 per cent of total credit. Bank losses on loans to the household market averaged 1.3 per cent annually in the period 1990-1992 as a whole, while the figure for the corporate market was 5.3 per cent. On the other hand, we cannot rule out that the most exposed households are currently more vulnerable to the shocks mentioned here than they were during the banking crisis. The SEBRA model, which is used in the direct calculation of losses, shows that the probability of bankruptcy in enterprises is clearly lower than before the banking crisis. This is partly due to favourable profitability developments in recent years with a similar increase in buffers in the form of equity in enterprises. Consequently, losses in the enterprise sector are lower than during the banking crisis.

Five to six years elapsed between the cyclical peak in 1986 and the culmination of the banking crisis in 1991-1992. If adverse developments persist over a sufficiently long period, any financial system will experience problems irrespective of how solid it was at the outset. A three-year horizon is not always long enough to assess the overall negative effects of a shock. On the other hand, a stress period that is longer than three years would be difficult to model. It is difficult to take into account financial institutions' adjustments when loss levels rise. For example, lending policies may change, institutions may merge and new capital may be raised to boost the institutions' financial strength. All of this must be taken into account when assessing the size of calculated losses.

We have no basis for commenting in advance on which of the two calculation methods will generate the highest losses. Losses estimated in the top down approach are based on models estimated on historical data. Due to an improvement in banks' risk management and internal control in recent years, the models may have overestimated losses. This suggests that the losses may be too high with a direct calculation. On the other hand, it is possible that banks have underestimated the indirect effects of large macroeconomic adjustments. Indirect effects are, for example, changes in unemployment which coincide with changes in asset prices and interest rates.

Both methods give the highest calculated losses and lowest capital adequacy in scenario 2. For scenario 1, losses differ only slightly when calculated by the two methods. At the end of the three-year period, capital adequacy based on banks' estimates is 0.4 percentage point lower than when the direct method is used. The differences for the two methods are somewhat more pronounced for scenario 2. After three years, capital adequacy based on direct calculations is 1.1 percentage point lower than capital adequacy based on bank's calculations.

There was a spread between banks' calculated losses. At the three-year horizon, calculated capital adequacy varied from 5 to 11 per cent. A specific macroeconomic shock will affect the individual financial institutions differently. The effect will depend on a number of factors: the type of macroeconomic shock, the institutions' exposures, the quality of risk management and not least the institutions' initial capital adequacy. The IMF places emphasis on the financial system and not the individual insti-

tutions in its FSAPs. Stress tests such as the ones performed during the FSAPs for Norway do not take into account the spillover effects to other institutions of problems with financial strength or liquidity in individual institutions.

3.5 Effect of changes in individual factors

The eight banks have also conducted sensitivity analyses of the effect of immediate and unconnected changes in individual factors. The factors mainly describe market risk and show how, for example, changes in equity prices and the interest rate level affect the value of banks' assets, debt items and off-balance sheet items. The exception is the analysis of changes in house prices, which reflect credit risk. Here, banks have estimated loan losses using credit assessment models and/or qualitative assessments.

Table 2 shows the assumptions underlying the sensitivity analyses and the results of these. The results show the effect on overall capital adequacy. The figures have been scaled up to cover the banking sector as a whole in the same manner as in Table 1.

Table 2. Immediate effect on banks' capital adequacy in the event of a change in individual factors

Capital adequacy in per cent

Changes in individual factors	Capital adequacy
Starting point (30.09.2004)	11.8
Yield level, parallel shift + 5 percentage points	11.6
Yield level, parallel shift -1 percentage points	11.9
Equity prices + 40 per cent	11.9
Equity prices -40 per cent	11.8
Exchange rate NOK + 20 per cent	11.8
Exchange rate NOK -20 per cent	11.8
House prices – 25 per cent (credit risk)	11.7

The table shows that market risk has relatively limited implications for banks. The effect is most pronounced when there is a parallel positive shift in the yield curve of 5 percentage points and the value of bond holdings and holdings of other interest-bearing securities declines. The effects are also minimal here, however, due in part to hedging instruments and the predominance of variable interest rates on bank lending. Banks have estimated relatively low loan losses in the event of an isolated 25 per cent decline in house prices. The effect is limited because banks have not taken into account changes in other variables that will probably coincide with falling house prices. Scenario stress tests are an effective means of shedding light on these factors.

3.6 Stress tests of insurance companies

For banks, the main risk of loss is associated with generally unfavourable economic developments with resultant loan losses, as described in the two macroeconomic scenarios. The situation is different for insurance companies. Lending represents a small share of insurance companies' total assets (currently less than 4 per cent for life insurance and less than 2 per cent for non-life insurance), and credit risk is of relatively limited importance compared with market risk. Insurance companies are also exposed to insurance risk, i.e. the risk that current premiums and provisions are inadequate to cover future claims and related costs.

The three largest life insurance companies (market share of 86 per cent of Norwegian companies) and the three largest non-life insurance companies (market share of 61 per cent of Norwegian companies) have performed sensitivity analyses of immediate and separate changes in individual factors. The analyses are generally based on the same assumptions as for banks. One exception is the assumption that property prices, and not house prices, will decline by 25 per cent. Insurance companies have considerable investments in commercial properties and will experience a direct loss in value if prices for these properties fall.

Sensitivity to insurance risk has also been calculated for insurance companies. Life insurance companies have estimated the effect of an immediate 50 per cent increase in provisions for future disability pensions. Non-life insurance companies have calculated the effect of a general 15 per cent increase in provisions for outstanding claims combined with a further 20 per cent increase in workers' compensation and motor liability insurance. These two sectors are long-tailed, i.e. claims are often set a long time after the premiums have been paid in, and are therefore often exposed to higher risk than other sectors.

Table 3 shows the results of the sensitivity analyses for the insurance companies in the survey. The table shows the average effect on solvency margin capital as a per cent of the solvency margin capital requirement.[6]

The table shows that a 40 per cent fall in equity prices will have the largest negative effect for life insurance companies. A positive parallel shift in the yield curve of 5 percentage points also weakens considerably the solvency margin in life insurance companies. For non-life insurance companies, an increase in technical provisions as specified above will have the largest impact.

In contrast to banks, insurance companies would incur considerable losses in the event of pronounced and immediate changes in financial markets. If such major changes occur over time, companies will probably try to gradually reduce their exposure through the disposal of securities and property portfolios so that overall losses are lower than the results indicated here.

---

[6] Norwegian insurance companies are subject to the EU's solvency margin rules. The solvency margin requirements are calculated on the basis of the insurance fund in life insurance and premium and claims costs for non-life insurance. Solvency margin capital consists of own capital and other solvency margin capital (including 50 per cent of supplementary provisions in life insurance and parts of the fluctuation provisions in non-life insurance).

Table 3. Immediate effect on banks' capital adequacy in the event of a change in individual factors. Change as a percentage of minimum requirement

Changes in individual factors	Change in solvency margin capital	
	Life insurance	Non-life insurance
Starting point[1] (30.09.2004)	158	339
Yield level, parallel shift + 5 percentage points	-65	-27
Yield level, parallel shift -1 percentage point	13	6
Equity prices + 40 per cent	128	29
Equity prices - 40 per cent	-119	-25
Exchange rate NOK + 20 per cent	-5	0
Exchange rate NOK - 20 per cent	5	0
Property prices - 25 per cent	-45	-16
Increased provisions (see specification in the text)	-42	-95

[1] With a value of 100, the capital will match the minimum requirement.

4. Summary and possible further extensions

Stress testing of financial institutions' robustness to macroeconomic shocks is an important tool both for the institutions themselves and in connection with the authorities' oversight of financial stability. Stress tests of the Norwegian financial system conducted by the Norwegian authorities in cooperation with the IMF showed that the banking sector as a whole could withstand the consequences of a reduction in the quality of loan portfolios resulting from relatively substantial changes in key macroeconomic variables. Whereas market risk is of less importance for Norwegian banks, it is a substantial risk factor for insurance companies. Stress tests showed that a sharp fall in equity prices would substantially reduce solvency margins and buffer capital in life insurance companies, whereas non-life insurance companies were most vulnerable in the event of considerable changes in their technical provisions.

Results from the stress tests showed that the risk of stability problems in the Norwegian financial system is limited in the near term. Losses were calculated on the basis of macroeconomic scenarios that were extreme but still plausible and that touch on potential vulnerabilities in the financial system. If such vulnerabilities increase further before a shock occurs, the losses may be more substantial than calculated here. For example, if house prices and the debt burden climb to a very high level, a decline in house prices may be augmented if households and banks are forced to sell at the same time as there is a clear reversal of expectations concerning future price developments.

Different kinds of stress tests have been used by financial institutions and public authorities for a long time, but they have been used to test market risk more frequently than credit risk. Using stress tests to assess the robustness of the financial system has become more common in recent years. This has been encouraged in part by the IMFs use of such tests in their FSAPs. Stress testing is undoubtedly an important tool, but there are still a number of weaknesses. It is difficult to take into account the correlation between different types of risk, such as market risk and credit risk, and it can be difficult to calibrate the various types of shock. Nor is it satisfactory to add up the risk in individual institutions to get a picture of the systemic risk that can arise or be augmented through exposures across institutions. In financial conglomerates in particular, stress tests must take into account the correlation between the various types of risk faced by the conglomerate. Macroeconomic stress tests often have a horizon of one to three years. Even a three-year horizon may be too short to analyse the full effects of major economic disturbances. A significant weakness of most stress tests is that they do not take into account the institutions' adjustments and collective effects on markets and the economy. In addition, there may often be uncertainty attached to the parameters in the macroeconomic models. One should be aware of all of these factors when assessing the results of the FSAP for Norway.

Stress tests are also an important tool for Norges Bank and Kredittilsynet in their monitoring of financial stability. Institutions' own stress tests are part of the supervision of individual institutions. In addition, they provide valuable information about the vulnerability of the financial system. The use of macroeconomic stress tests based on extreme but plausible macroeconomic shocks, explained at both the aggregate and institutional level, will continue. Experience has shown that financial instability is often triggered by unexpected, negative macroeconomic shocks which take root through effects on the most vulnerable households, enterprises and financial institutions. In Norway, micro data for enterprises, households and individual financial institutions are readily available, and it will be a challenge to assess the contagion effects associated with macroeconomic stress scenarios.

References

Bernhardsen, Eivind (2001): "A model of bankruptcy prediction". Working Paper 2001/10, Norges Bank.

Eklund, Trond, Kai Larsen and Eivind Bernhardsen (2001): "Model for analysing credit risk in the enterprise sector". *Economic Bulletin* 3/01, pp. 99-106.

Evjen, Snorre, Arild J. Lund, Kjersti Haare Morka, Kjell Bjørn Nordal and Ingvild Svendsen (2005): "Monetary and financial stability in Norway: what can

we learn from macroeconomic stress tests?". BIS Papers No. 22 - Investigating the relationship between the financial and real economy, pp. 409-430.

Frøyland, Espen and Kai Larsen (2001): "How vulnerable are financial institutions to macroeconomic changes? An analysis based on stress testing". *Economic Bulletin* 3/02, pp. 92-97.

Husebø, Tore Anders, Sharon McCaw, Kjetil Olsen and Øistein Røisland (2004): "A small calibrated macromodel to support inflation targeting at Norges Bank". Staff Memo 2004/3, Norges Bank.

IMF (2005): "Norway: Financial system stability assessment, including reports on the observance of standards and codes on the following topics: Banking supervision, insurance regulation and payment systems". *IMF Country Report* 05/200, June 2005.

Jacobsen, Dag Henning and Bjørn E. Naug (2004a): "What influences the growth of household debt?" *Economic Bulletin* 3/04, pp. 103-111.

Jacobsen, Dag Henning and Bjørn E. Naug (2004b): "What drives house prices?" *Economic Bulletin* no. 1/2005, pp. 29-41.

Jacobsen, Dag Henning, Tor Oddvar Berge and Kjersti-Gro Lindquist (2005): "Stress test scenarios for Norway", unpublished VPM Notat No. 03/2005, Norges Bank.

Jones, Matthew T., Paul Hilbers and Graham Slack (2004): "Stress testing financial systems: What to do when the governor calls". IMF Working Paper 04/127.

Sorge, Marco (2004): "Stress testing financial systems: an overview of current methodologies". BIS Working Papers No. 165.

211