Monetary and financial stability in Norway: what can we learn from macroeconomic stress tests?

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1. Introduction

Over the past few years, the discussion among academics and central bankers about the relationship between monetary and financial stability has intensified. The discussion has particularly focused on whether inflation targeting is consistent with financial stability, and if an inflation targeting regime contributes to financial stability. Furthermore, is there a conflict between monetary and financial stability, and if so, in what situations do such conflicts typically occur?[2]

The traditional view has been that a monetary policy regime preserving low and stable inflation tends to facilitate financial stability. Low and stable inflation provides households and enterprises with a clear indication of changes in relative prices, thereby making it easier for economic agents to make the correct decisions. Low and stable consumer price inflation also contributes to price stability in financial and property markets. An unexpected decline in inflation increases the real value of outstanding debt, making defaults more likely. Furthermore, the vulnerability of the financial system tends to rise when inflation is high, particularly if monetary policy needs to be tightened significantly to reduce inflation or restore economic stability. Hence, the traditional view has been that low and stable inflation provides a sound foundation for financial stability and that the two objectives normally underpin each other.

However, financial imbalances can build up in a low-inflation environment. This relates to the fact that high credibility in the policymakers' commitment to price stability, or stable inflation expectations, may enhance price rigidity at the mean level. As a result, overall inflation may be under control even in a macroeconomic environment with high and increasing demand, and where demand pressure results in higher asset prices and credit growth. The same may ensue from supply side developments putting downward pressure on prices.

It has therefore been argued that inflation targeters should more explicitly consider developments in financial variables such as equity and bond prices, credit and property prices when setting interest rates. Some argue that central banks' key interest rates should also respond to these variables in situations where inflation pressures seem to be under control.

Financial imbalances may build up in a low-inflation environment without threatening the inflation target in the short to medium term. However, these imbalances may be a threat to nominal stability in the somewhat longer run when a burst of the bubble could imply strong deflationary pressure and bring inflation below target. Consequently, it has been argued that monetary policy in some situations should adopt a somewhat longer policy horizon allowing inflation to undershoot the target for some time in order to dampen credit growth and the rise in asset prices and thus reduce the risk of a burst of the bubble which may threaten an even more substantial undershoot of the inflation target in the future. The build-up of financial imbalances may also constrain the use of monetary policy. High levels of debt and overvalued asset prices may prevent the central bank from taking adequate steps because of the risk of turmoil in the financial sector.

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[2] See for instance Bernanke and Gertler (1999), Borio and Lowe (2002), Cecchetti et al (2000) and Borio et al (2003).

The costs to society associated with a crisis in the financial system can be large. But keeping inflation below the target for a certain period also involves costs. In some cases, substantial increases in interest rates may be required in order to curb the build-up of financial imbalances. Unemployment may rise, inflation expectations may fall below target and central bank credibility may be jeopardised. Furthermore, not all situations involving a build-up of financial imbalances result in financial crisis. We therefore need good indicators to show whether financial imbalances are emerging and the danger they impose on the macroeconomic balance. Some promising steps have been taken in this field.[3]

The aim of this paper is (1) to investigate the effects on financial institutions' losses of different monetary responses to supply and demand side shocks and discuss how stress tests may assist in monetary policymaking, and (2) to present the model used to conduct the stress tests.

The paper is organised as follows: we first discuss important characteristics of macroeconomic stress tests. In Section 3, we present the methodology, ie how the stress tests are implemented. In Section 4, the results of the stress tests are presented and discussed. The major findings are discussed in Section 5.

2. Macroeconomic stress tests of the Norwegian financial sector

In essence, a stress test is a what-if analysis. What-if analyses are undertaken to gain an insight into the mechanisms of the economy by analysing the effects of certain shocks to the economy. In this paper we focus on shocks in demand and wage growth and study the impact on banks' loan losses of different monetary policy responses. This may be viewed as a post-shock analysis. The results from these analyses are particularly relevant to monetary policymaking in an ex ante perspective if they give insight into how today's monetary policy decision influences the probability and nature of future instability in the financial sector.

Financial stability is often defined as the absence of financial instability. Financial instability is typically characterised by large and abrupt changes in property prices and securities markets and by financial institutions or financial markets that do not function adequately. Disturbances occur in the credit supply or in the flow of capital. In most cases, this will have consequences for output, employment and inflation.

Increases in banks' provisioning for bad debt may be used as an indicator of the degree of financial stability. This indicator typically summarises the financial situation for both households and enterprises and their implications for the financial sector. The macroeconomic environment is crucial for the debt servicing capacity of households and enterprises and for the level of prices of those assets which often serve as collateral. Macroeconomic shocks have an impact on these variables and hence on banks' loan loss provisioning.

We apply macroeconomic stress testing to illustrate the financial sector's robustness to adverse macroeconomic shocks and to analyse whether a monetary policy reaction to the same shocks will mitigate or amplify banks' credit losses. The stress test approach in Norges Bank is model based. Output from a macroeconomic model - the RIMINI model of Norges Bank[4] - is used as input when forecasting loss provisioning. Losses are forecast separately for the household sector and the corporate sector. For the corporate sector, a micro model, based on firms' accounts, is used. Combining predicted bankruptcy probabilities with information about each firm's bank loans and general property prices as a proxy for the value of the collateral enables us to compute expected bank losses at an aggregate level. The variation in risk structure across lenders is explicitly taken into account. For the household sector, we use a single loan loss function where loan losses depend on the initial debt to income ratio, the level of interest rates and the unemployment rate. The methodology is described in Section 3.

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[3] See Borio and Lowe (2002).

[4] See Eitrheim and Gulbrandsen (2001) and Olsen and Wulfsberg (2001) for an overview of key aspects of the model.

We consider both a demand and a supply shock. The demand shock stems from a sudden drop in public spending, while a strong rise in wage costs is the source of the supply side shock. We model the shocks with and without a monetary policy response. For simplicity, we chose to model the monetary response by a standard Taylor rule.[5] According to the Taylor rule, the interest rate is set as a function of the neutral long-term rate of interest, excess production (the output gap) and excess inflation (the inflation gap). In a situation where inflation is on target and the output gap is zero, the Taylor rule interest rate will be equal to the neutral nominal interest rate (the neutral real interest rate plus the inflation target); see Taylor (1993). We have applied a backward-looking Taylor rule, which normally gives a somewhat slower monetary policy reaction than forward-looking rules.[6] The scenarios with a Taylor rule response are compared with scenarios without a monetary policy reaction (ie monetary policy as in the reference scenario). Few, if any, inflation targeting central banks follow a Taylor rule. However, a Taylor rule has in many cases proved to be useful as an empirical description of an inflation targeting regime.

Stress tests at two different points in time

The initial situation for enterprises and households is important. For the individual households and enterprises, their ability to service their loan is a result of both the general economic situation and individual characteristics.

We have stress-tested the economy at two different points in time, in 1996 and 2001. The purpose is to see how different economic conditions influence the impact of the shocks. In particular, we are interested in situations with different levels of indebtedness and different levels of asset prices. The vulnerability of the household sector to increases in the unemployment rate depends positively on the initial debt burden and how debt is dispersed among different groups of households. In general, a firm's bankruptcy probability, given a drop in new orders, depends on operating income and expenses, own funds, debt structure and other individual characteristics.

In 1996, the macroeconomic environment in Norway was relatively balanced. Around three years of growth above trend had closed a negative output gap. Inflation seemed to be under control. Norwegian enterprises had gradually built up their capital reserves. The level of debt and asset prices was low. The banking crisis was over. We would have expected the financial system to be quite robust if faced with a negative shock to the economy.

The latest observation in the dataset of Norwegian enterprises' accounts is 2001. The situation for enterprises and households that year is comparable to their financial situation today, although the macro fundamentals and corporate key variables have changed negatively from 2001 to 2003. In 2001, capacity utilisation in the Norwegian economy was very high after several years of high growth. The financial situation of the corporate sector was still very sound, but the indebtedness of firms had increased compared to 1996. Also the indebtedness of the household sector had increased, but to a lesser extent. House prices had risen considerably. See Table 1 for a summary of key variables in 1996 and 2001.

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[5] The Taylor-rule applied: $i_t = i^* + 1.5 \cdot (\pi_t - \pi^*) + 0.5 \cdot y_t$. y_t is output gap at time *t*, *i* is the nominal interest rate, π is inflation, π^* is the inflation target and *i** the neutral real interest rate.

[6] It should be noted that assuming a Taylor rule is completely different from actual monetary policy in Norway in the 1990s. In the 1990s monetary policy aimed at stabilising the exchange rate. Since March 2001, the government has defined an inflation target for monetary policy in Norway. The operational objective is an inflation rate of 2½% over time. See www.norges-bank.no for more information about Norwegian monetary policy.

Table 1

Summary of key variables describing the state of the Norwegian economy and the corporate and financial sectors in 1996 and 2001

Per cent

	1996	2001
Macroeconomics		
GDP growth (mainland economy)	4.2	1.7
Output gap	0	2
Unemployment rate (registered)	4.2	2.7
Annual wage growth	4.4	5.8
CPI inflation	1.2	3.0
Households		
Credit growth	4.8	10.4
House prices, annual rise	9.1	7.3
Interest rate on loans	7.2	8.9
Annual real disposable income growth	3.4	0.5
Saving ratio	2.3	4.0
Enterprises[1]		
Return on capital	9.1	6.3
Return on equity	20.0	7.3
Interest paid/debt	4.3	5.8
Equity ratio	30.7	34.3
Growth in bank debt	1.3	2.9
Banks[2]		
Return on equity	17.5	12.0
Non-performing loans/gross loans	3.0	1.3
Equity/total capital	6.5	6.5
Tier 1 and 2 capital/risk-weighted assets	12.9	12.6
Tier 1 capital/risk-weighted assets	9.9	9.7

[1] Information based on accounts for all joint stock companies. [2] The numbers apply to Norwegian banks. Norwegian banks' branches abroad are not included.

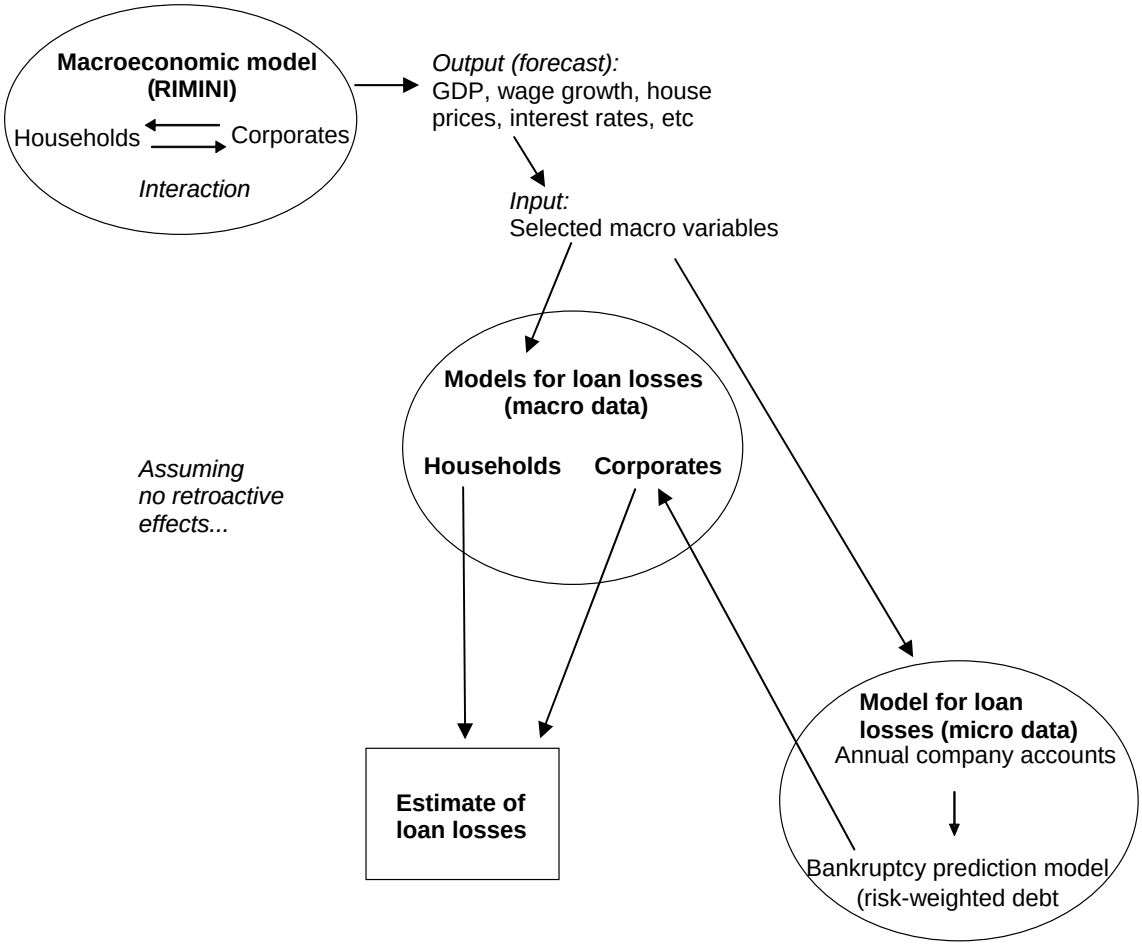
Sources: Norges Bank; Statistics Norway.

3. The methodology used to estimate loan losses

Estimation of losses on loans to both the household and corporate sectors is based on macroeconomic variables such as GDP growth, wage growth, interest rates and changes in house prices; see Figure 1. The macroeconomic variables reflect the interaction between firms and households as both sectors are included in the macroeconomic model RIMINI. There is, however, no feedback from estimated bank losses to the macroeconomic scenario.

Figure 1

Outline of methodology used to calculate loan losses



For a lender, the *expected* loss on a portfolio of loans is the product of the probability of default or bankruptcy, the borrower's outstanding debt and the level of loss in the event of default or bankruptcy.[7] The probability of bankruptcy, debt and loss-given-default is a function of both macroeconomic developments and microeconomic conditions associated with the individual borrower. To analyse loan losses, all these factors should be assessed.

Losses are estimated separately for the household and corporate sectors. These sectors have specific risk characteristics and they are treated as different segments by financial institutions.

[7] Expected loss is computed as $\sum_{i=1}^{n} p_t^{(i)} D_t^{(i)} LGD_t^{(i)}$, where $p_t^{(i)}$ is the probability of borrower *i* defaulting or going bankrupt, $D_t^{(i)}$ is borrower *i*'s debt and $LGD_t^{(i)}$ is the level of loss-given-default or bankruptcy at a point in time, *t*. By aggregating the figures for all borrowers, we obtain an estimate of the overall expected loan loss in the economy.

Household sector

The model for financial institutions' provisioning for bad debt in the household sector is solely based on macroeconomic variables. The equation for losses in per cent of outstanding debt, *LOSSREL*, is given by

$$lossrel_t = 3.31dburd_t - 1.45rhous_t + 13.55R_t + 31.55UMP_t - 7.05DUM97_t \quad (1)$$

where *dburd* is the debt burden measured as debt in per cent of disposable income, *rhous* is the real value of private houses, *R* is the interest rate, and *UMP* is the unemployment rate. The use of lower case letters indicates that the variables are in logarithmic form. Equation (1) is estimated on actual losses for the time period 1978-2001. For the model summary, see Appendix 1.

The partial effects of the variables on provisioning are intuitive. An increase in the debt burden, higher unemployment and higher interest rates increase financial institutions' losses. Losses may also increase as a result of reduced values of private houses, which result in lower values of collateral.

This analysis does not reflect the fact that households are a heterogeneous group. Debt burden, for example, varies widely across income deciles in the household sector and has developed differently over time. This implies that changes in interest rates may have a very different effect on households in different income deciles. In a more micro-based approach, financial institutions' loan losses could be modelled for the various income categories in the household sector.

Corporate sector

The provisioning for bad debt in the corporate sector is modelled according to the equation

$$loss_t = 0.95rwd_{t-1} - 13.34\Delta rph_t, \quad (2)$$

where *LOSS* is financial institutions' losses on loans to enterprises, *RWD* is the sum of risk-weighted debt for all enterprises and *RPH*[8] is the real price of existing dwellings.[9] The collateral pledged by enterprises to lenders consists mainly of real estate, operating assets and inventories. Information about the realisation value of these assets is, however, not available. The annual change in real house prices is therefore used as a proxy for the change in the realisation value of the lenders' collateral.

According to equation (2), a 1% increase in risk-weighted debt will increase loan losses by 0.95%. A 1 percentage point reduction in the value of financial institutions' collateral will increase losses by 13%.

Risk-weighted debt for a company is defined as the product of the company's debt and its bankruptcy probability. It is an estimate of how much the lender can expect to lose in the absence of collateral. The risk-weighted debt will vary across firms according to the level of their debt, and according to their individual bankruptcy probabilities. The bankruptcy probabilities are estimated using Norges Bank's bankruptcy prediction model (SEBRA). For a description of the model, see Appendix 2. In SEBRA, the bankruptcy probabilities are a function of selected accounting variables (operating income, operating expenses, interest expenses, long-term debt and overdraft debt), company age and size and industry characteristics.

For actual and modelled losses in per cent of outstanding debt in Norway for the years 1989-2002, see Figure 2. This period covers the peak of the banking crisis in 1990-92, the following consolidation phase and the recent period from 2001 with increasing losses. The modelled losses are based on historical figures.

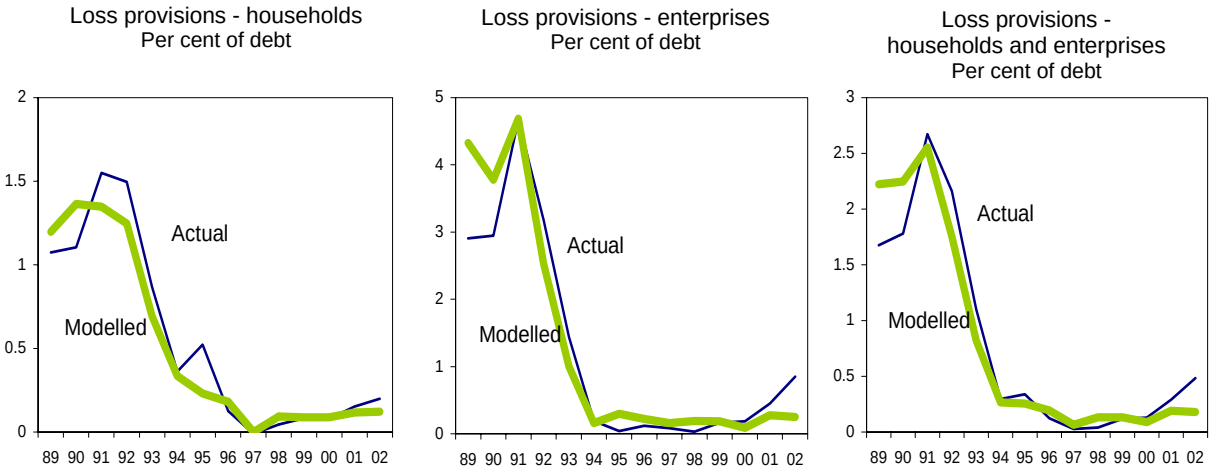
[8] The variable *RPH* is an output from RIMINI in the stress tests.

[9] Lower case letters indicate logarithmic form and Δ indicates the first difference of the variable.

Figure 2

Losses as a percentage of debt, by sector and aggregate

Loss in sector/debt in sector



For the corporate sector, risk-weighted debt is computed in three steps. First, each company's annual accounts are projected for the scenario period. This is done by assuming that key revenue and expense items in the accounts will vary in tandem with estimated changes in key macroeconomic variables. See Table 2 for a summary of the modelled relationship between macro and accounting variables.

Second, a bankruptcy probability is estimated for each company based on the projected accounts. Finally the risk-weighted debt for all companies is computed and aggregated.

The heterogeneity between companies is reflected in the variable risk-weighted debt. Risk-weighted debt is computed based on actual accounting figures. Hence, sectoral and regional differences in the profitability, liquidity and solvency of individual firms are reflected in their bankruptcy probabilities. Differences in debt growth between companies will also be reflected in the aggregate.

Table 2

Modelled relationship between accounting variables for companies and macro variables

	Accounting variable (at the company level)	Macro variable (output from RIMINI)
1	Operating income	Mainland GDP
2	Operating expenses excl wage expenses	Mainland GDP
3	Wage expenses	Wages
4	Interest expenses	Interest rate
5	Long-term debt and overdraft debt	

Variables 1-3 in the left-hand column are assumed to have the same yearly percentage increase (decrease) as the accompanying macro variables in the right hand column. Variable 4 is based on the level of the interest rate. Variable 5 is not an output of the RIMINI model.

However, some of this heterogeneity is lost when we project the accounts for the scenario period as we assume that all companies develop similarly. As an example, consider the case of operating income. The percentage growth in operating income will be equal to the growth in mainland GDP, irrespective of the industry. The year prior to the first scenario year also influences the projections. If a company has a particularly low operating income in the year in question, the results for the whole

scenario will be influenced. The simplified modelling of company accounts is motivated by tractability. We do not, however, lose all the heterogeneity between companies. The debt and bankruptcy probability is still computed for each company individually.

4. Stress test results

4.1 The macroeconomic demand side shock

We study the impact on banks' loan losses of a considerable adverse macroeconomic demand side shock, initiated by a significant decline in public expenditure. Public consumption and investments are reduced permanently by 6 percentage points compared to a reference scenario. Note that the reference scenario that has been used to calculate the changes in macro variables due to the shocks is the forecast presented in Norges Bank's inflation report at that time, and not the actual outcome.

This drop in demand leads to a reduction in public sector employment, which also gives rise to other changes in the macroeconomic environment. In the scenario with no monetary policy response, the unemployment rate increases by around 1.5 percentage points in the first year, and after three years it is 2-2.5 percentage points higher than the unemployment rate in the reference scenario. Furthermore, we assume that these changes are followed by a decrease in the rise in house prices of around 10 percentage points per year in the first two of the three years involved in the forecasts, which means that house prices actually fall. Moreover, the inflation rate drops by 1 percentage point compared to the reference scenario after two years and 1.5 percentage points after three years. As these shocks yield substantial effects on both inflation and aggregate output, the results from no monetary response and a Taylor rule response are expected to be appreciably different. The results, which are summarised in Tables 3 and 4, show that monetary policy easing according to a Taylor rule mitigates the negative effects of the demand shock on the variables presented.

The shocks illustrated in this analysis are substantial. However, they are probably not necessarily unrealistic. The substantial macroeconomic instability and volatility experienced in the 1980s illustrate that large oscillations in macroeconomic variables can occur. For example, house prices in Norway fell by almost 30% from early 1988 to early 1993. The unemployment rate was 2% cent in 1986/87, before it increased and reached around 6% in 1993; see Figure 3.

Figure 3

Unemployment rate (per cent) and house prices (index) in Norway

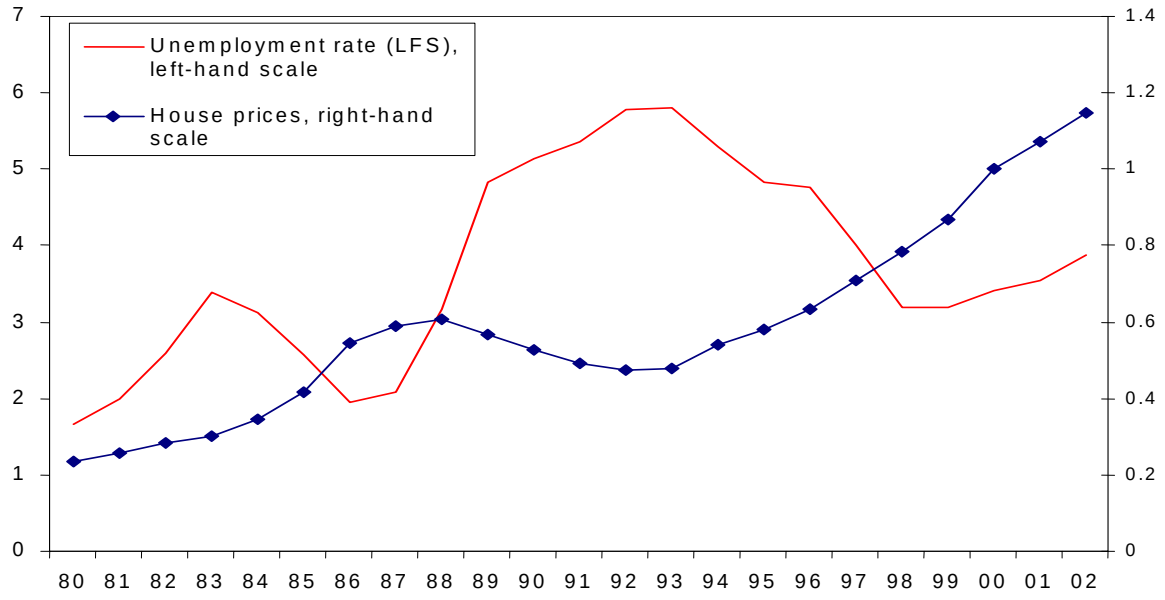


Table 3

Demand shock with no monetary policy response[1]

	t + 1	*t* + 2	*t* + 3
Macroeconomic variables			
Mainland GDP	–2.5	–2.0	–1.7
Unemployment rate (change in level, percentage points)	+1.3	+1.8	+2.2
Wages	–0.3	–1.8	–2.0
CPI	–0.2	–1.0	–1.6
Household variables			
Credit growth households	–0.2	–2.8	–4.6
House prices	–10.0	–10.0	0.0
Value of house capital	–10.0	–10.0	0.0
Interest rate on loans (change in level, percentage points)	0.0	0.0	0.0
Interest expenses	0.0	–2.0	–4.7
Disposable income	–2.8	–1.9	–2.2

[1] Effect on growth rates (percentage points) unless otherwise stated. Shock occurs in year *t* + 1.

Table 4

Demand shock with monetary policy response according to a Taylor rule[1]

	t + 1	*t* + 2	*t* + 3
Macroeconomic variables			
Mainland GDP	–2.3	–0.8	+0.3
Unemployment rate (change in level, percentage points)	+1.3	+1.7	+1.8
Wages	–0.4	–1.7	–1.6
CPI	–0.2	–0.9	–1.3
Household variables			
Credit growth households	–0.2	–1.9	–2.3
House prices	–9.0	–7.0	+3.0
Value of house capital	–9.0	–7.0	+3.0
Interest rate on loans (change in level, percentage points)	–0.9	–2.8	–3.5
Interest expenses	–10.0	–32.2	–8.2
Disposable income	–2.5	–1.1	–1.2

[1] Effect on growth rates (percentage points) unless otherwise stated. Shock occurs in year *t* + 1.

A motivation for a shock initiated by a drop in public spending could for example be the fact that approximately 25% of the Norwegian government's revenues stem from petroleum activities.[10] A large drop in the oil price that is perceived by policymakers as permanent could enforce a reduction in public sector expenses in order to balance the expected public revenues and expenses in the longer term.[11]

Loan losses with the demand side shock

Estimated losses for households in the cases involving demand shocks are higher than estimated losses in the baseline scenario; see Figure 4. The household sector is hit by the demand shock in the form of increased unemployment, reduced growth in disposable income and a reduction in households' housing wealth. These factors contribute to higher losses on loans to households. The monetary response partly reverses the changes in unemployment, disposable income and housing wealth. The net effect is that losses are higher compared to the baseline scenario, but lower than in the case with no monetary response.

Also, estimated losses in the corporate sector increase with the demand shock; see Figure 5. Losses in the corporate sector are larger than losses in the household sector. As expected, corporate loans are more risky. The effect of the demand side shock on the corporate sector's risk-weighted debt only influences estimated losses in years two and three of the scenarios. The reason is that risk-weighted debt is lagged by one year in the loan loss equation.

The demand effect of the demand side shock on the value of collateral, proxied by the change in value of housing, is negative and causes losses to increase in 1996 and 2001. Higher risk-weighted debt and a further fall in house prices contribute to increased losses in year two of the scenarios. In the final year, estimated losses fall. This is primarily due to a stabilisation of property prices.

The average bankruptcy probabilities for the different shocks, ie, risk-weighted debt per unit of debt, are illustrated in Figure 7. The demand shock increases risk-weighted debt primarily because it reduces sales in the corporate sector. Low wage growth contributes to a reduction in risk-weighted debt, but this effect is not sufficiently strong to dominate the effect of the sector's fall in revenues.

The monetary policy response according to the Taylor rule reduces the fall in property prices, thereby reducing the losses in the first year of the scenarios. The growth in risk-weighted debt is reduced, contributing to reduced losses in years two and three of the scenarios.

Risk-weighted debt increases more slowly because of lower interest rates and because of the smaller reduction in sales. These positive effects are not outweighed by the smaller decrease in wage growth.

Estimated losses in the cases involving demand shocks are higher than estimated losses in the baseline scenario in both sectors. Applying a Taylor rule for monetary policy implies reduced losses in both the household and corporate sector. Hence, with a demand shock, there is no conflict between inflation targeting and financial stability.

4.2 The macroeconomic supply side shock

If the economy is hit by a cost-push shock, there may be a trade-off between stabilising output and stabilising inflation. As often illustrated in the inflation targeting literature, a cost-push shock may lead to an increase in both inflation and unemployment. A tightened monetary policy aiming at stabilising inflation will then lead to a further increase in unemployment. Such a monetary policy reaction increases the burden on the financial system, due to both increased interest rates and an extra reduction in employment.

We have analysed the effects on banks' losses of a macroeconomic supply side shock. In this scenario, growth in annual wages increases by 4 percentage points per year compared to the baseline scenario. The results are summarised in Tables 5 and 6.

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[10] Estimate for 2003; see the Government's Revised National Budget 2003 (Ministry of Finance).

[11] According to the fiscal policy rule in Norway, over time, the use of petroleum revenues over the government budget should be equal to the expected real return on the capital of the Petroleum Fund, stipulated at 4% per annum. Hence, a substantial fall in oil prices that is perceived as permanent will probably lead to a reduction in public spending.

The increase in wages leads to higher consumer price inflation. This is a result of both higher costs for enterprises/employers and higher domestic demand. In the short term, ie within a two-year horizon, higher wages lead to higher private consumption. Consequently, GDP growth increases. In turn, higher demand and production lead to lower unemployment. Usually, in the literature, a positive cost-push shock leads to an increase in both inflation and unemployment. When we as a result get an increase in inflation but a fall in unemployment, it is a result of the way we have designed the shock (ie as a wage shock) and a quite strong link from wage growth to private consumption in our model. In addition, expectations are not explicitly modelled, and households' and firms' current decisions are not affected by the long-run consequences of higher wage growth.

In the longer term, one would expect a wage shock to cause a deterioration in conditions for enterprises. As wage costs rise dramatically, many enterprises will be forced to cut back on their stocks of employees. In addition, the bankruptcy rate would increase. It normally takes some time before these effects on employment are exhausted. In a perspective of about one year, it is not clear whether the positive aggregate demand effect or the negative cost effect of a large wage rise dominates. In our scenarios, the total effect on employment from such a wage shock is slightly negative after two years, so that unemployment is higher. In the longer term we would expect the negative effects on employment to dominate more clearly. (A parallel to this is the situation in Norway where wage growth was high in the period 1998-2002. This has probably had a negative impact on employment growth, especially in the internationally exposed industries.)

Table 5

Supply shock with no monetary policy response[1]

	***t* + 1**	***t* + 2**	***t* + 3**
Macroeconomic variables			
Mainland GDP	+0.2	+1.0	+1.6
Unemployment rate (change in level, percentage points)	0.0	+0.3	+0.5
Wages	+4.0	+4.0	+4.0
CPI	+0.6	+2.2	+2.3
Household variables			
Credit growth households	+0.1	+1.0	+2.1
House prices	+1.2	+4.3	+5.5
Value of house capital	+1.2	+4.4	+5.8
Interest rate on loans (change in level, percentage points)	0.0	0.0	0.0
Interest expenses	0.0	+0.7	+2.0
Disposable income	+3.0	+3.3	+3.4

[1] Effect on growth rates (percentage points) unless otherwise stated. Shock occurs in year *t* + 1.

Table 6

Supply shock with monetary policy response according to a Taylor rule[1]

	$t+1$	$t+2$	$t+3$
Macroeconomic variables			
Mainland GDP	+0.3	–0.1	+0.1
Unemployment rate (change in level, percentage points)	0.0	+0.4	+1.0
Wages	+4.0	+3.0	+2.0
CPI	+0.6	+2.0	+1.4
Household variables			
Credit growth households	+0.1	+0.2	–0.8
House prices	0.0	–1.4	+2.4
Value of house capital	0.0	–1.5	+2.3
Interest rate on loans (change in level, percentage points)	+0.7	+3.0	+2.3
Interest expenses	+7.7	+36.5	–13.1
Disposable income	+2.8	+1.7	+1.6

[1] Effect on growth rates (percentage points) unless otherwise stated. Shock occurs in year $t+1$.

Moreover, in the scenario with no monetary policy response, the rise in wages contributes to higher house prices. This increases the value of the collateral of banks, which in turn reduces banks' losses.

Under inflation targeting, a sudden increase in labour costs will prompt an increase in interest rates to counteract the build-up of inflationary pressures. If the response pattern of the central bank is well known, we expect the monetary policy regime to have a disciplinary effect on wage growth. The labour unions will foresee that high wage growth results in higher inflation and then higher interest rates, reducing the disposable income of households with debt. Higher interest rates will typically lead to an appreciation of the krone, with a further reduction in earnings and employment for the exposed businesses. In line with these arguments, we have assumed in our cost-push scenario with a monetary policy reaction that the central bank's response pattern is gradually internalised by trade unions. When a Taylor-rule monetary policy response is implemented, we assume that wage growth only increases relative to the reference scenario by 4 percentage points the first year, 3 percentage points in the second, and 2 percentage points in the third year (see Table 6).

As wage increases lead to higher inflation, the Taylor rule yields higher interest rates. This in turn curbs aggregate demand and house prices. Unemployment increases.

Loan losses in the supply side shock case

The supply shock causes a reduction in estimated losses compared to the baseline scenario in the household sector; see Figure 4. Higher wage growth increases disposable income and house prices. The effect of these positive factors is not reversed by the increase in unemployment.

The monetary policy response causes higher interest rates, increased unemployment and a more moderate development in housing wealth in the household sector. Due to the hike in interest rates, house prices fall in year two, relative to the reference scenario. The result is that losses increase. The level of estimated loss is higher than the loss in the baseline scenario.

The supply shock causes a reduction in estimated corporate losses compared to the baseline scenario; see Figure 5. With a Taylor-type monetary policy response, losses increase to a level above the losses in the baseline scenarios.

The supply shock increases risk-weighted debt because of the large increase in companies' wage costs. The increase in wages is, however, also accompanied by an increase in sales, but the increase in wages dominates the latter effect. Risk-weighted debt increases and contributes by itself to increased losses in years two and three of the scenarios. Increased wage growth is accompanied by higher property prices. This increases the banks' value of collateral. Estimated losses are marginally reduced in the first year of the scenarios. This effect is, however, reversed by the rise in property values, leaving the estimated losses well below the losses in the baseline scenario.

A shortcoming in the way we model the loan losses in the corporate sector is that companies exposed to foreign competition and companies sheltered from foreign competition are equally influenced by the rise in domestic demand caused by increased domestic consumption. In general, internationally competing companies will be severely hit by the supply shock through increased wages. The result is that losses in the corporate sector are underestimated.

With a Taylor-like monetary policy response, the interest rate increase causes lower wage growth, reduced sales growth and lower property prices. In the first year of the scenario, property prices are unchanged compared to the baseline scenario. Accordingly, the estimated losses are unchanged. An increase in risk-weighted debt contributes to increased losses in year two of the scenario. The effect of a further increase in risk-weighted debt in year three of the scenario is counteracted by an increase in property values. Property prices increase in the third year because households' disposable income growth is high (due to a high wage increase and somewhat lower interest rates in this year). Estimated losses are accordingly reduced in the final year.

The supply shock with no monetary policy response causes a reduction in estimated losses compared to the baseline scenario in both the corporate and household sector. With a Taylor-like monetary policy response, however, losses increase above the level in the baseline scenario in both sectors. Of all the scenarios we consider, the supply shock with a monetary response increases risk-weighted debt the most. The combination of high wage growth and high interest rates severely worsens the cost burden of the corporate sector. In addition, with a supply shock, there may be a potential conflict between the objective of monetary policy and financial stability. In the relatively short time frame analysed here, monetary policy aimed at achieving the inflation target leads to higher losses in both the household and corporate sector. However, in a longer time perspective, this trade-off might be somewhat different (for further discussion see Section 5).

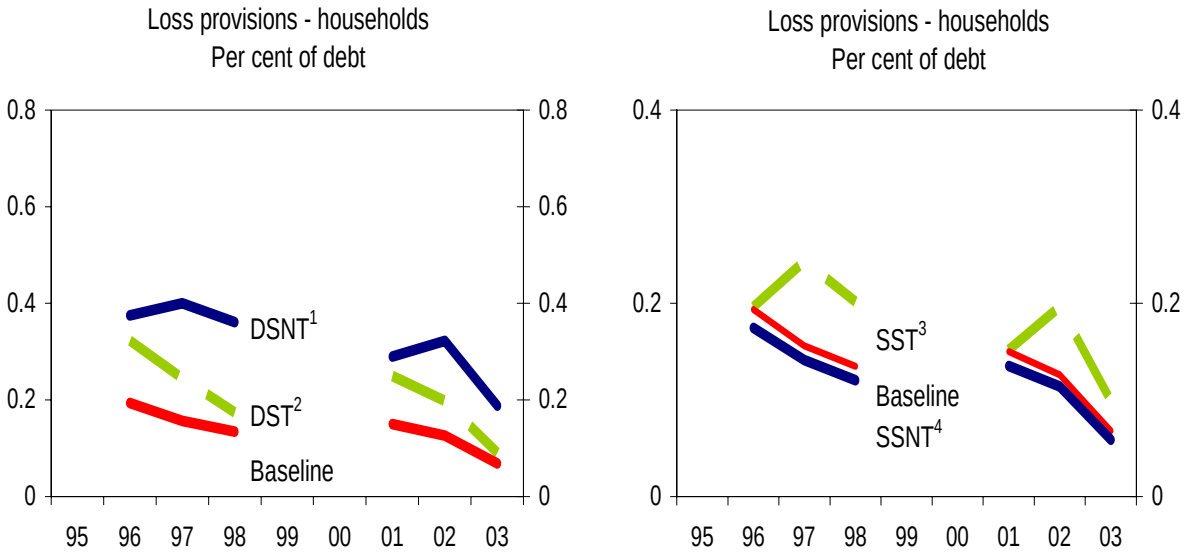
The difference between 1996 and 2001

The household sector was marginally better positioned in 2001 than in 1996, as measured by estimated losses in the first year of the baseline scenarios. Estimated losses (measured as a percentage of loans) fell by 0.04 percentage points from 1996 to 2001; see Figure 8. This reduction was caused by lower unemployment and an increase in housing wealth. During this period, the debt burden and interest rates rose, but not sufficiently to increase the household sector's losses. With the household sector in approximately the same condition along the baseline scenarios during the two time periods, the effects of the identical shocks are also almost identical irrespective of whether the shocks occur in 1996 or 2001.

Figure 4

Losses in the household sector by type of shock

Per cent of debt (loss in sector/debt in sector)

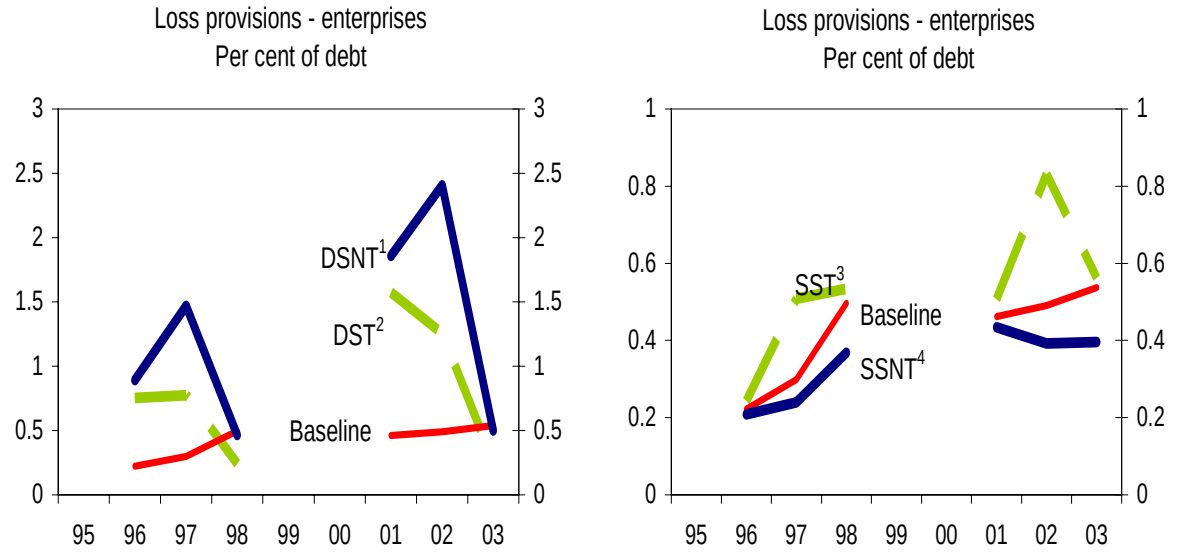


[1] Demand shock no Taylor rule (DSNT). [2] Demand shock with Taylor rule (DST). [3] Supply shock with Taylor rule (SST). [4] Supply shock no Taylor rule (SSNT).

Figure 5

Losses in the corporate sector by type of shock

Per cent of debt (loss in sector/debt in sector)

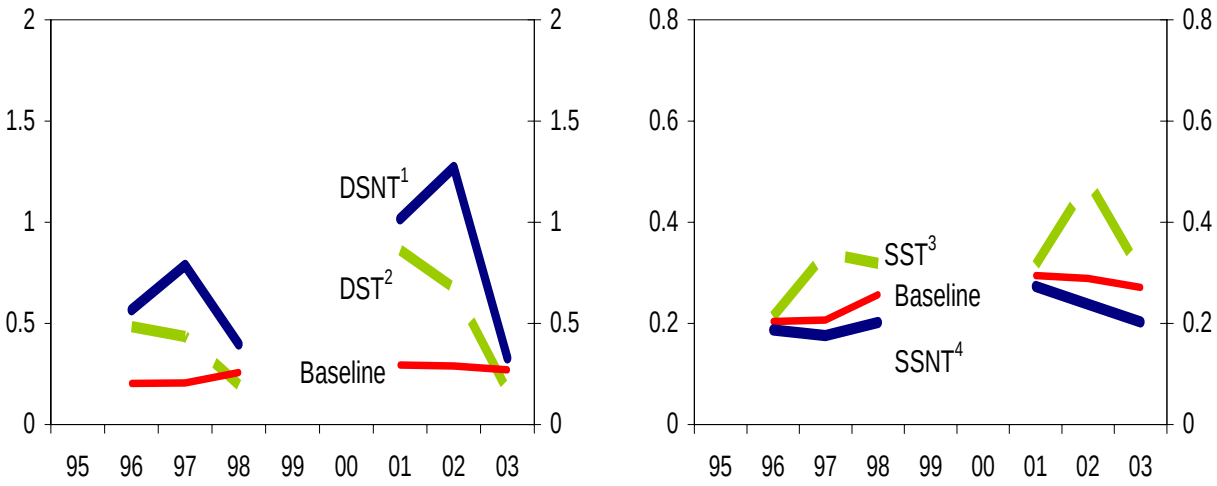


[1] Demand shock no Taylor rule (DSNT). [2] Demand shock with Taylor rule (DST). [3] Supply shock with Taylor rule (SST). [4] Supply shock no Taylor rule (SSNT).

Figure 6

Total losses by type of shock (household and corporate sector)

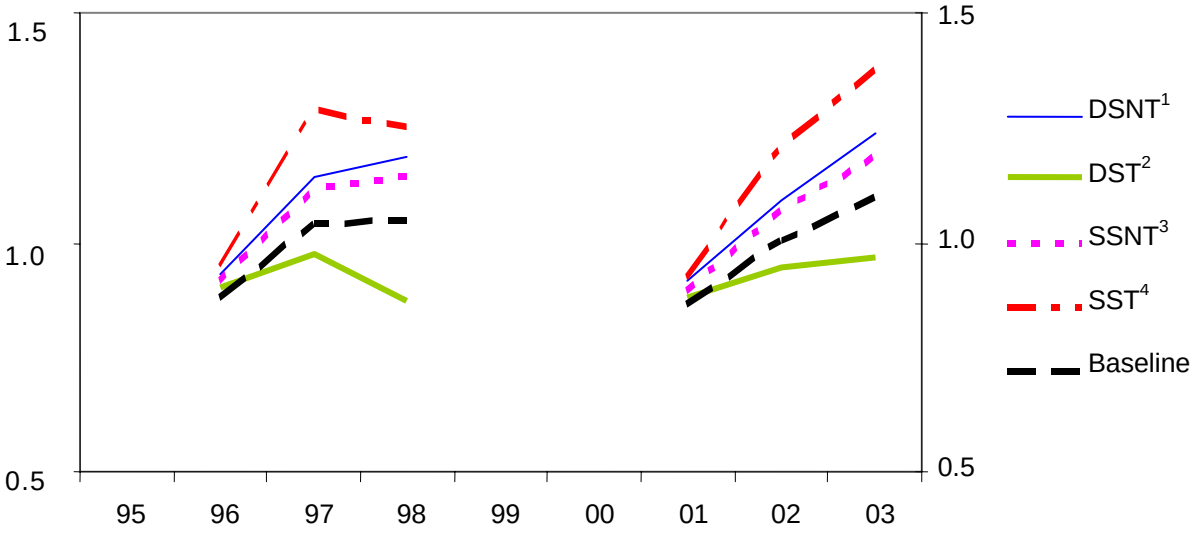
Per cent of debt



[1] Demand shock no Taylor rule (DSNT). [2] Demand shock with Taylor rule (DST). [3] Supply shock with Taylor rule (SST). [4] Supply shock no Taylor rule (SSNT).

Figure 7

Average bankruptcy probabilities in per cent for various shocks (risk-weighted debt/debt)

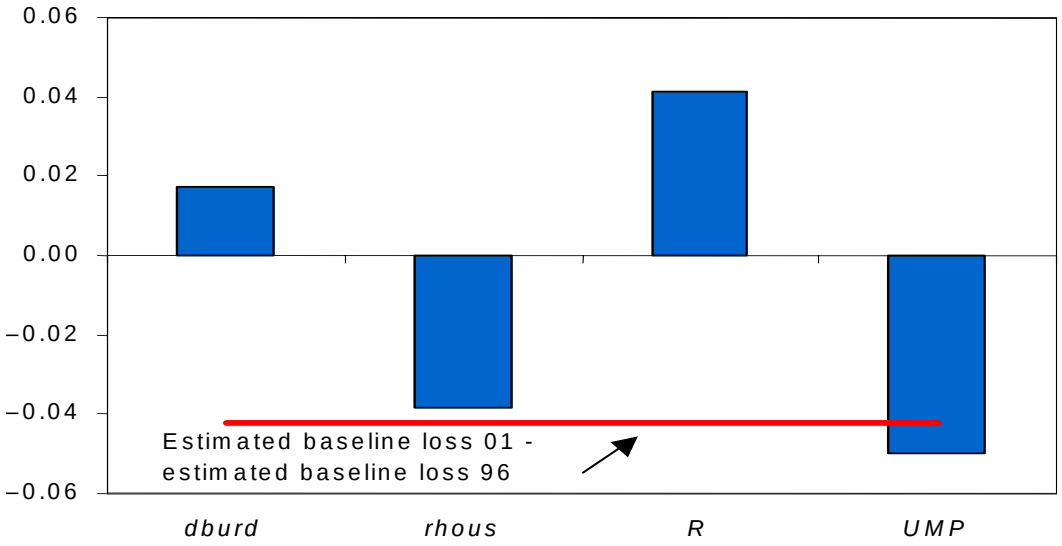


[1] Demand shock no Taylor rule (DSNT). [2] Demand shock with Taylor rule (DST). [3] Supply shock no Taylor rule (SSNT). [4] Supply shock with Taylor rule (SST).

Figure 8

Partial effects of the explanatory variables causing a lowering of the estimated losses in the household sector from baseline scenario in 1996 to baseline scenario in 2001

Red line shows total effect. Percentage points of loans (*dburd*: debt burden, *rhous*: real value of houses, *R*: interest rate, *UMP*: unemployment rate)

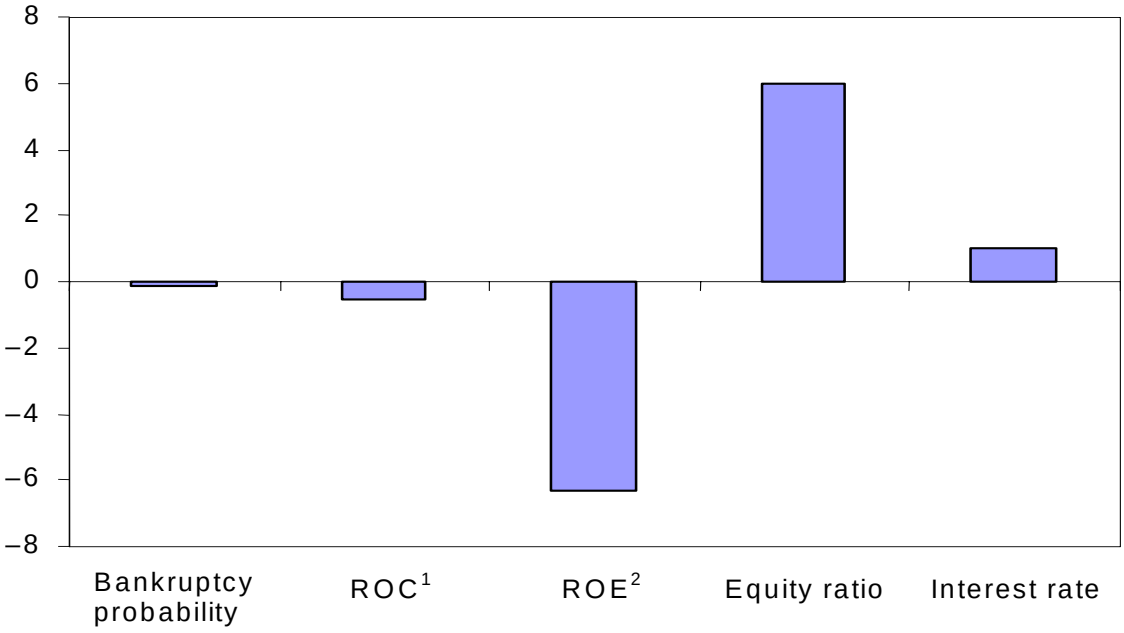


In spite of a higher debt burden, the corporate sector was also in a better position in 2001 than in 1996 measured by the average bankruptcy probability. The corporate sector had been operating profitably for five years and the equity ratio had increased by approximately 6 percentage points. This was the main factor behind the drop in bankruptcy probability between the two periods; see Figure 9.

Figure 9

Changes in key variables influencing companies' risk-weighted debt from 1996 to 2001

Changes measured in percentage points



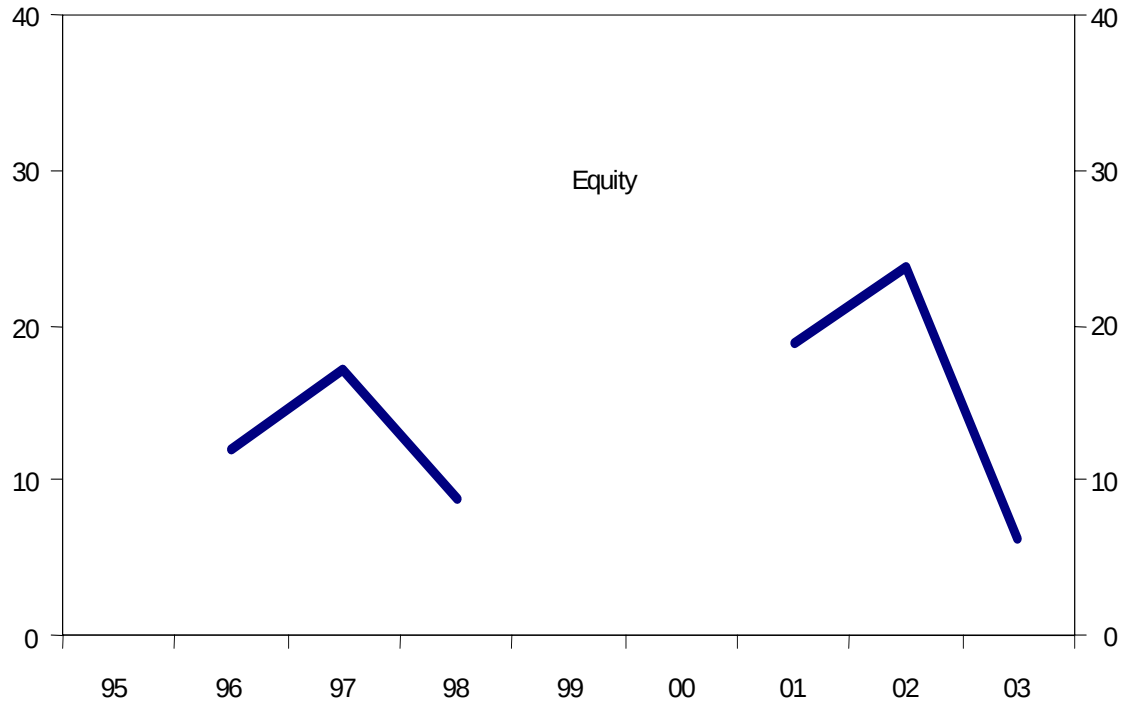
[1] ROC: return on capital. [2] ROE: return on equity.

As can be seen from the loan loss equation (2) for the corporate sector, property prices play an important role in the estimation of loan losses. The growth in house prices along the baseline scenario is lower in 2001 than in 1996. This outweighs the impact from the lower bankruptcy probability and causes the estimated losses to be higher in 2001 than in 1996.

The estimated demand shock losses as a percentage of banks' equity were small; see Figure 10. The shock starting in 2001 would have reduced equity more than the shock starting in 1996. The shocks would probably not have caused a banking crisis, especially since banks could have raised additional capital to improve their capital ratios.

Figure 10

Aggregate losses in the demand shock scenario without a monetary response[1]



[1] Aggregate losses for DSNT as a percentage of banks' equity at beginning of 96 and 01.

5. Conclusions and implications

Should monetary policy pay special attention to asset prices and the build-up of financial imbalances? The answers to this question differ somewhat in the international debate, but it has been pointed out that there need not be a conflict between the objectives of maintaining both financial and monetary stability.

First, flexible inflation targeting, where the central bank puts emphasis on smoothing variability in both inflation and output, reduces the scope for conflict between the monetary policy objective and financial stability. After a shock has brought inflation away from its target, a central bank may choose to bring inflation back to target rapidly. Such a strategy, which can be termed strict inflation targeting, would typically imply instability in output and employment. By contrast, flexible inflation targeting involves applying a somewhat longer horizon to achieve the inflation target. This would normally represent a smaller threat to financial stability than a strict inflation targeting regime, as it involves smaller fluctuations in production, employment, asset prices and interest rates.

Second, when assessing how financial stability issues should be dealt with in the conduct of monetary policy, it is useful to distinguish between the short and the long term. In this paper we have calculated the short-term effects of interest rate changes on the financial sector. Lower interest rates will reduce

debt servicing costs and thus reduce the risk of higher loan losses in the short term. In the long term, the isolated effect of an expansionary monetary policy will be a faster rise in indebtedness and asset prices, which may increase future financial fragility. Higher interest rates have the opposite effect.

As illustrated in this paper, there seems to be no short-term conflict between financial and monetary stability when the economy is facing a typical negative aggregate demand shock. In this case, a monetary policy reaction following a standard Taylor rule, which may be interpreted as the response of a central bank with a flexible inflation target, would dampen the drop in inflation and production, but also reduce banks' loan losses. Even in the longer term a monetary policy aimed at stabilising inflation and output would most likely have a positive impact on financial stability by improving the robustness of the banks and their borrowers.

However, there may also be a risk that in the longer term the lower interest rate may stimulate excessive indebtedness and asset prices, so that financial fragility increases. Many firms will have excess capacity during an economic downturn, making it less probable that the corporate sector will react to an expansionary monetary policy by sharply increasing its debt exposure. The risk may be higher for the household sector. A heavily indebted household sector will be vulnerable to adverse shocks that may hit the economy in the future. Some households may also face financial problems when the economy recovers and interest rates return to their neutral level. The risk of increased financial fragility should be weighed against the consequences for activity, inflation and financial stability in the short run, if monetary policy is not eased sufficiently to counteract a negative demand shock.

With regard to cost-push shocks stemming from a sudden boost in wages, a conflict between monetary and financial stability may arise in the short term. The higher interest rate needed to maintain monetary stability will increase debt servicing costs, which may increase credit losses. In our scenario, aggregate demand increases immediately due to a positive effect on households' disposable income. Consequently, companies producing for domestic markets will experience reduced pressure on operating profits and loan losses are lower than in the baseline scenario. However, in the somewhat longer run increased wage costs have a negative impact on the operating results of all companies.[12]

Due to the higher inflationary pressures, the monetary policy reaction to such cost shocks would be increased interest rates. The positive demand effect is thus partly counteracted, while increased interest rates (and a potential appreciation of the currency due to increased interest rate differentials) at the same time place an extra burden on enterprises' expenses. Regarding the cost-push shock, we showed that a Taylor-rule monetary policy reaction raises the level of credit losses above the baseline scenario.

In the longer term, this conclusion may be turned around. Without monetary tightening, a continued increase in wage growth will have to stop at a later stage, due to longer-term economic dynamics. However, the consequences, if not curbed at an early stage, may be higher unemployment due to reduced competitiveness of exposed industries, and hence higher credit losses. As debt levels, asset prices and hence financial fragility most likely would have increased further in the meantime, the consequences for financial stability could even be more severe than if monetary policy was tightened immediately.

The appropriate central bank response when a cost-push shock occurs would of course depend on the magnitude of the forecast short-term losses. We found that the losses in these cases were rather small from a historical perspective and they would probably not have caused a banking crisis. The banks' buffer capital would have been sufficient to absorb the losses. The costs of not raising the interest rate would be related to the deviation of inflation from its target for a longer period, which could reduce monetary policy credibility.

We have run the same set of stress tests on what seemed to be two different periods with regard to financial vulnerability. When concerned with financial stability, the main focus is on the level and

[12] In particular, companies in exposed industries may experience a deterioration in profitability and competitiveness. Unfortunately, the difference between the sheltered and exposed sectors is not modelled within the micro-based SEBRA framework. If it were, we could have separated the effects of increased private consumption between domestic/sheltered industries and exposed industries.

increase in debt and asset prices. But other variables are also important. The household sector is particularly affected by lower unemployment in 2001 relative to 1996. This offsets the negative impact of other factors like the higher debt burden.

Growth in the debt burden was stronger for enterprises than for households in the period between 1996 and 2001. As with households, this was accompanied by an improving economy that increased the equity ratio of firms and thus strengthened their ability to withstand shocks. The level of the average bankruptcy probability fell slightly.

These results show that a sole focus on debt and asset prices may be too narrow when assessing the financial fragility of households and enterprises. It is important to include other factors that may have an impact on the different sectors' debt servicing capacity.

Also, the chosen years may not capture precisely the trough and the peak of the credit cycle. The results might have been different if the current year (2003) had been chosen instead of 2001. Debt levels have continued to rise and the unemployment rate is now significantly higher. It is possible that the financial situation in the corporate sector has deteriorated somewhat. In general, when an economy is recovering from a recession, a rise in debt levels and asset prices is not necessarily worrying. It is the excessive build-up of debt over time - and clearly over a time period when unemployment cannot continuously fall - that gives cause for concern.

It is clear from our loan loss equations that losses will increase with the level of indebtedness. Hence, the weight of preserving the soundness of the banking sector in monetary policy decisions should increase with the level of indebtedness.

Analyses of alternative scenarios are important as part of the monetary policymaking process. With the help of stress testing we may analyse the effects on the banking system of different macroeconomic scenarios. Within the SEBRA framework, the basis for making this analysis is the accounting data for all Norwegian joint stock companies. Also in the future, situations may arise in which the financial sector is vulnerable to adverse shocks. Stress testing may give us an early warning and monetary policy authorities may then assess whether this should give cause for particular concern.

One shortcoming of using this framework as an "early warning tool" is the fact that the accounting data for Norwegian companies lag. For example, data are only available up to 2001. This can, however, be partly solved by using projections for companies' operating results and other key variables.

Stress testing is a useful tool when analysing developments in the economy and financial stability. Such analyses improve the understanding of the interaction between "traditional" macroeconomics and financial stability issues. It is, however, important to understand the shortcomings of the method. As with all models, we may fail to include important variables. It is also not obvious that models calibrated on historical data are relevant for forecasting.

Finding better indicators for assessing the vulnerability of households, enterprises and financial institutions is probably the most important step to improve this kind of analysis. One important step in this regard would be to find indicators of bubbles in the property market. For example, it is reasonable to expect that the change in property prices following a negative macroeconomic shock would be larger the higher property prices are above their "equilibrium" values. The use of house prices as a proxy for commercial property prices and the value of collateral may also be solved in a better way.

An important question is how, and at what cost, monetary policy can curb the build-up of financial imbalances (ex ante). A "leaning against the wind" policy requires indicators which give information on the build-up of financial imbalances. Although our framework has some shortcomings, it may add to the suite of indicators we use in order to detect looming financial instability.

Appendix 1:
Model for losses in the household sector

The model is a re-estimation of the model presented in Frøyland and Larsen (2002). The time series underlying this model has been revised. We tested various model specifications with alternative variable specifications. These alternative specifications did not, however, give any new insights into the effects of the shocks.

Summary

The estimation sample is: 1978-2002

	Coefficient	**Std error**	***t*-value**	***t*-prob**	**Partial R^2**
dburd	3.31404	0.8116	4.08	0.001	0.4547
rhouse	–1.44635	0.2499	–5.79	0.000	0.6261
R	13.5534	3.002	4.51	0.000	0.5047
UMP	31.5508	8.068	3.91	0.001	0.4333
DUM97	–7.04948	0.3576	–19.7	0.000	0.9511

sigma	0.322947	RSS	2.08589821
log-likelihood	–4.42751	DW	1.96
no of observations	25	no of parameters	5
mean(lossrel)	–1.63586	var(lossrel)	3.33868

AR 1-2 test:	$F(2,18) = 0.75655$ [0.4836]
ARCH 1-1 test:	$F(1,18) = 0.026134$ [0.8734]
Normality test:	$X^2(2) = 9.0003$ [0.0111]
hetero test:	$F(9,10) = 0.88651$ [0.5670]
RESET test:	$F(1,19) = 0.70515$ [0.4115]

Appendix 2:
The bankruptcy prediction model SEBRA

The bankruptcy prediction model SEBRA is a logistic model. For each joint stock company in the database (in 2001 the number of companies is approx 140,000) the model produces an estimate of the bankruptcy probability. The model is presented in Eklund et al (2001). The explanatory variables reflect primarily company-specific information, like earnings, liquidity, financial strength and age, but industry-specific information is included in the model, like the average equity ratio and dispersion in earnings. A summary of the variables is given below.

Earnings

- Earnings as a percentage of total assets

Liquidity

- Liquid assets less short-term debt as a percentage of operating revenues
- Unpaid indirect taxes as a percentage of total assets

Financial strength

- Equity as a percentage of total assets
- Dummy variable for book equity less than paid-in equity capital
- Dummy variable for dividend payments the last accounting year

Industry

- Industry average for the variable “equity as a percentage of total assets”
- Industry average for the variable “trade accounts payable as a percentage of total assets”
- Industry standard deviation for the variable “earnings as a percentage of total assets”

Age

- Dummy variable for number of years since establishment

Size

- Total assets

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