No. 11 | 2012

Staff Memo

Norges Bank's new monetary policy loss function – further discussion

Snorre Evjen, Norges Bank Monetary Policy and Thea B. Kloster, Norges Bank Financial Stability

NB NORGES BANK

ISSN 1504-2596 (online only)

ISBN 978-82-7553-666-0 (online only)

Norges Bank's new monetary policy loss function – further discussion

Snorre Evjen, Norges Bank Monetary Policy, and Thea B. Kloster, Norges Bank Financial Stability[1]

Abstract

Norges Bank's Monetary Policy Report (MPR) 1/12 *introduced amendments to the criteria for an appropriate interest rate path in order to explicitly take into account the risk of a buildup of financial imbalances. The monetary policy "loss function" used in model-based analyses was accordingly adjusted mainly in two ways: The weight on the output gap was increased and a weight on the deviation between the actual and the normal interest rates was added. We present both theoretical and empirical studies underpinning these changes.*

[1] We would like to thank Andrew Binning and Aslak Bakke Kvinlog for contributing empirical research. We are grateful for comments from and discussions with Anders Vredin and colleagues at Norges Bank.

"If we want to avoid large adverse consequences, even when they are small probability, we might want to take precautions, especially if conclusive analysis is likely to take a long time." Rajan (2005).

I. Background

Since 2005, Norges Bank has published its own forecasts for the key policy rate. As a guideline for the forecasts, the central bank has established a set of criteria for an appropriate interest rate path. These criteria have been adjusted as new insights have provided a basis for further development of the conduct of monetary policy.[2]

In this *Staff Memo* we discuss the latest adjustments to the criteria communicated in the *Monetary Policy Report* published on 14 March 2012 (MPR 1/12). A new criterion 3: *"Monetary policy is robust"* replaced former criteria 3 and 4. In the explanation of the new criterion it was stated that "*interest rates should be set so that monetary policy mitigates the risk of a buildup of financial imbalances (...)."*

The amended criteria were accompanied by corresponding adjustments to the monetary policy "loss function" used in model-based analyses. By increasing the weight attached to the output gap and putting weight on the deviation between the actual and normal level of nominal interest rates (i.e. an interest rate gap), the loss function would more explicitly take into account the risks related to financial imbalances. This *Memo* discusses some of the theoretical and empirical background for the changes made.

The new loss function does not represent a shift in the conduct of Norges Bank's monetary policy – but rather an adjustment to the loss function (or the criteria for an appropriate rate path) so that it better reflects the conduct of monetary policy since the financial crisis.

[2] The criteria were first introduced in Norges Bank's *Inflation Report* 1/05 as a guideline for assessing market participants' expected interest rate path (see also Qvigstad (2005)). Since *Monetary Policy Report* 3/05 they have served as a guideline for the central bank's projected interest rate path. The criteria were slightly adjusted both in MPR 1/07 and in MPR 2/10 (the latter for the first time expressed the criteria mathematically as a "loss-function").

Norges Bank has taken into account the risks related to possible financial imbalances in its monetary policy assessments for many years. Following the financial crisis, however, the weight on guarding against financial imbalances was expressed more explicitly as supplementary assessments in the rationale for the interest rate forecasts.

MPR 3/10 stated that "*The key policy rate in Norway has been low for a fairly long period. The consideration of guarding against financial imbalances that may trigger abrupt and sharp falls in output and inflation somewhat further ahead suggests that the key policy rate should not be kept low for too long."*

MPR 3/11 stated that "*Low inflation suggests in isolation that the key policy rate should be lowered. But the key policy rate is already low. Capacity utilization is close to a normal level. Low interest rates over time entail the risk of a buildup of imbalances. This suggests that the key policy rate should gradually be raised towards a more normal level.*" This was quantified in a chart conveying factors behind changes in the interest rate forecasts since MPR 2/11 as supplementary assessments.

The monetary policy loss function should be perceived as a way of formalising the actual considerations underlying monetary policy decisions, but it can only be an approximation. It is used to make conditional interest rate forecasts under different assumptions about monetary policy and economic developments. It is also a tool for assessing the consistency of Norges Bank's monetary policy over time.

II. Norges Bank's criteria for an appropriate interest rate path

To clarify Norges Bank's response pattern, the criteria for an appropriate interest rate path were adjusted in MPR 1/12. The main change was in criterion 3.[3] In the *Report* it was reconfirmed that, over time, Norges Bank seeks to maintain inflation close to 2.5 percent. An appropriate interest rate path should meet the following criteria:

[3] See the former criteria and the corresponding loss function in MPR 3/11 pp. 15-16.

1. **The inflation target is reached:**
   The interest rate should be set with a view to stabilising inflation at target or bringing it back after a deviation has occurred.

2. **The inflation targeting regime is flexible:**
   The interest rate path should provide a reasonable balance between the path for inflation and the path for overall capacity utilisation in the economy.

3. **Monetary policy is robust:**
   The interest rate should be set so that monetary policy mitigates the risk of a buildup of financial imbalances, and so that acceptable developments in inflation and output are also likely under alternative assumptions concerning the functioning of the economy.

Norges Bank stated in MPR 1/12 that the various considerations taken into account in the criteria must be weighed against each other. The specific time horizon for stabilising inflation at target will depend on the type of disturbances to which the economy is exposed and their effect on the path for inflation and the real economy ahead.

Mathematically, these criteria can be represented, as shown in MPR 1/12, in somewhat simplified terms by a loss function where the parameters λ, γ and τ and represent relative weights:

$$L_t = \underbrace{(\pi_t - \pi^*)^2}_{\text{Criterion 1}} + \underbrace{\lambda(y_t - y_t^*)^2 + \gamma(i_t - i_{t-1})^2 + \tau(i_t - i_t^*)^2}_{\text{Criterion 3}}$$

(Criterion 2 = Criterion 1 + Criterion 3)

In the calculations for the MPR 1/12 the parameters were λ=0.75, γ=0.25 and τ = 0.05. In general, the parameters will depend on the model specification and how the model is solved.[4]

[4] See Alstadheim et al. (2010).

The new loss function entails a somewhat higher weight on output than the old loss function (where λ was 0.5).[5] In addition, weight on deviations of the key policy rate from a simple rule in the old loss function is replaced by weight on deviations of the key policy rate from a normal level. In general, with the new loss function, the interest rate response to supply shocks will be smaller than with the old loss function. The interest rate responses to demand shocks have not changed much, while the response to an exchange rate shock is marginally smaller with the new loss function than with the old (see Lund and Robstad, (2012)).

Furthermore, in MPR 1/12 Norges Bank explained:

"Criterion 1, which states that the inflation target is reached, is covered by the first segment. The loss L_t will be greater, the more actual inflation π_t deviates from the target π^*.

Criterion 2, which states that the inflation targeting regime is flexible, is covered by the first and second segments. For given inflation developments, the loss L_t will increase with fluctuations in economic activity, measured as the deviation between actual output y_t and the normal output level y_t^*. Often, a reasonable balance will imply opposite signs for the projected inflation gap ($\pi_t - \pi^*$) and output gap ($y_t - y_t^*$) some time ahead.

Criterion 3, which states that monetary policy is robust, is covered by the second, third and fourth segments. Experience shows that financial imbalances often build up in periods of high capacity utilisation. For that reason, increasing the weight λ of the output gap in the loss function may reduce the risk of a build-up of such imbalances. (...)

The last segment states that the loss increases when the interest rate deviates substantially from a normal level i_t^*. This consideration can help to mitigate the risk of a build-up of financial imbalances – even in periods when capacity utilisation is not particularly high.

Over time, income level, saving behaviour, the tax system and the structure of financial markets determine the level of household and corporate indebtedness. Low interest rates for extended periods can increase the risk that debt and asset prices will move up and remain higher than what is sustainable over the economic cycle. In addition, banks may ease credit standards and financial market participants may increase risk taking. High debt levels make borrowers more vulnerable and increase the risk of long-term instability in the real economy. A sudden, unexpected drop in incomes, higher unemployment or other macroeconomic shocks may result in a fall in property prices, creating imbalances between borrowers' debts and the value of leveraged assets.

[5] See MPR 3/11 pp. 15-16.

By incorporating the interest rate level in the loss function, the Bank is seeking to counter the build-up of such imbalances. This does not imply that the interest rate becomes an independent objective of monetary policy. Rather, the purpose is to overcome flaws in our analytical tools related to the effects of low interest rates. Monetary policy will continue to react to shocks that affect the path for inflation, output and employment."

III. Taking account of financial stability in monetary policy – some different views on why and how

Why should monetary policy take into account financial stability?

Internationally, different researchers and policymakers draw different conclusions as to whether (why and how) the central bank should react using a precautionary principle by tightening monetary policy to counter the emergence of financial imbalances – often referred to as "leaning against the wind". This debate started well ahead of the recent financial crisis.[6]

Some think that monetary policy strategy should be completely changed (see, e.g., Eichengreen et al. (2011)): *"Now, however, there is growing recognition that the conventional approach to central banking needs to be rethought. The relationship between price stability and the broader goals of macroeconomic and financial stability clearly needs to be redefined."*

Others argue that the inflation targeting strategy does not have to be reformed since macroprudential regulation is nearing implementation and is much better suited for the job of guarding against financial instability (see, e.g., Svensson (2012)). Yet others seem to have views in between, arguing that the inflation targeting strategy is basically right but that monetary policy has to consider other objectives than inflation and the output gap, at least when there is a risk that financial imbalances are building up (see, e.g., Woodford (2012)).

Possible distortions stemming from financial market frictions can influence aggregate demand and is one argument underpinning that monetary policy should pay attention to financial stability. It can also be argued that monetary policy has an impact on the risk of financial imbalances building up (through its impact on

[6] See, for example, Haugland and Vikøren (2006) for an overview.

credit and asset prices) and hence the probability of a financial crisis. Financial crises can be extremely costly to society and should be avoided if possible.

The main counter arguments are typically:

- It is very difficult to predict financial crises because it is difficult to identify precisely financial imbalances, sometimes referred to as "bubbles". Because bubbles are difficult to identify until after they have burst, it has been argued that it is more practical for the central bank to simply "mop up" after the crash.

- Monetary policy has too small an effect on financial imbalances. A moderate monetary policy response would not necessarily be able to reduce the imbalances in, for instance, credit and house prices significantly. Only a sharp increase will suffice to prick a bubble, but at the risk of depressing output growth and increasing output volatility disproportionally.

- Other tools (i.e. macroprudential policies) are better suited for such tasks.

With regard to the first counter argument, Woodford (2012) argues that: "*After all, in order for it to be useful to adjust policy in order to reduce the risk of financial crisis, one needn't be able to predict exactly when crises will occur; it suffices that one is able to identify circumstances under which the* ***risk*** *of a crisis increases (and that there are policies that can affect these risks)*." If there are reasons to believe that risks are high,[7] and if monetary policy can affect those risks, it may be wise to use monetary policy to dampen them. Many countries are still struggling with high levels of unemployment and debt following the financial crisis. Hence, relying on mopping up afterwards can entail substantial costs.

With regard to the second counter argument, it is not certain that the effects of

[7] Riiser (2005 and 2008) are examples of research supporting the view that financial and macroeconomic indicators can be useful tools for predicting financial vulnerability. These papers use a methodology similar to Borio and Lowe (2002 and 2004). Borio and Lowe (2002) find that episodes of sustained rapid credit expansion, booming stock or house prices, and high levels of investment are almost always followed by periods of stress in the financial system.

monetary policy on financial imbalances are small.[8] One may argue that even if it is hard to control asset prices and debt levels using monetary policy, central banks could seek to deter extreme levels of leverage.

The last reason for skepticism is cited by, for example, Svensson (2012) who argues that the introduction of financial stability instruments (macroprudential instruments) that have a more direct effect on leverage than the policy rate will allow monetary policy and financial stability policy to be conducted separately, with monetary policy focusing on the traditional objectives of stabilising inflation and resource utilisation and financial stability policy focusing on the objective of financial stability.

Generally, one could argue that using regulation close to the source of externality is welfare superior to using the interest rate. However, that depends on the nature of the regulation. Implementation of strict loan-to-value limits, for instance, may also entail welfare losses.

Many will argue that even if macroprudential tools are better suited to reduce financial imbalances, as long as they are not able to eliminate financial instability completely, monetary policy should lend a hand (see, e.g., Eichengreen et al. (2011) and Angelini et al. (2011)). Svensson (2012) acknowledges that monetary policy should address threats to financial stability in certain situations. "*In a second-best situation, without appropriate supervision and regulation, if the policy rate is the only available tool and there is a trade-off between achieving the monetary policy objectives and threats to financial stability, that trade-off should be taken into account.*"

Macroprudential tools have yet to be implemented in most countries, and it will take time to accumulate knowledge about their full effects. Existing empirical research on the effects of macroprudential tools indicates that these tools will have a dampening, but limited, effect on credit growth.[9] Few policymakers and researchers seem to believe macroprudential tools will be a complete solution to the problem of the buildup of financial imbalances.

[8] See e.g. Jacobsen and Naug (2005 and 2006) for empirical analysis on Norwegian data.
[9] See e.g. BIS (2010) and Jacobsen et al. (2011).

How should monetary policy address possible financial imbalances?

Woodford (2012) discusses (why and) ***how*** monetary policy could address financial stability. He argues that a flexible inflation-targeting central bank should balance financial stability objectives against its price stability objective and its concern for output-gap stabilisation when choosing among alternative short-run paths for the economy at a given conjuncture. In his model a high level of resource utilisation (by assumption) leads to higher leverage in the financial sector and this in turn entails a greater risk of a financial crisis. There is then reason for a central bank to consider the effect of leverage on the risk of a financial crisis. Woodford argues that for a committed central bank this should not require any compromise of the primacy of price stability as the central bank's long-run objective.

Woodford suggests that the central bank should minimise a loss function augmented with an argument capturing financial stability, in addition to arguments measuring the volatility of inflation and output. He shows that the corresponding target criterion (or first order condition for optimal monetary policy) does not depend solely on the paths of the general price level and the output gap; it also depends on the projected value of another variable referred to as the *marginal crisis risk*. This variable measures the rate at which the expected loss from the occurrence of a financial crisis increases per unit increase in leverage.

A key assumption in his model is that the probability of a financial crisis is endogenous and a function of leverage. The idea of a positive dependence of crisis on leverage is "*that the more highly levered financial institutions are, the smaller the unexpected decline in asset values required to tip institutions into insolvency – or into a situation where there may be doubts about their solvency – and hence the smaller exogenous shock required to trigger a crisis*."

Norges Bank has chosen to incorporate a concern for financial stability into the monetary policy loss function represented both by a higher weight attached to the output gap and by putting weight on an interest rate gap. The latter amendment could be interpreted as representing the marginal crisis risk in Woodford's loss

function. One could argue that low interest rates (compared with a normal level) for an extended period would increase the "marginal crisis risk". The former amendment is consistent with Woodford's assumption that leverage is a positive function of the output gap.

In Section IV we take a closer look at some literature related to these two amendments to the loss function.

IV. Theory and empirical evidence related to the amendments to Norges Bank's monetary policy loss function

Higher weight on the output gap – some empirical evidence

The financial crisis starting in 2007 was preceded by a period of high economic growth and increased leverage. This is but one example of leverage rising with resource utilisation (and low interest rates), and financial instability arising from high leverage.

In order to investigate the relationship between credit and capacity utilisation more closely, we have studied the cycles of credit and GDP (mainland economy) using Norwegian data.[10] The most common approach to business cycle analysis is *time domain* analysis, where a Hodrick-Prescott filter is used to calculate a trend. From this point of view, the cycle is the time it takes to accomplish a peak-to-peak around the trend. Another perspective comes from the so-called frequency domain, and is analysed using spectral analysis. Each observed economic time series can be interpreted as consisting of *several cycles* with different frequencies. The economic process *at each point in time* can hence be viewed as *the sum* of the contributions from the different cyclical components. Some cycles will contribute importantly to this sum at each point in time throughout the observed time series. These are the important cycles as seen from the frequency domain analysis. For ease of communication, we divide these cycles into three categories:

[10] We draw on preliminary work by Andrew Binning, Aslak Kvinlog Bakke and others working on the ongoing "MAFI project" at Norges Bank.

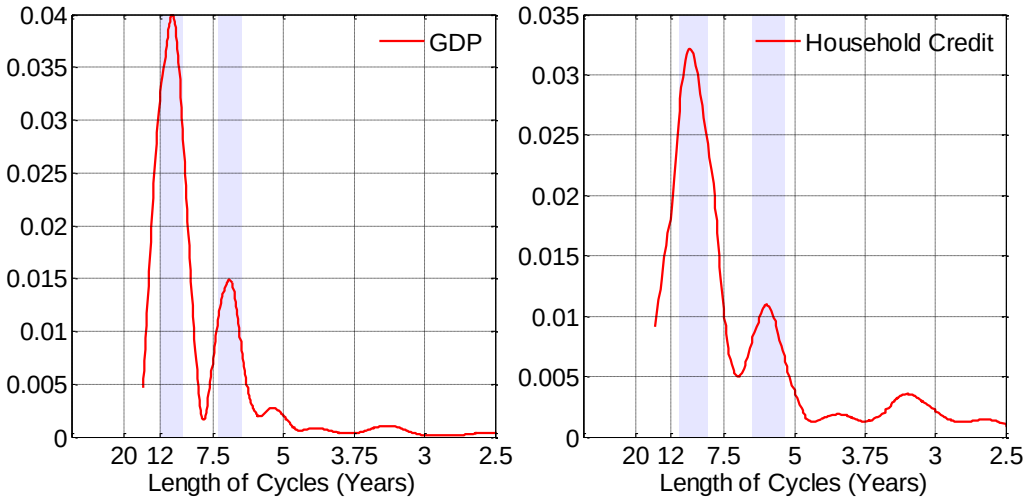
- Low frequency, which will be the trend including cycles of 15 years and longer
- Medium term, which are cycles of between 4 and 15 years
- High frequency, which will be the remainder, or the unsystematic noise components of the series

There seems to have emerged a common assumption that "the credit cycle is longer than the business cycle". Huge, long-lived waves in credit may have contributed to this view. Some recent econometric papers have looked into this question using spectral analysis. Aikman et al. (2011) look at lengthy time-series across 12 developed countries and find that credit cycles tend to be distinct from business cycles in amplitude as well as in frequency. Drehman et al. (2011) also find, looking at more than 50 years of data from 7 countries, that medium-term cycles are more pronounced in financial series than in GDP and have become longer and stronger in the past 25 years.

Also Norwegian data suggest that a larger part of credit than GDP may be connected to low-frequency cycles or long-lived trends. However, it could be argued that it is not the long-term cycles, but medium-term cycles, that are most relevant for monetary policy. It seems plausible that the longest waves (i.e. low-frequency cycles or trends) are mostly driven by factors other than monetary policy (e.g. income level, financial market structure and regulation, tax system, preferences). If medium-term cycles in credit and GDP are of broadly the same length, and in phase, it indicates that putting extra weight on the output gap in the conduct of monetary policy could help dampen credit cycles.

Yearly data on real GDP and real total credit for the period 1946-2010 suggest that several medium-term cycles account for a large portion of the variance of GDP, whereas low-frequency cycles account for a very large portion of the time-series variance for credit. One interpretation of these findings is that the rather strict regulation of credit in Norway over the larger part of the post-WWII period until 1985 may have stymied short- and medium-term cyclical movements in the credit series.

Chart 1 Spectral density for real GDP (mainland Norway) (1978Q1 – 2011Q3) and real household credit (1987Q4 – 2011Q3)



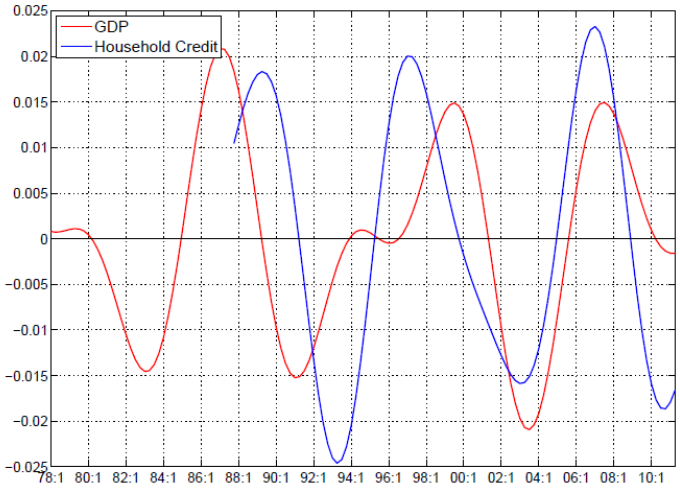
Source: Own calculations

Quarterly detrended[11] data on real GDP (mainland Norway) and real household credit for the period 1987Q4 – 2011Q3 exclude the period of credit regulation in Norway, and give a picture of the important cycles in the two data series (see Chart 1). A peak in the graph over a certain cycle range means that the corresponding cyclical components in the time series account for a portion of the variance of the series that is proportional to the area under this peak. The numbers on the y-axis are hence related to the variance of the variable.[12] The data on real GDP suggests (as did the yearly data) that a 6-7 year cycle and a 10-12 year cycle dominate the fluctuations, whereas data on real household credit suggest that slightly shorter cycles, i.e. a 5-6 year cycle and a 9-11 year cycle, dominate. Chart 2 shows medium-term cycles based on this analysis, and suggests that the correlation between GDP and credit is fairly high. In some periods GDP leads credit while in other periods the lead/lag seems to be the opposite. Based on the findings illustrated in Charts 1 and 2, one can conclude that Norwegian data suggest that medium-term cycles of household credit and GDP over the past 25 years have been broadly of the same length and tended to move together.

[11] A Band Pass filter, as suggested by Christiano and Fitzgerald (2003), was used to detrend the data, cutting at 15 years, i.e. components in the time series that belong to cycles longer than 15 years are disregarded.

[12] The values themselves on the y-axis cannot be interpreted in any meaningful way. What counts is the area under the graph over one range *relative* to the area under the graph over another range.

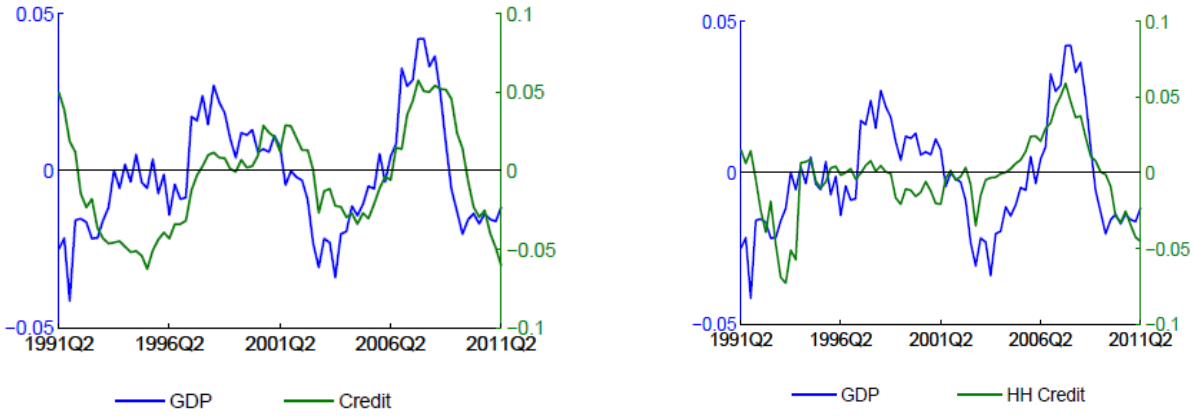
Chart 2. Medium-term cycles in GDP mainland Norway and household credit



Source: Own calculations

Turning to the time dimension, there is also a fairly strong correlation between the real credit gap and the output gap, see Chart 3 that shows the gaps measured as deviations from an HP-trend for both credit and GDP.[13]

Chart 3. Output gap and real total credit gap (left), and output gap and real household credit gap (right)

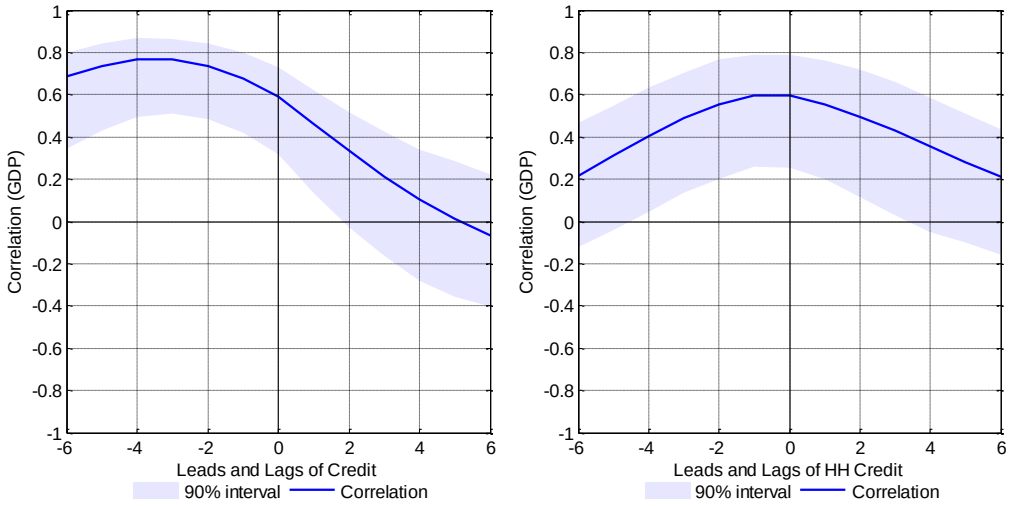


Source: Own calculations

[13] We have used a Hodrick-Prescott (HP) filter with λ=6400. Comparing these gaps with gaps calculated using a Band Pass filter with a cut-off at 15 years show small differences. This suggests that the gaps identified in the time dimension using a HP filter with a low λ picks up the relevant high and medium-term cycles in the data.

Chart 4 shows the correlations between the output gap and the total credit gap (left panel) and between the output gap and household credit gap (right-hand panel) – with different leads and lags between these variables. (The sample is 1991 Q3 - 2001 Q2). The main point is that the output gap is positively correlated with both the total credit gap and the household credit gap. Furthermore, according to this methodology, output leads credit by around 3 quarters while it leads household credit by 1 quarter.

Chart 4. Correlation: Output gap and total real credit gap (left) and output gap and household real credit gap (right)



Source: Own calculations

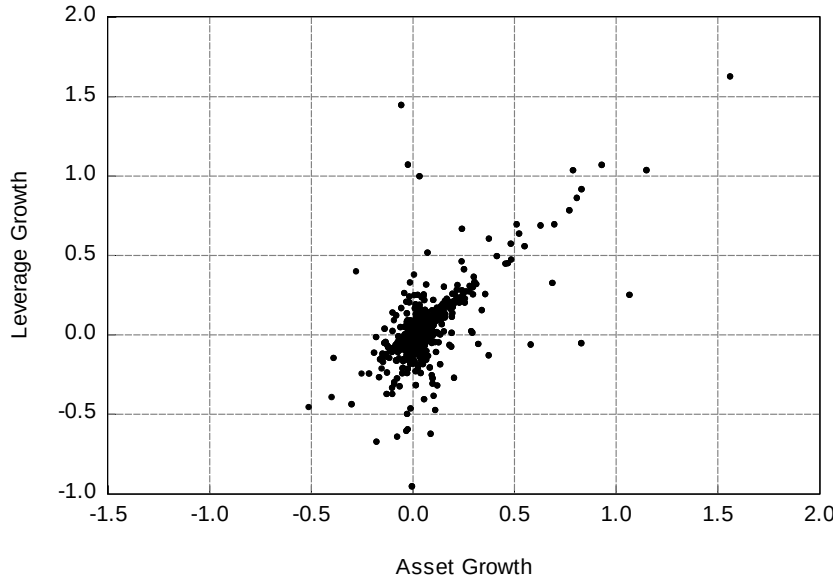
Overall, Norwegian data suggest that positive credit gaps tend to build up in periods with high output gaps. Hence, Norwegian data seem to support the idea that an increased weight on the output gap in the conduct of monetary policy may also help stabilise credit growth. This may help reduce the risk of growing financial imbalances.

Another piece of evidence suggestive of resource utilisation being linked to changes in a "marginal crisis risk" emerges from Norwegian banking data when we investigate whether banks increase their leverage during periods of high levels of economic activity. The hypothesis is that more highly leveraged banks represent a higher probability of future disruptions to the economy, and hence putting more weight on the output gap should help reduce the risk of future financial instability.

Looking at quarterly changes in leverage (calculated as total assets over Tier 1 capital) and changes in total assets for all Norwegian banks (excluding foreign branches) during the period 1991Q2-2011Q1, we find that leverage does tend to increase when banks' balance sheet size increases (see Chart 5). (Each dot in the chart represents a bank's quarterly combination of growth in leverage and in assets.)

The effect seems to be stronger for commercial banks than for savings banks, with the correlation between changes in leverage and changes in total assets being above 0.9 for commercial banks and a more modest 0.4 for savings banks. In other words, Norwegian banks, and commercial banks in particular, seem to increase their leverage during periods of high levels of economic activity.

Chart 5: Total assets and leverage of Norwegian commercial banks



Source: Norges Bank

The analysis using Norwegian banking data builds on Adrian and Shin (2010) who document that leverage in US investment banks is strongly procyclical. According to their paper, evidence points to "*a strongly positive relationship between changes in leverage and changes in balance sheet size. Far from being passive, the evidence points to financial intermediaries adjusting their balance sheets actively, and doing so in such a way that leverage is high during booms and low during busts. That is, leverage is procyclical*."

Furthermore, Riiser (2005 and 2008) finds that gap indicators (the gap between actual observations and trend) for real house prices, real equity prices, gross fixed capital formation and credit calculated on the basis of Norwegian data back to 1819 are useful in predicting episodes of financial instability. To the extent that these indicators are high during booms (i.e. periods of high output gaps), increasing the weight on the output gap in the loss function should also dampen their levels. Given that these indicators are not only symptoms of adverse economic developments but also causal factors, these analyses support the notion that a more stable output gap may reduce the occurrence of episodes of financial instability.

Incorporating an interest rate gap: Theory and evidence

The second step taken in order to take into account financial stability considerations in the Norwegian monetary policy loss function was to include the deviation between the actual and normal level of interest rates[14] (i.e. a nominal interest rate gap). Internationally, there has been a growing awareness of the risk that low interest rates over a prolonged period of time may increase risk-taking, deliberately or not, by banks, and also possibly by households (and non-financial firms). To the extent that there is a possibility that low interest rate levels increase risk-taking, and hence the probability of financial instability and economic disruptions, a robust monetary policy should put weight on avoiding excessively loose monetary policy over an extended period of time.

The economic literature suggests that low interest rates can influence banks' risk-taking in a number of ways.[15] The first way is through their impact on valuations, earnings, cash flows and measured risk. A reduction in the policy rate boosts asset and collateral values, which in turn can modify banks' risk perceptions (due to lowered probabilities of default, loss given default and volatility).

A second way the risk-taking channel may operate through is the "search for yield". Low interest rates may increase incentives for asset managers to take on

[14] Our definition of the normal interest rate is the interest rate that is consistent with an inflation and output gap at zero over the medium term. The normal (nominal key policy) interest rate a few years ahead is assumed to be around 4 per cent. The normal rate will typically be time-varying.

[15] This part is based on the description in Altunbas et al. (2010). See also Borio and Zhu (2008) and Rajan (2005) for a discussion about low levels of interest rates and risk-taking. Furthermore, in an empirical study, Jordà et al. (2011) find that short-term rates tend to be depressed in the run-up to global financial crises.

more risk for a number of reasons. Some are psychological or behavioural such as so-called money illusion: investors may ignore the fact that nominal interest rates may have been reduced due to lower inflation, hence they do not recognise how high real interest rates actually are. Others may reflect regulatory constraints. For example, life insurance companies in some countries have liabilities that are linked to a minimum guaranteed nominal rate of return. In an environment of reduced short-term rates, long-term bond yields may also fall. This may reduce the return on assets and tempt companies to compensate by taking more risk.

A third possible set of effects relates to moral hazard. Any anticipation among economic agents that monetary policy will be easy in economic downturns could lower the perceived probability of large downside risk, thereby producing an insurance effect. Such effects could have played a role in the run-up to the financial crisis in the US where anticipation of low interest rates may have been strengthened by the so-called Greenspan Put, whereby the financial sector believed that if it ever came under strain because of excessive expansion, the Federal Reserve would cut interest rates.

Diamond and Rajan (2009) for similar reasons argue that "*reducing interest rates drastically when the financial sector is in trouble, but not raising them quickly as the sector recovers could create incentives for banks to seek out more illiquidity than good for the system. Such incentives may have to be offset by raising rates in normal times more than strictly warranted by macroeconomic conditions."*

Turning to empirical evidence, there are only a few studies that try to test directly for the existence of a risk-taking channel. Identifying a relationship between interest rate levels and risk-taking in banks suggests the need for detailed information on loan contracts and non-performing loans. Jiménez et al. (2008) look at monthly information on all loans to non-financial firms by all credit institutions in Spain over the period 1985Q4 – 2006Q4. They find that when monetary policy is expansionary, not only do banks give more loans to borrowers with either bad or no credit history, but the new loans themselves are also more hazardous. The authors interpret this as evidence that following a monetary expansion, banks seek more credit risk. Tabak et al. (2010) find similar results

using Brazilian data.

Altunbas et al. (2010) provide further support for the existence of a risk-taking channel based on empirical findings for banks operating in the euro area and in the US. They find that banks increase risk-taking when interest rates are low for an extended period of time.

Karapetyan (2011) attempts to identify a potential risk-taking channel of monetary policy in Norwegian banks. The study does not find evidence of increased risk-taking following expansionary monetary policy. However, this study was performed using macro level data, and may therefore not pick up increased risk-taking in individual banks' loan portfolios. More research using micro level data needs to be performed before we can conclude that Norway is different from other countries in the sense that low interest rates do *not* lead to increased risk-taking by banks.

A bank risk-taking channel may play a smaller role in the Norwegian banking sector than in other countries due to, e.g., different institutional set-ups and financial market structures. But an even more important channel in the Norwegian economy may perhaps be that low levels of interest rates may increase risk-taking in other parts of the economy as well. In Norway, growth in household credit and house prices has, after a short dip in 2008, again gained momentum and both credit and house prices have now reached new record levels. To the extent that households form their expectations based on the (recent) past,[16] a prolonged period of low interest rates may induce households to accumulate more debt than is sustainable if they mistakenly conclude that future interest rate levels will be lower than a fully informed, rational agent would assume. In a (non-technical) sense this represents increased risk-taking by households as they increase their leverage when interest rates are low. It may well be that households are not aware of their increased risk-taking due to myopic behaviour and adaptive expectations. High household indebtedness may in turn be a strong contributor to financial instability and economic disruptions. Mian and Sufi (2010) find that areas in the

[16] Leece (2001) finds evidence using UK data that households adopt regressive (i.e. adaptive) interest rate expectations.

United States that experienced the largest run-ups in household leverage before the financial crisis typically experienced the most severe recessions. Theory and empirical evidence on the role of household expectations and the transmission of monetary policy are limited so far.

As we have shown there is some support in the literature for the proposition that an overly expansionary monetary policy may increase the risk of growing financial imbalances. The next question is then how to measure the monetary policy stance. Norges Bank has chosen one approach – a nominal interest rate gap. Using a nominal interest rate gap is simple. Under the assumption that inflation expectations are relatively stable, one could interpret variations in the nominal interest rate gap as a proxy of variations in the real interest rate gap. However, one could argue that using a real interest rate gap or a Taylor rule gap instead would capture the effects of the current monetary policy stance in a better way, although such approaches would raise new questions about how to best measure real interest rates etc.

V. Concluding remarks

Norges Bank's adjusted loss function is founded on three assumptions. First, there is a positive relationship between leverage and economic activity. This is the background for increasing the weight on the output gap in the loss function. We find empirical support for this assumption.

Second, incorporating the interest level in the loss function builds on the trivial and uncontroversial assumption that there is a relationship between interest rates, asset prices and debt. These relationships may be different for very low interest rates due to several possible mechanisms – often jointly referred to as "the risk-taking channel". Such non-linearities are difficult to identify, but here we have referred to some international empirical evidence.

Third, excessive debt may lead to not only financial instability but also to instability in the real economy. This is shown by the recent and past financial crises and is well documented in the literature.[17]

[17] See Reinhart and Rogoff (2009).

Norges Bank has taken one approach by including a deviation of the interest rate level from a normal interest rate and by increasing the weight on the output gap in the loss function. Although we find both empirical and theoretical support for such an approach, there are of course also other ways of addressing financial imbalances in a monetary policy loss function. The interest rate gap could, for example, be replaced by other variables – but such choices would typically raise new questions. There is also the question of whether the interest rate gap in the loss function should be symmetric. However, it seems reasonable that interest rates that are too high may also represent, at least in certain situations, a challenge to financial stability.[18]

Norges Bank indicates that financial imbalances might be handled differently in the monetary policy loss function in the future. As stated in MPR 1/12, the bank's assessments of economic relationships may change and its models may be further developed. New insight into the functioning of the economy and an enhanced understanding of how to mitigate risks of financial imbalances may influence the formulation of the loss function.

There is no doubt that macroeconomic models used for monetary policy analysis have shortcomings. For example, the effects of interest rates are linear in our models (which may be reasonable but we do not know with certainty) and the behaviour of the financial sector is not modeled properly. As long as there are considerable uncertainties regarding the effects of very expansionary monetary policy and other possible shortcomings in the central bank's analytical tools, it may be wise to take a precautionary approach by putting some weight on avoiding interest rates at very low levels for extended periods.

[18] For example, in Norway, real after-tax interest rates facing households surged from 0 percent in 1987 to more than 7 percent in 1992 (see Vale (2004)). This was probably one of the factors leading to the severe financial consolidation among households contributing to the economic downturn and the banking crisis in the early 1990s.

References:

Adrian, Tobias and Hyun Song Shin (2010): "Liquidity and Leverage" *Journal of Financial Intermediation*, 19 (3), 418-437, 2010

Aikman, David, Andrew G. Haldane and Benjamin Nelson (2011): "Curbing the credit cycle", paper presented at the Columbia University Center on Capitalism and Society Annual Conference "Microfoundations for Modern Macroeconomics", New York, November 2010 (revised March 2011), also available at www.voxeu.org

Akram , Q. Farooq and Øyvind Eitrheim (2008): "Flexible inflation targeting and financial stability: Is it enough to stabilize inflation and output?" *Journal of Banking & Finance 32 (2008) 1242–1254*

Alstadheim, Ragna, Ida Wolden Bache, Amund Holmsen, Junior Maih and Øistein Røisland (2010):"Monetary Policy Analysis in Practice", *Norges Bank Staff Memo* 11/2010

Altunbas Yener, Leonardo Gambacorta and David Marqués-Ibáñez (2010): "Does Monetary Policy Affect Bank Risk Taking?", *European Central Bank Working Paper* 1166

Angelini, Paolo, Stefano Neri and Fabio Panetta (2011): "Monetary and macroprudential policies", *Temi di Discussione* (Working Papers), No. 801, Banca D'Italia

BIS (2010): "Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements", Macroeconomic Assesment Group – Interim Report

Borio, Claudio and Philip Lowe (2002): Asset prices, financial and monetary stability: exploring the nexus", *BIS Working Paper*, No 114, Bank for International Settlements

Borio, Claudio and Philip Lowe (2004):"Securing sustainable price stability: Should credit come back from the wilderness?", *BIS Working Paper*, No. 157

Borio, Claudio and Haibin Zhu (2008): "Capital Regulation, Risk-Taking and Monetary Policy: A Missing Link in the Transmission Mechanism?", *BIS Working Paper*, No.268

Christiano, Lawrence J. and Terry J. Fitzgerald (2003): "The Band Pass filter", *International Economic Review*, Vol. 44, No. 2 (May, 2003), pp. 435-465

Diamond, Douglas W., and Raghuram G. Rajan (2009): "Illiquidity and Interest Rate Policy", *National Bureau of Economic Research Working Paper Series*, No.15197

Drehman, Mathias, Claudio Borio and Kostas Tsatsaronis (2011): "Characterising the financial cycle: don't lose sight of the medium-term!", paper presented at the

Reserve Bank of Chicago-ECB 14th Annual International Banking Conference, *The role of central banks in financial stability: How has it changed?*, Chicago, 10–11 November.

Eichengreen, B., M. El-Erian, A. Fraga, T. Ito, J. Pisani-Ferry, E. Prasad, R. Rajan, M. Ramos, C. Reinhart, H. Rey, D. Rodrik, K. Rogoff. H.S. Shin, A. Velasco, B. Weder di Mauro and Y. Yu (2011): "Rethinking central banking. Committee on international economic policy and reform", Brookings Institution, Washington DC

Haugland, Kjersti and Birger Vikøren (2006): "Financial stability and monetary Policy – theory and practice", *Economic Bulletin*, 1/06, Norges Bank

Jacobsen, Dag Henning and Bjørn Naug (2004):"What influences the growth of household debt?", *Economic Bulletin*, 3/2004, Norges Bank

Jacobsen, Dag Henning and Bjørn Naug (2005):"What drives house prices?", *Economic Bulletin*, 1/2005, Norges Bank

Jacobsen, Dag-Henning, Thea Birkeland Kloster, Aslak Bakke Kvinlog and Unni Larsen (2011): "Makroøkonomiske virkninger av høyere kapitalkrav for bankene", (in Norwegian only), *Norges Bank Staff Memo*, 14/2011

Jiménez, Gabriel, Steven Ongena, José Luis Peydrò og Jesùs Saurina (2008): "Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking?", *Banco de España Working Papers*, No. 0833, Banco de España

Jordà, Òscar, Moritz Schularick og Alan M. Taylor (2011): "Financial Crises, Credit Booms, and External Imbalances: 140 years of lessons", *IMF Economic Review*, Vol. 59, No.2

Karapetyan, Artashes (2011): "Credit, house prices, and risk taking by banks in Norway", *Norges Bank Staff Memo*, 13/2011

Leece (2001):"Regressive Interest Rate Expectations and Mortgage Instrument Choice in the United Kingdom Housing Market" *Real Estate Economics*, Vol. 29:4, pp.589-613

Lund, Kathrine and Ørjan Robstad (2012): "Effects of a new loss function in NEMO", *Norges Bank Staff Memo*, 10/2012

Mian, Atif R. and Amir Sufi (2010): "Household leverage and the recession of 2007 to 2009", *National Bureau of Economic Research Working Paper Series*, No. 15896

Norges Bank (2005): *Inflation Report* 1/05

Norges Bank (2005): *Inflation Report* 3/05

Norges Bank (2010): *Monetary Policy Report* 1/07

Norges Bank (2010): *Monetary Policy Report* 2/10

Norges Bank (2010): *Monetary Policy Report* 3/10

Norges Bank (2011): *Monetary Policy Report* 3/11

Norges Bank (2011): *Monetary Policy Report* 1/12

Qvigstad, Jan F. (2005): ”When does an interest rate path “look good”? Criteria for an appropriate future interest rate path – A practician’s approach”, *Norges Bank Staff Memo*, 6/05

Rajan, Raghuram G. (2005): “Has Financial Development Made the World Riskier?”, *National Bureau of Economic Research Working Paper Series,* No. 11728

Reinhart, Carmen M. og Kenneth S. Rogoff (2009): “This time is different”, *Princeton University Press*, 2009.

Riiser, Magdalena D. (2005): “House prices, equity prices, investment and credit – what do they tell us about banking crises? A historical analysis based on Norwegian data”, *Economic Bulletin,* 3/2005, Norges Bank

Riiser, Magdalena D. (2008): “Asset prices, investment and credit – what do they tell us about financial vulnerability?”, *Economic commentaries,* No. 6., Norges Bank

Svensson, L.E.O. (2012): “Comment on Michael Woodford, “Inflation Targeting and Financial Stability””, *Sveriges Riksbank Economic Review 2012:1*

Tabak, Benjamin M., Marcela T. Laiz and Daniel O. Cajueiro (2010): “Financial stability and monetary policy – the case of Brazil”, *Banco Central Do Brazil Working Paper Series*, No 217.

Vale, Bent (2004): “The Norwegian banking crisis”, Chapter 1 in Moe, Thorvald G., Jon A. Solheim and Bent Vale (eds): “The Norwegian banking crisis”, *Occasional Papers*, No. 33, Norges Bank

Woodford, M. (2012), “Inflation Targeting and Financial Stability”, *Sveriges Riksbank Economic Review 2012:1*