NORGES BANK

ØISTEIN RØISLAND (Ed.)

REVIEW OF FLEXIBLE INFLATION TARGETING (ReFIT)

END OF PROJECT REPORT

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May 2017

Foreword

Inflation targeting as a framework for monetary policy was introduced for the first time by New Zealand in 1990 and has since been adopted by more than 30 countries. In Norway, an inflation target was defined as the operational target of monetary policy and laid down in the form of a mandate in 2001.

Experience with inflation targeting, in Norway and internationally, has been predominantly positive The framework has provided a credible nominal anchor, while allowing monetary policy sufficient flexibility to respond appropriately to different shocks to the economy. Inflation targeting usually refers in practice to flexible inflation targeting. Both in Norway and internationally, central banks have moved towards a greater degree of flexibility than when inflation targeting was introduced. Flexibility in practice has been essential to achieving a balanced trade-off in response to economic shocks.

Even though inflation targeting has worked well, it is important to keep abreast of international developments in this field and conduct research into the appropriate monetary policy framework for a small, commodity-based economy such as Norway. Against this background, Norges Bank launched a research project in 2013 entitled ReFIT – Review of Flexible Inflation Targeting. This report contains a description of the research conducted and a discussion of the literature on the topics that have been the focus of the ReFIT project.

Even though the ReFIT project has now formally been concluded, Norges Bank will continue its research into a number of the issues discussed in this report. When circumstances change, we must be capable of adapting and revising our thinking. It is therefore important that in our conduct of monetary policy we learn from the past, keep up to date with international experience and take on board new insight provided by research.

Øystein Olsen

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1 Introduction

Øistein Røisland

In autumn 2013, Norges Bank launched a three-year research project to explore the potential for improvements in the monetary policy framework. The project, named ReFIT – Review of Flexible Inflation targeting – was headed by Øistein Røisland, with Professor Jordi Galí (Universitat Pompeu Fabra) and Professor Carl Walsh (University of California, Santa Cruz) as scientific advisers. Internal and external researchers and economists have contributed to the project (see box for research conducted under the ReFIT project).

Two conferences/workshops were organised under the ReFIT project:

- "Rethinking inflation targeting: New directions for monetary policy", 8–9 September 2016[1]
- ReFIT workshop, 21 April 2017[2]

The ReFIT project focused on two questions in particular:

- Should monetary policy incorporate financial stability considerations, and if so, how?
- What constitutes effective monetary policy formulation in a small, open, commodity-exporting economy such as Norway?

The first question was also explored in an earlier research project at Norges Bank – MAFI (Macrofinance Project) – which was launched in 2010. However, research in this field is evolving rapidly, and work on some of these issues naturally continued under the ReFIT project.

While we have been able to draw on extensive international research in our work on the first question, international research related to the second question is more limited. In order to analyse some of the issues particularly relevant to Norway, we have developed a large-scale three-sector model for the Norwegian economy that takes account of our specific industry structure, including oil-related activity. The model explicitly includes channels from the global to the Norwegian economy to a greater extent than Norges Bank's main model NEMO, but is, on the other hand, simpler than NEMO in other areas and does not include a financial sector. The three-sector model, NEMO and a number of smaller theoretical and empirical models have all been used to analyse the issues explored by the ReFIT project.

1 http://www.norges-bank.no/en/about/Research/Conferences/Rethinking-Inflation-Targeting/
2 http://www.norges-bank.no/en/about/Research/Conferences/2017-04-21-refit-workshop/

In autumn 2016, in connection with the preparations for a possible update of the monetary policy regulation, the Ministry of Finance requested input from Norges Bank on specific topics, such as the Bank's experience of monetary policy since 2001, the properties of alternatives to inflation targeting, the importance of stable inflation expectations and the challenges related to near-zero interest rates. The research and analyses conducted by ReFIT have provided useful background for Norges Bank's response to the Ministry of Finance.

This report provides a summary of international research in key areas relevant to the monetary policy framework and describes Norges Bank's own research contributions via the ReFIT project. The conclusions and assessments in the report are the authors' own and do not necessarily represent Norges Bank's assessments. The report is structured as follows:

Chapter 2 discusses the properties of inflation targeting and alternative targeting regimes. It is argued that modern monetary policy theory supports the view that optimal monetary policy can be implemented within a flexible inflation targeting framework, but that considerable flexibility may be necessary. This could create challenges with regard to accountability and confidence in the nominal anchor.

If fixed exchange rate regimes are disregarded, there are in practice only two alternatives to inflation targeting that are being discussed internationally: price level targeting and nominal GDP targeting. Price level targeting could contribute to inflation and output stability by making the expectations channel of monetary policy more effective. This could be particularly important in situations where the room for manoeuvre in monetary policy is constrained by the lower bound on policy rates. Price level targeting could, however, lead to greater economic imbalances compared with inflation targeting if expectations are not forward-looking or the price level target is not credible.

Nominal GDP targeting has some of the same properties as price level targeting with regard to increasing the effectiveness of the expectations channel. In addition, stabilising nominal GDP will to some extent safeguard the consideration of financial stability. For small, commodity-exporting economies such as Norway, nominal GDP targeting will also imply an appropriate response to shocks to the economy. However, nominal GDP targeting could be more demanding to communicate than inflation targeting, both because it is less familiar than inflation targeting and because the figures for nominal GDP are often subject to considerable revision.

Chapter 3 discusses alternative inflation targeting frameworks, including the choice of target index, the level of the inflation target and differences between target ranges and point targets with or without tolerance intervals. With regard to the choice of target index, international practice is to target the overall consumer

price index, typically because the consumer price index is the most relevant measure of prices paid by households and enterprises.

Strict inflation targeting with the overall consumer price index as the target index could, however, be detrimental to real economic and financial stability. If so, it may be appropriate to choose a target index that to a greater extent reflects underlying drivers of inflation and perhaps to include house prices directly in the target index. A disadvantage of such alternative target indexes may be that the central bank ends up stabilising a measure of inflation that is not known to or understood by the public. Such indexes may also be difficult to construct in practice. In Chapter 3, it is argued that if the central bank practises flexible inflation targeting, monetary policy can target the overall consumer price index and still gain the benefits of stabilising alternative target indexes.

On the subject of the choice of level for the inflation target, research does not provide a clear answer. On the one hand, there are a number of arguments to support the view that inflation makes the utilisation of economic resources less efficient, particularly when inflation is high and variable. On the other hand, inflation that is too low can also pose challenges to the economy. In practice, most inflation targeting countries aim for annual inflation of around 2%. An important reason to aim for above-zero inflation is the existence of a lower bound for the nominal interest rate.

Most inflation targeting countries use a point target. Most central banks using a point target also include a tolerance interval around the target. The interval reflects the central bank's level of ambition and shows that there is uncertainty around the inflation projections. The alternative to a point target is a target range for inflation. Common to both target ranges and tolerance intervals is that there is an area where the central bank does not attempt to fine-tune inflation. Thus, both can be regarded as ways of increasing the room for manoeuvre in monetary policy. At the same time, tolerance intervals and target ranges can contribute to the central bank's accountability. Inflation that exceeds the limits will result in sanctions against the central bank. For central banks with a longer time horizon and more flexible inflation targeting, the freedom to allow inflation to vary around the target is assured in that it is the inflation projections that are required to hit the inflation target, not current inflation.

Chapter 4 discusses a range of factors related to flexibility in inflation targeting. Flexible inflation targeting usually refers to taking output and employment into account to the extent there is a conflict in the short term between stabilising inflation at target and stability in output and employment. First, there is a discussion of how stability in output and employment, usually combined as the output gap, can be measured. In this chapter, the primary focus is on two issues that have been the

subject of research under the ReFIT project: the importance of labour immigration for the measurement of potential output and to what extent developments in financial variables are relevant to the measurement of capacity utilisation.

The chapter goes on to discuss the weight that is given to the output gap and the implications of the horizon for the achievement of the inflation target. We review international practice and conclude that inflation targeting has become more flexible in Norway and internationally, resulting in a somewhat longer horizon for achieving the inflation target.

For independent central banks, flexibility in inflation targeting requires a certain level of accountability. This issue is discussed in principle in this chapter, and we explore international practice with regard to transparency and accountability in monetary policy. The greater the flexibility in inflation targeting, the more important are accountability and communication requirements.

The degree of flexibility and transparency also has implications for credibility. The last part of this chapter focuses on the anchoring of inflation expectations. If inflation expectations in the medium and long term are stable close to the target, a given change in the central bank's policy rate can result in a stronger and more predictable change in real interest rates, which are the rates that are most important for most financial decisions. The more firmly anchored to the target inflation expectations are, the more actively it will be possible to use monetary policy to take account of considerations other than price stability, such as stability in output and employment. At the same time, there may be a risk of the anchor slipping if monetary policy gives too much emphasis to considerations other than price stability. Research results indicate that long-term inflation expectations in Norway are firmly anchored. For shorter forecast horizons, inflation expectations appear to be most closely correlated with developments in actual domestic inflation.

Chapter 5 discusses the relationships between monetary policy and financial stability. Empirical evidence for Norway indicates that the impact of the policy rate on financial imbalances may, in isolation, be considerable. Many studies find that the policy rate does not have a particularly strong effect on credit relative to GDP, and this result also holds for Norway. But the policy rate has a more significant effect on property prices and bank balance sheets. If we also include the effects of the policy rate on house prices and banks' wholesale funding, it appears that the overall effect of monetary policy on the probability of financial crisis may be greater than indicated by previous studies.

Studies of whether it is appropriate to "lean against the wind" in monetary policy, by giving some weight to financial imbalances when setting the policy rate, indicate that benefits in the form of less frequent and milder financial crises might

compensate for larger deviations from monetary policy objectives in the short term. This conclusion is sensitive to whether or not households and businesses recognise that a crisis could occur and the degree to which curtailing financial imbalances reduces the depth of financial crises. If economic agents are aware that a crisis can occur at regular intervals, they will take this into account, and there may then be nothing to be gained from "leaning". This is in line with most international research, which seems to find that the costs of "leaning" exceed the benefits. However, research in this field is relatively limited so far and is evolving rapidly.

This chapter also discusses the room for manoeuvre to take financial stability into account in monetary policy in a small, open economy. Empirical studies indicate that with Norway's flexible exchange rate, the room for manoeuvre in monetary policy is intact. A higher policy rate in Norway does not contribute to higher capital inflows, which could otherwise have made it more difficult to use the policy rate for financial stability purposes. Furthermore, empirical evidence indicates that Norwegian monetary policy is effective in coping with global credit cycles. The exchange rate softens the impact of uncertainty shocks that are typically associated with global credit cycles, and indeed such shocks do not seem to be associated with capital outflows from Norwegian banks.

Finally, this chapter discusses the interaction between monetary policy and macroprudential instruments. Research results imply that monetary policy should not necessarily "lean" when other instruments are available. If macroprudential tools have a stronger effect on financial imbalances than the policy rate, the result may be that monetary policy should lean "with" the wind – although the conclusion again depends on the premises. If the effect of the tools is uncertain, a more reasonable response is to use both the policy rate and macroprudential tools in such a way that they both have a dampening impact on financial imbalances.

ReFIT publications

Alstadheim, R. and C. Blandhol (2017) "Domestic monetary policy, uncertainty shocks and capital flows in a small open economy – the case of Norway". Forthcoming, *Norges Bank Working Papers.*

Alstadheim, R, Ø. Robstad and N. H. Vonen (2017) "Financial imbalances and monetary policy in Norway". Forthcoming, *Norges Bank Working Papers.*

Alstadheim, R. and Ø. Røisland (2017) "When preferences for a stable interest rate become self-defeating". *Journal of Money, Credit and Banking* 49, pp 393–415 (*Norges Bank Working Paper*s 8/2016).

Bergholt, D. (2017) "Optimal price stability for commodity producers: the role of terms of trade shocks". Forthcoming, *Norges Bank Working Papers.*

Bergholt, D. and V. H. Larsen (2016) "Business cycles in an oil economy: lessons from Norway". *Norges Bank Working Papers* 16/2016.

Bergholt, D., V. H. Larsen and M. Seneca (2017) "Business cycles in an oil economy". *BIS Working Papers* No 618.

Brubakk, L. and Ø. Røisland (2018) "Inflation Targeting and Alternatives: The Trade-Off between Flexibility and Accountability". Forthcoming, *Norges Bank Working Papers*.

Ellingsen, J. (2017) "Relationships between nominal GDP and financial variables in OECD countries". *Staff Memo* 4/2017. Norges Bank

Erlandsen, S. and P.B. Ulvedal (2017) "Are Norwegian inflation expectations well-anchored?". Forthcoming, *Staff Memo.* Norges Bank.

Ferrero, A. and M. Seneca (2015) "Notes on the underground: monetary policy in resource-rich economies". *Norges Bank Working Papers* 2/2015.

Furlanetto, F. and Ø. Robstad (2016) "Immigration and the macroeconomy: some new empirical evidence". *Norges Bank Working Papers* 18/2016.

Gelain, P., K. J. Lansing and G. J. Natvik (2015) “Leaning against the credit cycle”. *Norges Bank Working Papers* 4/2015.

Gerdrup, K. R., F. Hansen, T. Krogh and J. Maih (2016) “Leaning against the wind when credit bites back”. Norges Bank Working Papers 9/2016 (forthcoming in *International Journal of Central Banking*).

Hagelund, K. (2016) “Produksjonsgap og finansielle variable” [The output gap and financial variables]. *Staff Memo* 14/2016. Norges Bank. (In Norwegian only.)

Husabø, E. (2017) “Indicators of underlying inflation in Norway”. Forthcoming *Staff Memo.* Norges Bank.

Karapetyan, A. (2016) “The risk-taking channel of monetary policy in Norway”. *Norges Bank Working Papers* 5/2016.

Natvik, G. and T. Sveen (2017) “Immigration, capacity utilisation and monetary policy”. Forthcoming, *Norges Bank Working Papers*.

Røisland, Ø. (2017) “On the Interplay between Monetary Policy and Macroprudential Policy: A Simple Analytical Framework”. *Norges Bank Working Papers* 18/2017.

2 Inflation targeting and alternative monetary policy strategies

Øistein Røisland[1]

2.1 INTRODUCTION

The primary objective of monetary policy is price stability, in the sense of low and stable inflation. Historically, central banks have often been set an operational "intermediate target" to ensure that the central bank achieved its primary objective and at the same time increase monetary policy transparency. To meet these requirements, the target had to be a variable that monetary policy could control in the short term. Exchange rate targets and monetary aggregate targets have been the most widely used intermediate targets.

An inflation target cannot be characterised as an intermediate target, partly because monetary policy can only control inflation in the short term to a limited extent. The introduction of inflation targeting in New Zealand in 1990 was a fairly radical change in monetary policy compared with common practice. As far as inflation targeting is concerned, it could be said that practice preceded theory. The view expressed by Persson and Tabellini (1993) was probably prevalent among economists: "*Why do we observe central banks rarely held accountable for the rate of inflation?...It may be that a commitment to a more readily observable nominal variable, such as a monetary aggregate or the exchange rate, is easier to enforce. A second possible answer is that central bankers would not like to be held accountable for something they do not control tightly, and hence are more liable to miss rather often."*

Because experience indicated that monetary targeting is not successful[2] and exchange rate targeting is demanding when capital flows freely across national borders, an increasing number of countries have abandoned intermediate targets in favour of inflation targeting. Today, over 30 countries operate an inflation targeting monetary policy regime.

1 This chapter is to a great extent based on Øistein Røisland's paper "Valg av styringsmål for pengepolitikken: Hva sier forskningen?" [Choosing the operational target of monetary policy: a review of the research], published in "Erfaringer med inflasjonsmål for pengepolitikken" [Experience with inflation targeting as a framework for monetary policy], Arbeidsnotat 2017/4, Ministry of Finance (in Norwegian only).

2 Mishkin (1999).

International experience with inflation targeting is predominantly positive.[3] There are few relevant alternatives and much of the debate focuses on how inflation targeting can be improved. The main alternatives to inflation targeting that are being discussed internationally are *price level targeting* and *nominal GDP targeting*.[4]

In this chapter, we first discuss the theoretical basis for flexible inflation targeting. We then summarise the research on price level targeting and on nominal GDP targeting, with particular focus on the properties of nominal GDP targeting in the context of the Norwegian economy. Finally, we discuss, within the framework of principal agent theory, the degree of flexibility a central bank should have in allowing the target variable to deviate from the target in order to take other considerations into account.

2.2 THE THEORETICAL BASIS OF INFLATION TARGETING

The costs of inflation have long been the subject of research, and low and stable inflation has been regarded as the primary objective of monetary policy. However, it was not until the evolution of New Keynesian theory that inflation targeting received a solid theoretical foundation. New Keynesian theory is based on many of the same assumptions as Real Business Cycle theory, deriving macroeconomic effects from microfoundations of household and firm behaviour. However, in contrast to Real Business Cycle theory, New Keynesian theory assumes that there are market imperfections in the form of monopolistic competition and price and wage rigidities. In recent years, the model has been further expanded to include heterogeneous agents and a number of types of imperfection, including financial imperfections.

Michael Woodford has been the most influential contributor to New Keynesian theory.[5] An important result of his research was that monetary policy would deliver the highest possible welfare, in terms of the utility of the representative consumer, by minimising the following "loss function":

$$L_t = \pi_t^2 + \lambda y_t^2 \qquad (1)$$

where π_t is inflation[6], yt is the output gap and λ is the relative weight given to output stability and inflation stability. The above loss function can be described as *flexible inflation targeting*. Flexible inflation targeting had thus been given a welfare-theoretic foundation.

3 See Norges Bank (2017).
4 Alternative price indexes under inflation targeting are discussed in Chapter 3.
5 His main contribution to this theory is summarised in his book *Interest and Prices* (Woodford, 2003).
6 In Woodford's model, the optimal inflation rate is zero. More generally, π in equation (1) can be interpreted as the inflation *gap*, ie the deviation of inflation from the target.

The description of the welfare loss as a loss function (1) is based on a very simple model. In the simplest New Keynesian model, there is no conflict between inflation stability and output stability, as inflation is only dependent on the output gap.[7] Monetary policy can therefore concentrate on stabilising inflation, which will result in output that is always at the socially optimal level. This result is often referred to as "divine coincidence".[8] The result, however, is not very robust. For example, a shock to the Phillips curve could mean that the central bank must face a trade-off between inflation stability and output gap stability. In more realistic models with a number of market imperfections, the welfare loss function will also be more complicated than the simple loss function in equation (1). In addition to inflation and the output gap, the welfare loss function can include unemployment, wage growth, the real exchange rate and financial stability, defined as the stability of a relevant financial variable around an equilibrium level. In many models featuring financial imperfections, financial stability will have a direct influence on welfare, and not merely because of the risk of instability in the output gap further ahead. The reason is often that the distribution of risk across different households is not perfect, so that financial instability generates undesirable distributional effects and uncertainty that cannot be insured against.[9] In addition, fluctuations in some financial variables can result in a less efficient allocation of capital.[10]

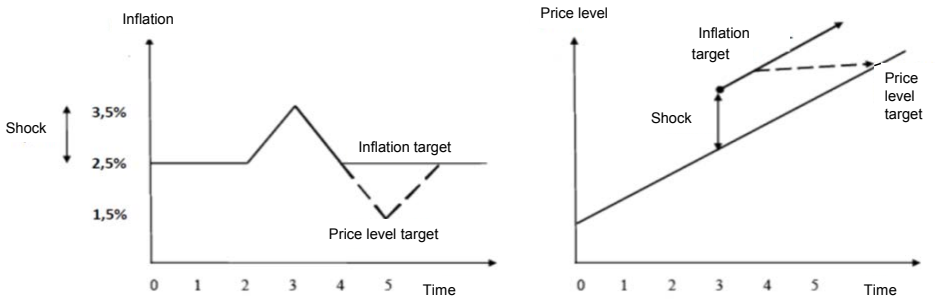
These recent monetary policy research results do not argue against inflation targeting, as inflation is still an important variable to stabilise. But the results imply that it is important for inflation targeting to be *flexible* and to take sufficient account of output, employment and, if necessary, other variables if the objective is to achieve the highest possible degree of social welfare. An objective function for monetary policy specifying a number of variables it is intended to stabilise will, however, face challenges with regard to transparency and accountability. A somewhat simpler mandate for the central bank than the monetary policy mandate that, according to theory, is ideal may therefore be justified.

2.3 PRICE LEVEL TARGETING

Price level targeting is a strategy whereby monetary policy is oriented towards keeping the level of prices (for example as measured by the CPI) close to a pre-defined path. Price level targeting does not necessarily imply zero inflation, as the pre-defined path may include a rise in the price level over time, for example at the same pace as under an inflation targeting regime (Chart 2.1). If a shock occurs that

7 The output gap is measured here as the deviation from the level it would have had if all nominal variables were completely flexible and if there were also a subsidium to ensure that equilibrium output did not become too low as a result of monopolistic competition.
8 This expression was first used by Blanchard and Galí (2007).
9 See for example Nisticò (2016).
10 See for example Woodford (2012a).

Chart 2.1 Inflation target versus price level target. It is assumed that inflation will increase unexpectedly by one percentage point in period 3. The chart shows subsequent developments under an inflation target and a price level target.



pushes inflation below target, the objective of monetary policy under an inflation targeting regime is to bring inflation back to target. Under price level targeting, monetary policy is oriented in such a way that inflation moves above the implied inflation target for a period so that the price level reverts to the pre-defined target path. Thus, while inflation targeting implies that "bygones are bygones", price level targeting means that the central bank takes previous deviations from the target into account.

Like flexible inflation targeting, price level targeting can be flexible, where the horizon for bringing the price level back to the target path depends on to what extent developments in output and employment are taken into account. Thus, price level targeting does not necessarily mean that the central bank should aim for deflation if inflation has been high for a period. Both because the target path may indicate that the price level should gradually increase and because the central bank can choose a longer horizon for achieving the price level target, price level targeting may, in principle, entail that the central bank always aims for positive inflation.

There has been little practical experience of price level targeting monetary policy. The only historical example is Sweden in 1931–1937, when the Riksdag (the Swedish parliament) tasked Sveriges Riksbank with stabilising the price level.[11] There is, however, disagreement about whether the Riksbank in reality operated a price level targeting regime.[12] The arguments in favour of price level targeting are therefore primarily based on theory and not on experience.

11 See Berg and Jonung (1999).

12 Straumann and Woitek (2009) argue that the Riksbank in reality pursued a fixed exchange rate policy.

2.3.1 Theoretical arguments in favour of price level targeting

Reduced uncertainty about the future purchasing power of the currency

Under inflation targeting, deviations from the target will have permanent effects on the price level (base drift). Under price level targeting, previous deviations from the target are corrected and as a result do not have permanent effects on the price level. Uncertainty with regard to the future purchasing power of the currency is therefore reduced under price level targeting. This may be important to agents trading in long-term securities where the return is not indexed to the price level, as is the case for the majority of debt contracts. An unexpected decrease in the price level will increase the real value of debt, while an unexpected increase in the price level will reduce its value. Uncertainty around the real value of debt can involve costs for the individual agent and make financial planning more difficult. It can also result in undesirable distributional effects.[13]

Effect on expectations

In the discussion of inflation targeting versus price level targeting, the most prominent argument is the effect of price level targeting on expectations with regard to future monetary policy. According to theory, price level targeting can increase the effectiveness of the expectations channel of monetary policy, which may be particularly important if monetary policy is constrained by a lower bound on interest rates.

Within simple New Keynesian models, stabilising inflation and stabilising output around its natural level are the best contribution monetary policy can make to the primary objectives of economic policy, cf loss function (1) in Chapter 2.2. A feature of optimal monetary policy in such New Keynesian models is that the central bank should aim to bring the price level back to its starting point if a shock to inflation has occurred. Even when there is stability in inflation, and not stability in the price level, which is relevant to welfare in such models, monetary policy should aim to "overshoot" the inflation target if inflation has fallen below the target. An optimal policy under inflation targeting is therefore similar to price level targeting in these models. According to theory, such a reaction pattern increases the effectiveness of the expectations channel of monetary policy as firms will adjust their prices to a lesser extent to accommodate changes in costs and market conditions. This results in a better trade-off between stability in inflation and stability in output and employment. For a more detailed discussion of this mechanism, see the box in this chapter entitled "Optimal policy under commitment and discretion".

In practice, it can be demanding to commit to bringing the price level back to the level it would have had if the shock had not occurred. Once the shock that led to

13 See Meh et al (2010).

the deviation unwinds, the central bank no longer has an incentive to allow inflation to deviate from the target to bring the price level back. Monetary policy thus faces a time inconsistency problem.

If the central bank is not able to commit in any credible manner, institutional measures can strengthen the commitment mechanism. One such institutional measure is a price level target set for the central bank by the political authorities. A price level targeting monetary policy regime can, within a standard New Keynesian model, be close to an optimal policy under commitment and thereby achieve a better trade-off between stability in inflation and stability in employment and output.[14]

The favourable properties of price level targeting may in theory be even more important in situations where the policy rate is at or near its lower bound. If the economy is in a situation where a lower real interest rate is needed, but where the central bank cannot reduce the nominal interest rate any further, an increase in inflation expectations is the only way to reduce the real interest rate. Under inflation targeting, the central bank will normally attempt to bring inflation up to, but not above, the target if inflation has fallen below target. The inflation target will therefore have a limiting effect on the potential rise in inflation expectations and the fall in the real interest rate. With a price level target, inflation would in this situation have to be higher than the implicit target to bring the price level up to the target path. If economic agents have confidence in the price level target, inflation expectations will increase more and the real interest rate will thereby be lower than under inflation targeting. The literature indicates that a credible price level targeting monetary policy can therefore shorten the duration of a downturn where the policy rate is at or near its lower bound. In addition, the probability of such situations arising can be lower for the same reason.[15]

2.3.2 Arguments against price level targeting

The beneficial properties of price level targeting rely to a great extent on forward-looking, rational agents and a credible price level target. If these conditions are not fully in place, price level targeting could result in less stability in inflation and the real economy than under inflation targeting.

Research suggests that inflation expectations are not fully rational and forward-looking. If this is the case, the benefit today of a commitment to overshoot the inflation target in the event of a deviation will be smaller. Price level targeting

14 See Vestin (2006). Svensson (1999) shows that price level targeting can also deliver a favourable outcome within types of model frameworks other than the New Keynesian model.

15 Because the likelihood of reaching the lower bound is lower under price level targeting, the optimal pace of inflation under price level targeting may be lower than the optimal level of inflation under inflation targeting. See Coibion et al. (2012).

could then result in less stability in inflation and the real economy than under inflation targeting.[16]

The credibility of a price level targeting regime is crucial for the beneficial effects of expectations to outweigh the costs of bringing the price level back to the target path. If economic agents expect the authorities or the central bank, with some probability, to change the target path for the price level or switch to inflation targeting, price level targeting could result in less nominal and real stability than inflation targeting.[17] Credibility could in particular be impaired if shocks have occurred that have pushed the price level far away from the target. The costs of bringing the price level back to the target path could then be perceived as considerable, prompting the formation of expectations that the target path will be changed. This will in turn increase the costs of achieving the target, and expectations could thus be self-fulfilling.

Achieving a price level target in a context of low credibility or backward-looking expectations could imply a substantial monetary policy tightening or stimulus to force prices back to the target. Price level targeting also shares some similarities with exchange rate targeting. Exchange rate targeting is a regime whereby the domestic price and cost level must adjust to the price and cost level in those countries whose currency serves as a nominal anchor. Experience of exchange rate targeting shows that it can be demanding to maintain the credibility of the target if the domestic price and cost level has moved away from the level that is consistent with the exchange rate target over time.

Another disadvantage of price level targeting is that, in contrast to inflation targeting, it forces the central bank to respond to temporary shocks to inflation that it would otherwise be appropriate to disregard, such as temporary changes in energy prices.[18] However, this problem can be avoided to some extent by specifying an index for underlying inflation that excludes this type of disturbance and where the price level target is defined in relation to this index.

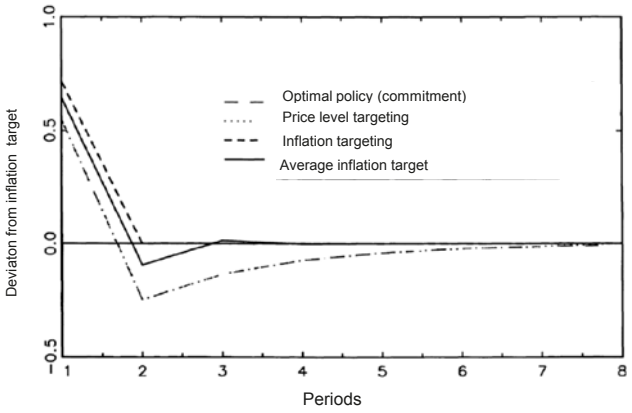
A more practical argument against price level targeting focuses on how easy it is for the public to understand. People can generally relate to inflation, but not to the price *level*. A price level target will therefore be more demanding for a central bank to communicate. It may be pedagogically challenging to explain, for example, why a period of contraction and low inflation is necessary after a period of high inflation.

16 See Steinsson (2003). It is assumed here that this group's inflation expectations are based on a rule-of-thumb according to which expected inflation in the next period is equal to inflation in the previous period. If the adaptive expectation formation process is more sophisticated than the simple rule-of-thumb assumption above, Gaspar et al (2007) show that price level targeting is not necessarily such a bad alternative.

17 Kryvtsov et al (2008).

18 See Andersson and Claussen (2017).

Chart 2.2 Inflation developments (in the short term) after a positive cost shock under different targeting regimes. The chart is taken from Nessén and Vestin (2005), who analyse different targets within a simple New Keynesian model frame. With the exception of "optimal policy", the policy response is derived under the condition of discretion. In the model, optimal policy under commitment is almost identical to price level targeting under discretion.



In connection with the five-yearly renewal of the agreement on the inflation control target, "Renewal of the Inflation-Control Target" for 2012–2016, the Bank of Canada conducted research into price level targeting. The conclusion was: *"[...] the potential benefits of [price-level targeting] over the inflation-targeting framework did not clearly outweigh the costs and the risks of moving away from a policy framework that had resulted in well-anchored expectations and strong central bank credibility."* [19]

2.4 AVERAGE INFLATION TARGETING

Something in between a price level target and an inflation target is a target for *average inflation.* In the same way as price level targeting, average inflation targeting would seek to bring inflation slightly above target for a period if it has been below target so that average inflation will be closer to the target. However, as this would not be done to the same extent as under price level targeting, the deviation from the target would to some extent have a permanent effect on the price level, though less so than under inflation targeting (ie partial base drift). (See Chart 2.2 for a comparison with inflation targeting and price level targeting.)

A target for average inflation has in theory many of the same properties as a price level target, but is more robust to the absence of rational expectations and full credibility.[20] In addition, a target for average inflation is probably simpler to communicate to the public than a price level target, although it may be somewhat more

19 See Bank of Canada (2016).
20 Nessén and Vestin (2005).

demanding than an inflation target. A balance between the gains and risks of price level targeting versus inflation targeting can be found through the choice of period for the average. If a very long period is used to calculate average inflation, for example 20 years, a target for average inflation will in practice be similar to a price level target, with the same potential gains and risks. If a relatively short average period is chosen, it will be similar to an inflation target.[21]

2.5 NOMINAL GDP TARGETING

The idea that monetary policy should be oriented towards stabilising nominal GDP (hereafter referred to as NGDP) is far from new,[22] but has received relatively wide attention in the monetary policy debate of recent years. In particular, the challenges related to the lower bound for the policy rate have brought NGDP into focus. As with inflation targeting versus price level targeting, a distinction can be made between a target for *growth* in NGDP and a target for the *level* of NGDP.

While the arguments in favour of price level targeting are that it reduces the time inconsistency problem and increases the effectiveness of monetary policy, the arguments in favour of NGDP targeting focus on both the time inconsistency problem and accountability. In recent years, the debate has been dominated by NGDP level targeting as, within New Keynesian theory, level targeting has a more favourable effect on expectations than growth targeting. This is regarded as an important property when expansionary monetary policy is constrained by the lower bound for the interest rate.

Since NGDP level targeting is also a monetary policy regime that has not been tested in practice, the arguments in favour of such a target are mainly based on economic theory.

2.5.1 Arguments in favour of NGDP targeting

The main argument in favour of NGDP targeting is that it provides a good balance between the considerations of nominal stability and output stability, as NGDP gives equal weight to the GDP deflator and real GDP. NGDP targeting can also be regarded as an indirect way of stabilising the money supply that is robust to changes in the velocity of money.[23]

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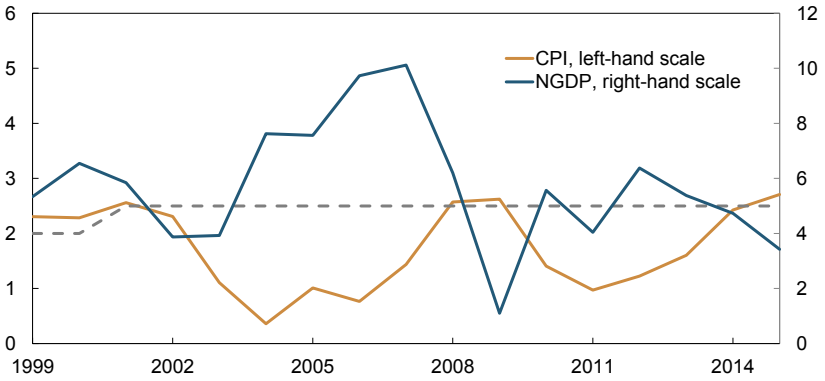
21 Strictly speaking, today's inflation targeting regime could be regarded as targeting average inflation over 12 months.

22 See Meade (1978) von Weizsacker (1978) and Tobin (1980).

23 The quantity equation can be written as MV=PY, where M is the money supply, V is the velocity of money and PY is nominal income (approximately equal to NGDP). If M is stabilised and there are considerable variations in V, this will lead to similar variations in PY. This is one of the reasons economists of the so-called "market monetarist" school, headed by Scott Sumner, have been vocal advocates of NGDP targeting.

Chart 2.3 Annual percentage change in nominal GDP and consumer prices. 1999 – 2015



Sources: Statistics Norway and Norges Bank

The idea of NGDP targeting experienced a renaissance when the New Keynesian revolution in monetary policy theory started in earnest towards the end of the 1990s. Like price level targeting, NGDP targeting is history dependent[24], which within this theory has a beneficial effect on expectations.[25]

As mentioned above, the challenges related to the lower bound for the interest rate have in particular brought the debate on NGDP targeting into focus. NGDP level targeting can make it easier to escape a liquidity trap.[26] Michael Woodford expanded on this argument and other properties of NGDP level targeting in his Jackson Hole lecture in 2012.[27] A target for the NGDP level has many of the same properties as a price level target. Compared with a price level target, an NGDP target has the advantage of a built-in emphasis on the real economy, while with a price level target, the real economy must be taken into account primarily in the form of deviations from the target, ie *flexible* price level targeting.

The above arguments are related to NGDP targeting as a way to increase the effectiveness of monetary policy by exploiting the expectations channel more effectively. The other argument for operational targets, mentioned in the introduction, is related to accountability. The less a central bank needs to deviate from the target to take other considerations into account, the more accountable monetary policy will,

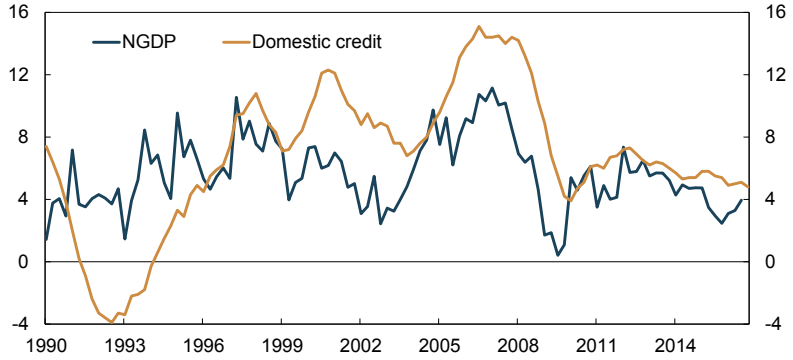
24 Level targeting (price level or level of NGDP) implies history dependence in the sense that previous deviations from the target are corrected. An NGDP growth target is somewhat less history dependent, but results from the inclusion of the previous period's GDP level in the target variable (ie the change in level since the previous period).

25 Jensen (2002) uses a simple New Keynesian model to show that NGDP growth targeting performs better than inflation targeting unless the economy is primarily subject to a pure demand shock. Garín *et al* (2016) show in a slightly larger New Keynesian DSGE model that strict NGDP targeting can deliver a better outcome than strict inflation targeting if the frequency of supply side shocks is sufficiently high.

26 Eggertsson and Woodford (2003).

27 Woodford (2012b).

Chart 2.4 Developments in nominal GDP and credit. Four-quarter percentage change. 1990 – 2016



Source: Statistics Norway

in principle, be. As mentioned above, NGDP targeting gives the same weight to the real economy as to inflation. In a sense, NGDP targeting can be regarded as an operationalisation of a "dual mandate". Even if flexible inflation targeting also takes the real economy into account, there is, in principle, less need to deviate from the target under NGDP targeting than under inflation targeting, noted by Charlie Bean (2013) as a positive property of NGDP targeting.

Chart 2.3 shows that nominal GDP and consumer prices have not always moved in step in Norway. This indicates that NGDP targeting would have resulted in a somewhat different monetary policy compared with inflation targeting, at least with relatively strict inflation targeting and NGDP targeting.

Recent research shows that NGDP can also have a favourable impact on financial stability. As most debt contracts are specified based on a given notional amount, unexpected changes in a debtor's nominal income will lead to undesirable changes in debt ratios. Stabilisation of NGDP will thus increase the stability of debt ratios and reduce undesirable distributional effects between lenders and borrowers.[28]

Research conducted by Norges Bank also suggests that a target for NGDP growth has at the same time a dampening effect on fluctuations in house prices. Part of the reason for this is that the GDP deflator captures changes in house prices to a greater extent than the CPI through the housing investment component. In general, NGDP seems to be fairly highly correlated with house prices and credit growth both in Norway (Chart 2.4) and internationally[29], indicating that stabilising NGDP growth could also dampen fluctuations in house prices and debt.

28 See Koenig (2013) and Sheedy (2014).
29 See Ellingsen (2017).

In the literature, alternative targets are often compared based on an assumption that the target variable is completely stabilised, ie with no flexibility. It is not surprising then that an NGDP target often delivers a better outcome than an inflation target, since an NGDP target automatically gives weight to developments in the real economy.[30] But inflation or NGDP targeting as strict as this is not realistic and could result in a biased ranking of the two alternative targets. In order to compare the properties of alternative targeting regimes, a comparison should ideally be made based on varying degrees of flexibility. See the box *Operational targets for monetary policy – a mathematical illustration* for a mathematical description of alternative operational targets under varying degrees of flexibility.

Brubakk and Røisland (2018) have simulated monetary policy under a flexible inflation targeting regime and a flexible NGDP targeting regime in Norges Bank's macroeconomic model NEMO. It is assumed that the welfare loss is greater the more instability there is in CPI inflation, the output gap and house prices.[31] The latter is not necessarily an objective in itself, but a simple approach to show that there may be costs and risks associated with financial instability that current macro models are not able to capture adequately.

The results show that inflation targeting requires a relatively high level of flexibility for monetary policy to have a stabilising effect on the variables that are assumed to influence welfare (inflation, the output gap and house prices). With NGDP targeting, the costs of less flexibility are lower. The reason for this is that as developments in nominal GDP are far more strongly correlated with developments in output and house prices than the consumer price index, a relatively strict form of NGDP targeting will to a great extent automatically take account of the other goals monetary policy is expected to achieve. These results therefore indicate, in isolation, that an NGDP target is more suitable than an inflation target if accountability is regarded as important.[32] See the box *Optimal inflation targeting in an open economy* for a more detailed description of these results.

Some research shows that an NGDP targeting framework for monetary policy may be well suited to small, open economies with substantial terms-of-trade fluctuations[33], particularly if the alternative is strict CPI inflation targeting.[34] The reason is partly that NGDP targeting implies weight given to the real economy through the target variable itself, but also that changes in the terms of trade have different effects on

30 The weight of 1 given to output may, however, deviate from "lambda" in the loss function.

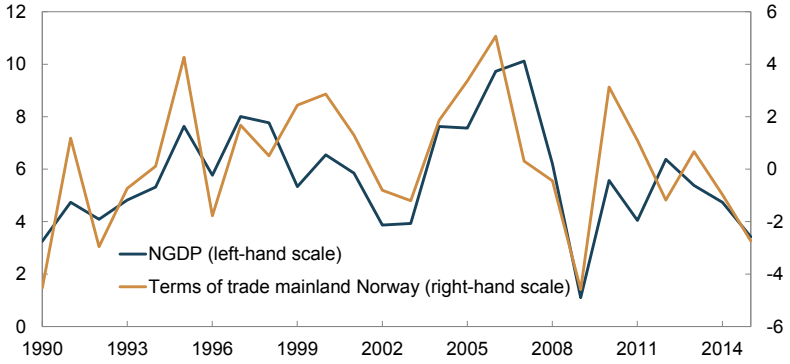
31 The welfare loss function is specified as $L_t = \pi_t^2 + y_t^2 + 0{,}1b_t^2$, where b_t is real house prices, measured as the deviation from the long-term equilibrium.

32 Given the assumption regarding the welfare loss function, strict NGDP targeting is not necessarily the optimal approach, partly because it is assumed that welfare is affected by CPI inflation, and developments in the CPI will often deviate to some extent from the GDP deflator.

33 The terms of trade show the relationship between export prices and import prices.

34 Bhandari and Frankel (2015) and Bergholt (2014).

Chart 2.5 Terms of trade (mainland Norway) and nominal GDP. Annual percentage change. 1990 – 2015



Source: Statistics Norway

the CPI index and the GDP deflator. For example, a deterioration in the terms of trade as a result of lower export prices will normally lead to an increase in CPI inflation as a result of a depreciation of the exchange rate. Because the GDP deflator contains export prices, it will increase less than the CPI and may also fall. Chart 2.5 shows that there is a fairly strong positive correlation between mainland Norway's terms of trade and NGDP. In isolation, this implies that monetary policy will have a countercyclical effect if the terms of trade change under NGDP targeting.

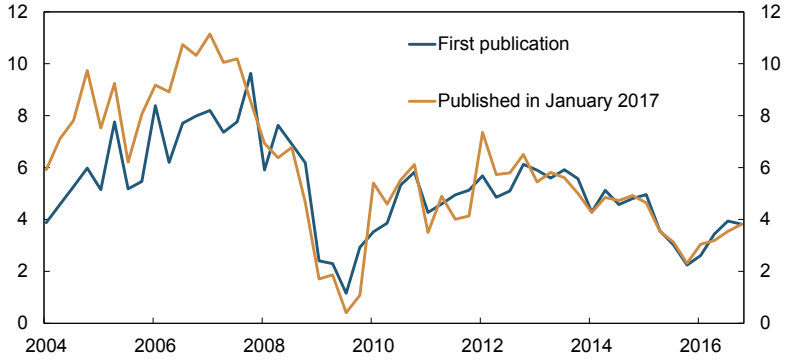
Bergholt (2017) has studied alternative targeting frameworks for monetary policy based on a three-sector model for the Norwegian economy.[35] The main focus of the study is the effect of international shocks, including changes in the terms of trade, on the Norwegian economy under different targeting regimes. The analysis, which is described in Appendix 4 to this chapter, shows that NGDP targeting will to a great extent deliver on the objectives of monetary policy, as represented by stable inflation and stability in output and employment.

2.5.2 Arguments against NGDP targeting

An obvious argument against an NGDP target compared with an inflation target is that NGDP is not as familiar to the public as inflation, which makes NGDP targeting more demanding to communicate. Particularly in situations where the central bank has to take "unpopular" decisions, such as an interest rate increase in the event of a negative supply-side shock, it could be an advantage to have an operational target that the public understands.

35 The model is an open economy DSGE model with a commodity sector (oil), a manufacturing sector and a service sector. The global economy is also modelled.

Chart 2.6 Nominal GDP for mainland Norway. Seasonally adjusted. Four-quarter percentage change. 2004 Q4 – 2016 Q4



Another disadvantage of NGDP targeting is that the numerical target value must be based on an uncertain estimate of trend growth in (real) GDP. On the one hand, it could be a disadvantage that a change in trend growth implies a change in the implicit inflation target if the NGDP growth target is kept unchanged. On the other hand, this could also be an advantage in view of the risk of the lower bound for the interest rate becoming binding as a result of lower trend growth.[36] Lower trend growth normally implies a lower neutral real interest rate. With an unchanged inflation target, this will increase the risk that the lower bound will become binding. But with an unchanged NGDP growth target, the implicit inflation target will increase by as much as the decrease in trend GDP growth. This will hold up the neutral nominal interest rate in spite of the fall in the neutral real interest rate.

It has also been argued that NGDP targeting may not anchor inflation expectations as successfully as inflation targeting.[37] However, it is not necessarily the case that the anchoring of inflation expectations will be weakened, as an NGDP-targeting central bank could still publish projections for CPI inflation that are consistent with the NGDP target. These projections will normally be close to the implicit inflation target[38] at the end of the forecast horizon. Some even argue that an NGDP target can be implemented within an inflation targeting framework, where the inflation target provides a nominal anchor in the medium term, while the NGDP target provides a concrete expression of the strategy the central bank is aiming for within the horizon for the achievement of the inflation target.[39]

36 See Williams (2016).
37 See Bean (2013) and Andersson and Claussen (2017).
38 The implicit inflation target under NGDP targeting is the level of inflation that is consistent with the NGDP growth target when (real) GDP grows in pace with its long-term trend.
39 Woodford (2013).

One of the most important arguments against NGDP targeting is related to data access. First, NGDP figures are published on a quarterly basis, in contrast to the CPI, which is published monthly. Second, the NGDP figures are often subject to considerable revision, as shown in Chart 2.6. This makes it more demanding to evaluate monetary policy. In addition, major revisions to NGDP figures back in time create the impression that monetary policy was based on incorrect data. Even though a forward-looking monetary policy must in practice still be based on uncertain real time projections of a number of economic variables, substantial revisions to the target variable itself will make the communication of monetary policy more demanding.

2.6. CONCLUSIONS

Modern monetary policy theory supports the notion that optimal monetary policy can be conducted within a flexible inflation targeting framework. But with the exception of very simple models, the theory implies that inflation targeting must be quite flexible and take account of other variables in addition to inflation and output to make the best possible contribution to welfare.

Assigning a price level target to the central banks could be advantageous if the central bank is not able to commit to an optimal policy. Price level targeting could then contribute to inflation and output stability by making the expectations channel of monetary policy more effective. This could be particularly important in situations where the room for manoeuvre in monetary policy is constrained by the lower bound on the policy rate. Price level targeting could then increase the credibility of the central bank's commitment to keep monetary policy expansionary for a long time, which would stimulate demand today. Price level targeting could, however, lead to greater economic imbalances compared with inflation targeting if expectations are not forward-looking or the price level target is not credible.

A nominal GDP target could be advantageous for the same reasons as a price level target. Compared with relatively strict inflation targeting, a nominal GDP target could provide a better trade-off between stability in inflation and stability in output and employment. In addition, stabilising nominal GDP would to some extent take financial stability considerations into account. For small, commodity-exporting economies such as Norway, nominal GDP targeting would also imply a better monetary policy response to international shocks than inflation targeting, unless the inflation targeting regime is sufficiently flexible. However, a nominal GDP target could be more demanding to communicate than an inflation target, both because it is less familiar than an inflation target and because the figures for nominal GDP are often subject to considerable revision.

The formulation of the monetary policy mandate involves a trade-off between the flexibility to respond appropriately to shocks on the one hand and accountability on the other. If sufficient accountability is ensured by limiting the room for deviation from the target, it is important that the choice of target variable takes account of the various considerations monetary policy should take into account. If there is a very high degree of flexibility, the choice of target variable is less important for the practical implementation of monetary policy. Accountability must then be ensured by other means, such as requirements with regard to transparency and disclosure. For further discussion, see Chapter 4.

Optimal policy under commitment and discretion

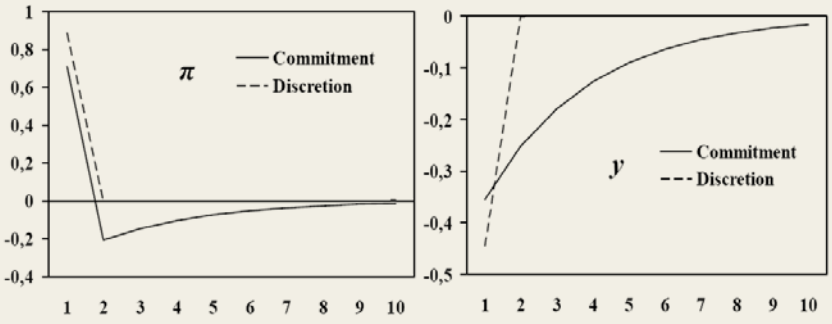
New Keynesian theory assumes that prices are sticky in the short term. Firms will therefore take expected future costs as well as today's costs into account in price setting. Expectations of higher (marginal) costs in the future will therefore already push up inflation today. The expectations channel of monetary policy is a key element of this theory. Firms are forward-looking in their price setting, and consumers take expected future interest rates into account when making consumption decisions today. Because agents' decisions depend on expectations with regard to the future, it would be an advantage to society if the central bank were able to establish commitment to a specific strategy.

The opposite of commitment is discretion. Discretion means that the central bank is not able to establish a commitment to a specific strategy, but decides what the policy rate should be in each period based on what it deems to be appropriate given its objectives and the state of the economy.

In Chart 1, it is assumed that a positive inflation shock occurs, for example as a result of an increase in labour costs. Under discretionary monetary policy, the central bank will face a trade-off between the objective of price stability and the objective of real stability and will raise the policy rate when the shock occurs. The output gap turns negative as a result of the policy rate increase and inflation rises above the target, but is not as high as it would have been without the increase in the policy rate. In the next period, the shock has unwound and the central bank will then choose to return the rate to its normal level to bring inflation back to target and close the output gap, as illustrated by the broken lines.

If the central bank can operate under commitment, it will signal its intention that the policy rate will not be returned to its normal level in the next period, but will be reduced gradually over time. If the policy rate is higher than the normal rate when the shock has unwound, the output gap will remain negative and inflation will fall below the target. In the periods after the shock has unwound, such a policy will in isolation seem unwise, as the central bank could have brought inflation back to target and closed the output gap by setting the rate at the normal level. The central bank has therefore an incentive to renege on its commitment to a tight policy in the period after the shock has unwound.

Chart 1. Impact on inflation and output gap due to inflation shock with commitment and discretion. π is inflation and y is output gap



The benefit of establishing a commitment to an "unwise" policy after the shock has unwound is achieved when the shock occurs. If firms expect inflation to be lower than the target in the subsequent periods, they will raise prices to a lesser extent when labour costs increase than if they expect inflation to remain at target. The benefit achieved when the shock occurs will always outweigh the costs in the form of poorer performance once the shock has unwound.[1] In a simple standard New Keynesian model, inflation will remain below target in the subsequent periods long enough for the price level to revert to its pre-shock level.

1 Judging by the areas between the curves and the target in the chart, the costs of commitment might seem to be higher than the benefits. But since the welfare loss function is quadratic, larger deviations from the optimal value will tend to result in higher losses than smaller, but more long-term deviations. Thus, an assessment of losses should not only be based on the size of these areas.

Operational targets for monetary policy – a mathematical illustration

In the literature, it is commonly assumed that the target for monetary policy can be represented in a simple welfare loss function. What is included in the welfare loss function generally depends on the model, ie which market imperfections are modelled. In practice, the focus is often on simple loss functions with variability in inflation and variability in the output gap.

Furthermore, some of the more recent literature shows that variability in financial variables also generates welfare losses in addition to the effect such fluctuations can have on the output gap, eg in the form of the risk of a financial crisis.[1] It is commonly assumed that the loss function is quadratic, and that monetary policy's primary task of is thus to minimise

$$E_t \sum_{k=0}^{\infty} \beta^k L^*_{t+k}, \qquad (1)$$

where E_t is the expectation operator and β is a discount factor (in practice close to or equal to 1). L^*_t is the period loss given by

$$L^*_t = (\pi_t - \pi^*)^2 + \lambda(y_t - y^*_t)^2 + \gamma(f_t - f^*_t)^2, \qquad (2)$$

where π_t is inflation, π^* is the optimal level of inflation, y_t is output, y^*_t is the equilibrium level (or optimal level) of output, f_t is a financial variable (or indicator) and f^*_t is the optimal level of the financial indicator. As it is, in practice, unclear which variables should be included in f_t and what the correct level of f^*_t is, the equation here must be regarded as a conceptual framework. There is broad consensus that the weight given to the output gap, λ, should be positive, while there is more disagreement about whether monetary policy should give weight to "financial stability" in itself, ie whether γ should be zero or positive. It is included in the loss function here to allow for monetary policy to take these considerations into account.

An operational target consists of a specified target variable (eg CPI inflation, the exchange rate, nominal GDP, etc) and a numerical value for this variable, ie

$$z_t = z^*_t \qquad (3)$$

1 See eg Woodford (2012a), Disyatat (2010) and Nisticò (2016).

where z_t is the relevant target variable and z_t^* is the numerical value. In the literature, it is not uncommon to assume that central banks set the policy rate to achieve the operational target perfectly at all times. This is probably most realistic under exchange rate targeting, while for other operational targets it is often neither possible nor desirable to achieve the target at all times. In practice, flexible targets will therefore be more realistic, and we model operational targets in the same way as Kenneth Rogoff (1985), who analysed the optimal degree of flexibility in monetary policy. Instead of minimising the welfare loss function, it is assumed that the central bank minimises a weighted sum of the welfare loss function and the deviation from the operational target:

$$L_t = (1-\theta)\, L_t^* + \theta(z_t - z_t^*)^2$$
$$= (1-\theta)\,(\pi_t - \pi^*)^2 + (1-\theta)\,\lambda(y_t - y_t^*)^2 + (1-\theta)\,\gamma(f_t - f_t^*)^2 + \theta(z_t - z_t^*)^2$$

The weight θ measures the degree of flexibility. If $\theta = 1$, there is no flexibility, ie the central bank only focuses on achieving the operational target. If $\theta < 1$, the central bank also takes account of fluctuations in the variables that affect welfare. Alternative operational targets can have differing optimal degrees of flexibility. For example, the optimal degree of flexibility can be greater with an inflation or price level target than with a nominal GDP target, since nominal GDP has an inherent weight on output.

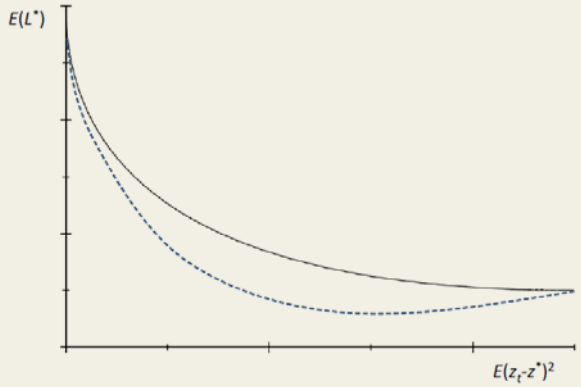
An inflation target ($z_t = \pi_t$) will in itself only take account of stability in the real economy to the extent that shocks to the economy are purely demand shocks. In the event of supply-side shocks (or, more precisely, shocks that create a trade-off between π_t and y_t), it will be appropriate to deviate from the target, ie inflation targeting should be flexible. The more important supply-side shocks are, the more flexible inflation targeting should be.

A **price level target** can be written as

$$z_t = p_t,$$
$$z_t^* = p_0 + \pi^* t$$

where p_t is the price level target (in logarithmic form) and p_0 is the price level when the price level target was introduced. Here, the optimal degree of flexibility will depend on the extent to which a price level target increases the effectiveness of monetary policy through a more effective management of expectations.

Chart 1 Relationship between welfare loss and degree of flexibility relative to the operational goal. The solid curve shows the case where the central bank can commit while the dotted curve shows the case where it can not commit



A target for **nominal GDP** growth can be written as

$$z_t = \pi_t + (y_t - y_{t-1}),$$
$$z_t^* = \pi^* + g^*,$$

where g^* is trend GDP growth. Here, we disregard the possibility that for a small, open economy, the difference between the GDP deflator and the CPI can be non-negligible and assume for the sake of simplicity that inflation as measured by the GDP deflator and the CPI is the same. As it is the change in GDP and not the level of output that is included in NGDP growth, stabilising NGDP growth will in isolation imply that that the output gap should not be closed rapidly when output is outside equilibrium. On the other hand, such a policy gives weight to the output gap in the previous period, making monetary policy history-dependent, which can increase its effectiveness.[2]

2 See Jensen (2002).

A **nominal GDP level target** can be written as

$$z_t = p_t + y_t,$$
$$z_t^* = p_0 + y_0 + (\pi^* + g^*)t.$$

Since an NGDP level target contains both the price level and the level of output, this target can also be regarded as a form of flexible price level targeting.

There is generally a trade-off between the degree of achievement of the operational target, eg as measured by the expected quadratic deviation $E(z_t - z_t^*)^2$, and the welfare loss measured by EL_t^*. The unbroken line in the chart is based on an assumption that the central bank can operate under commitment regardless of the operational target. Giving weight to the operational target ($\theta > 0$) will then lead to increased welfare losses, and the curve will show a negative slope throughout. There may nonetheless be reasons to give weight to an operational target, eg on the basis of democratic arguments for accountability. If the central bank cannot operate under commitment unaided, the operational target can lead to more effective monetary policy. Giving some weight to the operational target will then result in lower welfare losses, as illustrated by the broken line. There will then be an "optimal" weight for the operational target that minimises EL_t^*. If accountability in monetary policy is considered important in itself, the weight given to the operational target can be somewhat greater than the weight that in isolation minimises EL_t^*. The position on the curve depends on the operational target under consideration. One operational target may be better than another when high weight is given to the target (low flexibility), while the ranking across the alternative targets can be different for more flexible specifications.

Optimal inflation targeting in an open economy

Drago Bergholt

Norway is small, open economy and thus at times exposed to considerable movements in its terms of trade. These movements influence the mainland economy via trade channels and financial networks. Ensuing shocks across markets and sectors can involve significant trade-offs in the conduct of monetary policy: the objective of low and stable inflation must be weighed against real economic prospects. Developments in the global economy thus lay important premises for interest rate setting at Norges Bank. Global commodity prices are naturally part of the picture.

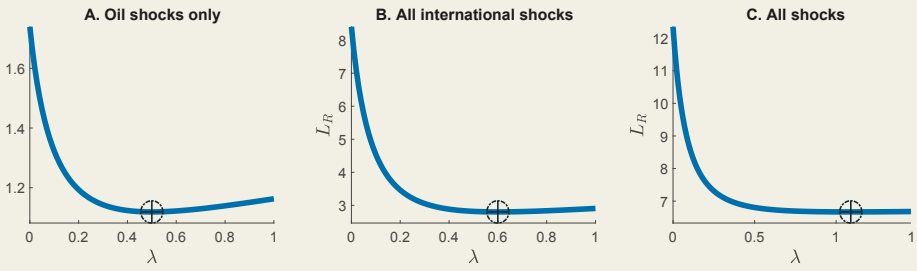
We analyse inflation targeting regimes in a commodity-exporting economy, partly based on Bergholt (2017). We assess the significance of flexibility in the monetary policy mandate and compare the properties associated with different operational targets. The theoretical framework is an augmented New Keynesian model for the Norwegian economy developed at Norges Bank (Bergholt and Larsen 2016, Bergholt, Larsen and Seneca 2017). The model explicitly incorporates channels from the international economy and takes into account Norway's specific industry structure.[1] The welfare costs associated with macroeconomic shocks are derived from household utility. The monetary policy that minimises these costs is called optimal. Welfare, however, depends on one of a number of nominal and real frictions. The true cost function is thus very complicated, which poses challenges with regard to communicating optimal monetary policy. With due regard for transparency and accountability, it may therefore be appropriate to represent the objectives of monetary policy using a simpler, quadratic loss function:

$$L_t^* = (\pi_t - \pi^*)^2 + \lambda(y_t - y_t^*)^2$$

π_t represents annualised quarterly consumer price inflation, while y_t is mainland GDP. The expression can be interpreted as an approximation of the

1 The framework distinguishes between mainland Norway on the one hand and the petroleum industry and the international economy on the other. Mainland consists of the non-tradable and tradable sectors. A supplier industry links mainland firms to activity in the petroleum industry. Public expenditure is financed partially through the fiscal rule for spending of petroleum revenues. The oil price and other international variables are determined endogenously by global supply and demand conditions. Dynamics are driven by a number of foreign shocks in addition to shocks to the mainland economy. The model is estimated on Norwegian and international data for the period 1995Q1-2015Q4 and provides a relatively good description of the macroeconomic picture during that period. We refer to Bergholt and Larsen (2016) for further documentation.

Chart 1 Relationship between welfare loss and λ

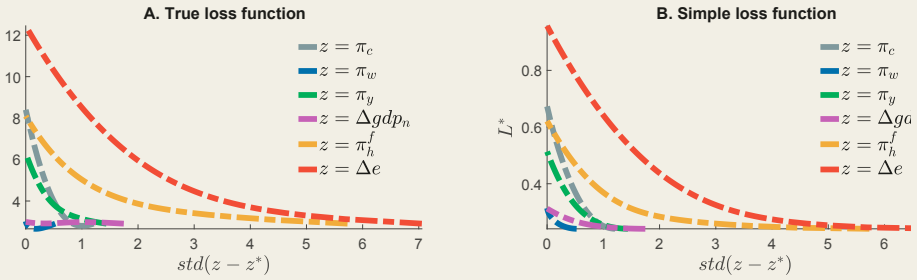


welfare costs.[2] Alternatively, it can be understood as an objective function for a flexible inflation targeting mandate, where λ quantifies the degree of flexibility provided by the mandate to deviate from the inflation target π^*.[3] In both cases, the weight on the output gap is an important factor in evaluating monetary policy, and entirely different values of λ have been proposed.[4]

If the central bank operates under a flexible inflation targeting mandate, the following question must be answered: What is a reasonable trade-off between nominal and real economic stability. We shed light on this question by estimating the true welfare loss in the model, L_S, given that the central bank minimises L^*. The exercise is repeated for different values of λ. Chart 1 reports selected results. In Chart 1.A we only look at the effect of the oil price shock. Chart 1.B takes into account all international shocks while chart 1.C also includes shocks to the mainland economy. The optimal weight depends on the shocks applied, but in all cases substantial inflation targeting flexibility is an advantage.[5] The chart also illustrates an asymmetry: a too low weight on the output gap can result in a substantially greater welfare loss than a too high λ. Uncertainty linked to the functioning of the economy and to the optimal trade-off between the inflation target and real economy stability therefore suggest that the central bank should give extra weight to the latter. Hereafter, we refer to a flexible inflation targeting mandate where con-

2 In some special cases, L^* is consistent with actual welfare costs, see Woodford (2003) for example.
3 We assume here that the central bank minimises the delegated objective function, and that all economic agents observe and understand the commitment equilibrium. These assumptions are conventional in the academic literature on monetary policy (see eg Woodford (2003)). Incentive problems and information frictions are discussed further in Section 4.3.
4 According to standard New Keynesian theory, λ should have a value of around 0.05 (Woodford (2003)). In larger policy models, however, the optimal weight on output can exceed 1 (see Debortoli, Kim, Lindé and Nunes (2015) and Adolfson, Laséen, Lindé and Svensson (2011, 2014).
5 The optimal value of λ in the three cases is 0.5, 0.6 and 1.1 respectively.

Chart 2 Welfare loss under different monetary policy regimes



sumer prices constitute the objective and λ is set optimally as optimal, flexible inflation targeting.

The academic literature has discussed a range of alternative monetary policy targets.[6] We can shed light on them by assuming that the central bank's objective function is a weighted sum of L^* and (quadratic) deviations from an operational target $z = z^*$, as in Rogoff (1985):[7]

$$L_t = (1 - \theta)\, L_t^* + \theta(z_t - z_t^*)^2$$

The expression above comprises as special cases (i) the flexible inflation targeting mandate described earlier ($\theta = 0$) and (ii) strict targeting regimes ($\theta = 1$). We compare the two alternative regimes by simulating the model for different values of θ, and for different operational targets z. Under the simulations $\lambda = 1$. This calibration provides a reasonable compromise between the inflation target and the consideration of real economic stability, cf discussion above. The following (annualised) targets are considered: (i) consumer price inflation π, (ii) wage inflation π_w, (iii) domestic producer price inflation πp, (iv) nominal GDP growth Δgdp_n, (v) export price inflation π_h^f, and (vi) nominal exchange rate growth Δe.[8]

6 In addition to consumer price stability, the literature has among other things studied stabilising producer prices (Galí and Monacelli 2005, Monacelli 2005), wage inflation (Erceg, Henderson, Levin 2000, Campolmi 2014, Galí and Monacelli 2016), nominal GDP (McCallum and Nelson 1999, Frankel 2010a), external terms of trade (Frankel 2003, 2010b), and exchange rate targeting (De Paoli, 2009, Corsetti et al, 2010).

7 See box "Operational target for monetary policy – a mathematical illustration" for a further description of this objective function.

8 If $\theta = 1$ and $z = \Delta e$, the regime is a fixed exchange rate regime or a currency union.

Chart 2 provides a summary of the results when we condition on all international shocks in the model.[9] The horizontal axis in each chart reports the volatility of the different target variables measured by the annualised standard deviation. The vertical axis quantifies the costs expressed as L_S (welfare loss) in Chart 2.A and L^* (the simple loss function) in Chart 2.B. The curves are constructed by simulating the model for values of θ from 0 to 1. Movements towards the left along a curve imply an increase in θ. An optimal, flexible inflation targeting mandate ($\theta = 0$) results in only small movements in nominal wage inflation, but accompanied by relatively high export price and exchange rate volatility. The latter is a relative price that both can and should respond to international shocks. In our case, nominal wage rigidities lead to costly misallocations in the labour market, and these misallocations are limited if the necessary real wage changes occur via the exchange rate rather than nominal wage adjustments.

As to the different target variables, we find a clear welfare ranking when $\theta > 0$. Nominal wage and GDP growth stand out as particularly good targets, and the costs associated with these variables depend to a marginal degree on the objective. For the other target variables, we generally find a positive relationship between welfare costs and θ. This is because the consideration of nominal stability becomes too dominant at the cost of the real economic picture. With the exception of nominal wage and GDP growth, the losses could become especially high under strict targeting regimes ($\theta = 1$). Among the alternatives analysed here, a fixed exchange rate regime entails the worst welfare properties, but all strict inflation targets entail substantial costs compared with nominal and GDP stabilisation. Finally, it is worth noting that the ranking of the different target variables shows little change if costs are instead estimated based on the simple loss function. The qualitative similarities between Charts 2.A and 2.B thus illustrate that a simple, quadratic loss function can be used to evaluate monetary policy, given that the weight on real economic stability is set in reasonable way.

9 Bergholt (2017) also explores other types of shock and decomposes the disturbances.

Model simulation of the properties of nominal GDP targeting and inflation targeting

Leif Brubakk and Øistein Røisland

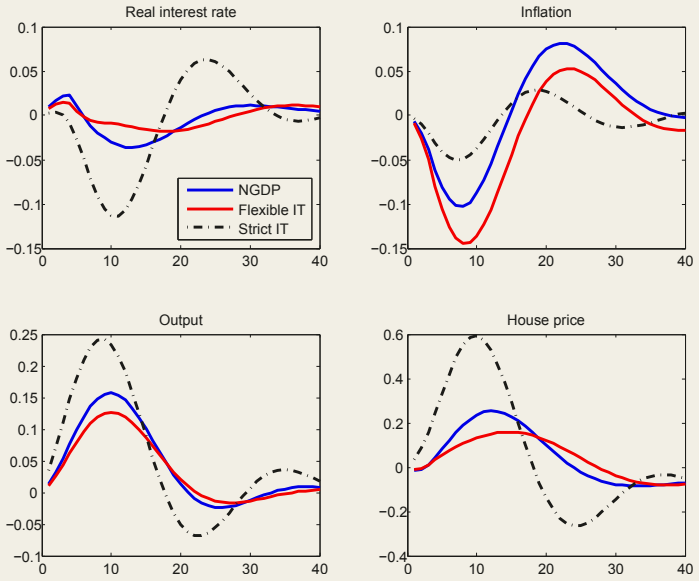
To what extent different operational targets contribute to stabilising economic developments partly depends on the type of shock that occurs. With a demand shock, there will be less of a conflict between inflation stability and real stability (and financial stability) considerations, and inflation targeting will be well-suited to the objective. With a supply-side shock, or a more general shock that leads to a conflict between inflation stability and stability in the real economy, it will be appropriate to deviate from the inflation target, ie to conduct flexible inflation targeting. In order to explore whether a target for NGDP growth could imply a monetary policy regime similar to flexible inflation targeting, though with smaller deviations from the target, we have examined the effects of a supply-side shock – lower wage growth (increased competition in the labour market).[1] We examine three different frameworks: strict inflation targeting, flexible inflation targeting and strict NGDP targeting. To concentrate on the question of to what extent stabilising NGDP takes the considerations into account that flexible inflation targeting is intended to address, we focus on the commitment solution. An NGDP target will not then increase the effectiveness of monetary policy, but only enhance accountability. The analysis is based on Norges Bank's macroeconomic model, NEMO.

The shock leads in isolation to lower inflation, but the overall effect on inflation, the output gap and house prices depends on how monetary policy responds to the shock, which in turn depends on the monetary policy framework. Under strict inflation targeting, shown by the broken line in Chart 1, the optimal choice would be a relatively aggressive response in order to stabilise inflation around the target. The fall in inflation will therefore be met by a marked reduction in the policy rate to bring about a fall in the real interest rate. As shown in the chart, such a policy will contribute to keeping inflation close to the target through the simulation period. At the same time, we observe that strict inflation targeting in this case increases variability in output and house prices.

Under flexible inflation targeting, monetary policy will seek to weigh inflation variability against variability in other target variables. The red lines

1 This analysis builds on Brubakk and Røisland (2018).

Chart 1: Effect of a supply-side shock under differing policy assumptions

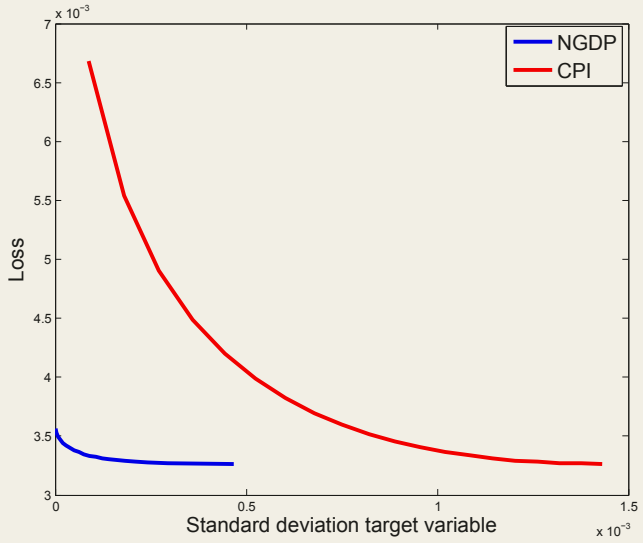


The simulation horizon is shown in quarters on the horizontal axis and in percentage points on the vertical axis. All variables are measured as deviations (in percentage points) from their respective equilibrium values. Thus, negative values do not necessarily indicate that the relevant variable assumes a negative value, but suggest weaker-than-normal developments. For example, a value of -0.15 for inflation will mean that actual inflation is 2.35.

in the chart show the result of optimal monetary policy when the central bank, in addition to controlling inflation, also gives weight to developments in output and financial conditions, in this case as summarised by house prices. An interest rate reduction in keeping with the broken line would under flexible inflation targeting have resulted in an undesirable rise in output and house prices. Optimal monetary policy entails in this case relatively small changes in the real interest rate over the simulation period. This illustrates the trade-off between stabilising inflation on the one hand and stabilising output and house prices on the other. Compared with strict inflation targeting, we see that in this case it is optimal to accept somewhat greater variability in inflation against somewhat lower variability in the other two target variables.

The blue lines in the charts illustrate optimal monetary policy when the central bank seeks to stabilise nominal GDP growth. As shown in the charts, such an objective function results in developments in output, inflation and house prices that are very similar to the developments resulting from flexible

Chart 2: Relationship between flexibility and welfare loss – supply-side shocks

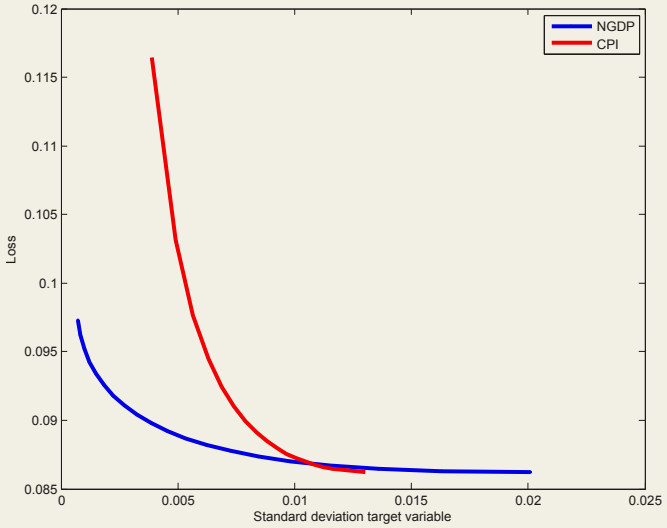


The trade-off between accountability and flexibility in an economy exclusively driven by shocks to competition in the labour market – under two different assumptions concerning the operational target of monetary policy. The red line illustrates the relationship between the degree of accountability/credibility, as measured by the standard deviation of CPI inflation, and the loss, as measured by a weighted sum of the standard deviations of target variables that reflect the preferences of the central bank. The blue line shows a similar trade-off where CPI inflation is replaced by nominal GDP growth as the operational target. For further details, see the box "Operational targets for monetary policy – a mathematical illustration".

inflation targeting. Thus, nominal GDP as the operational target of monetary policy largely internalises the trade-offs that arise under flexible inflation targeting. Such an alternative targeting regime could therefore also reduce a potential conflict between accountability on the one hand and the desire for flexibility on the other.

Chart 2 shows that in the case where the economy is exclusively exposed to trade-off shocks, illustrated here by a shock to competition in the labour market, an operational target focusing on growth in nominal GDP could provide a better trade-off between performance accountability and actual "loss", irrespective of the degree of flexibility. Demand shocks could, as mentioned, result in the opposite conclusion. Whether a nominal GDP target would overall result in a better trade-off between flexibility and accountability will therefore depend on the relative importance of the two different types of shocks over the business cycle. If the economy is primarily driven

Chart 3: Relationship between flexibility and welfare loss – all shocks



The trade-off between accountability and flexibility for all shocks in total. Interpretation in other respects as above.

by supply-side shocks, a GDP target will result in a better trade-off, while a CPI target will probably be preferable if the economy is largely exposed to demand shocks.

The different shocks driving economic developments at any time are to a great extent unobservable and must therefore be estimated. In the NEMO model, the relative importance of different types of shock is implicitly estimated based on historical data. Chart 3 shows the trade-offs when all the estimated shocks included in NEMO are incorporated. The conclusion that can be drawn now is not as clear-cut as in Chart 2. Nonetheless, the results indicate greater concurrence between flexibility and accountability under nominal GDP targeting than under CPI targeting, given that some degree of accountability is desirable.

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3 Formulation of the inflation target

Eilert Husabø

In Chapter 2, the properties of inflation targets and alternative operational targets were discussed. The properties of inflation targeting will depend on the formulation of the inflation target. In this chapter, some of the key aspects of the formulation of the inflation target are discussed with reference to economic theory and practical monetary policy considerations.

The first part of the chapter looks at which target index monetary policy should seek to stabilise. The second part discusses the level of the inflation target, ie the rate of increase the central bank should aim for. The third part considers the implications for inflation targeting of whether the inflation target is a point target with or without a tolerance band or a target range.

3.1 CHOICE OF TARGET INDEX

The choice of target index is basically a choice of groups of goods and services to be included in the price index that the central bank attempts to stabilise and of the weights assigned to the different groups. At one end of the scale all prices are included with a small weight assigned to each, and at the other end one price series is assigned the full weight.

The consumer price index is commonly used as a target internationally. Consumer prices indexes are designed to follow closely the cost of living of households. An advantage of consumer price indexes is that they are an established measure of the general rise in prices. The weights in the central bank's target index are then determined by the share of household budgets used for different goods and services.

According to the New Keynesian literature, the central bank should instead stabilise an index of sticky prices. The result follows from a key assumption in this literature, ie that nominal wage and price rigidities entail a time lag before all prices adjust after a shock. Many prices will therefore deviate from their optimal level, which can lead to misallocations of resources and a welfare loss. By stabilising prices that seldom change and can thus be expected to be mispriced, monetary policy can contribute to improving the welfare of the general public.

Others have argued in favour of choosing a target index that reflects underlying drivers of inflation. This can contribute to enhancing real stability and financial stability. It can generally be said that the weights in such an index should be deter-

mined by the extent to which the sectoral rate of inflation is due to random shocks or fluctuations in economic activity, and how quickly sectoral prices change. [1] Concrete proposals have been that the central bank should stabilise an indicator of underlying inflation, the GDP deflator or nominal wage growth.

In the following, we look at the pros and cons of different target indexes. In this chapter, it is argued that if the central bank operates a flexible inflation targeting regime, monetary policy can use the total consumer price index as an operational target for inflation and still achieve the advantages associated with alternative target indexes.

3.1.1 The total consumer price index

According to the traditional view, the central bank should use an operational target for inflation that is relevant for and understood by households and firms. This contributes to securing confidence in monetary policy and renders monetary policy transparent and verifiable. If the central bank uses a target index that is not recognised by the general public, inflation expectations can be expected to deviate from the target even when the chosen target index increases in pace with the inflation target. This suggests that a broad measure of inflation should be used as a target index. Stabilising a broad measure of inflation also underpins the primary objective of monetary policy, which is to preserve the long-term purchasing power of money.

The total consumer price index (CPI) is in that respect an attractive target index. This is the most common and best known measure of inflation. The CPI is published at frequent intervals (monthly) with a short time lag, receives wide attention and is well known among households and firms. Moreover, it is an advantage that it is produced by an institution that is independent of the central bank.[2]

All inflation targeting countries use the CPI as their target index (Table 3.1). The choice is typically motivated by the fact that the CPI is the most relevant inflation measure for households. For example, in connection with its switch to inflation targeting, the Swedish central bank highlighted that:

"There are many ways of measuring inflation, but the advantage of the CPI is that it is well known and based on prices that are relevant for a broad public." [3]

The Canadian central bank used a similar reasoning for its choice of target index:

1 See Mankiw and Reis (2003).
2 See Wynne (2008) and Heenan et al (2006).
3 See Bäckstrom (1995).

Table 1 Inflation target, target horizon and measure of house prices in inflation-targeting OECD countries

Country	Target decided by	Target index	Target type	Rang/ tolerance band	Target level	Target horizon	Measure of house prices
Australia	G + CB	CPI	I	2–3 %		Medium term	Net acquisition
Canada	G + CB	CPI	P + T	1–3 %	2.0 %	Medium term	User cost
Chile	CB	CPI	P + T	2–4 %	3.0 %	2 years	Operating cost
Iceland	G + CB	CPI	P + T	1–4 %	2.5 %	Average	User cost
Israel	G + CB	CPI	I	1–3 %		Max 2 years	Rent equivalent
Japan	CB	CPI	P		2.0 %	Medium to long term	Rent equivalent
Mexico	CB	CPI	P + T	2–4 %	3.0 %	Medium term	Rent equivalent
New Zealand	G + CB	CPI	P + T	1–3 %	2.0 %	Medium term	Net acquisition
Norway	G	CPI	P		2.5 %	Medium term	Rent equivalent
Poland	CB	CPI	P + T	1.5–3.5 %	2.5 %	Medium term	Not included
United Kingdom	G	CPI	P		2.0 %	As soon as possible	Operating cost
Sweden	CB	CPI	P		2.0 %	2 years	User cost
South Korea	G + CB	CPI	P + T		2.0 %	Medium term	Not included
Czech Republic	CB	CPI	P + T	1–3 %	2.0 %	Medium term	Rent equivalent
Turkey	G + CB	CPI	P + T	3–7 %	5.0 %	3 years	Not included
Hungary	CB	CPI	P + T	2–4 %	3.0 %	3 to 5 years	Rent equivalent

Abbreviations in the table: G = government/Ministry of Finance, CB = central bank, I = interval, P = point target, T = tolerance band

Sources: National central banks

"The CPI is the most relevant measure of the cost of living for most Canadians because it is made up of goods and services that Canadians typically buy, such as food, housing, transportation, furniture, clothing, recreation, and other items."[4]

A counterargument against using the CPI as a target index is that excessive focus on stabilising prices measured by the CPI can come at the cost of real stability and financial stability. As to real stability considerations, it is argued that the CPI is overly exposed to temporary swings and sectoral shocks and reflects developments in domestic capacity utilisation to an insufficient extent. As to financial stability, the main concern is that developments in house prices, and hence household vulnerabilities, are not captured by the CPI.

4 See Bank of Canada (2016a).

3.1.2 Optimal target indexes in New Keynesian theory

In the New Keynesian models, monetary policy is given a long-term role beyond anchoring inflation expectations. Nominal wage and price rigidities entail a time lag before all prices respond to shocks.[5] Many prices will thus deviate from their optimal level, resulting in undesired distortions of relative prices, which gives rise to inefficient resource allocation.

Monetary policy can increase the overall welfare of the public by steering towards the equilibrium that is consistent with fully flexible prices. This is done by stabilising a measure of inflation that gives greater weight to sticky prices than flexible prices.[6] In other terms, the central bank should stabilise prices that seldom change and can thus be expected to be mispriced, while prices that change frequently can be allowed to vary.

For a small open economy like Norway, the discussion can be broadened to whether the central bank should only stabilise domestic inflation or whether the target index should include imported prices. The answer depends on how fast changes in the exchange rate pass through to inflation.[7] If domestic prices are sticky, but exchange rate changes pass through fully and directly to import prices, the theory holds that monetary policy should stabilise domestic inflation. If the pass-through is slower, monetary policy should target total inflation.[8] Exchange rate changes then have a more gradual and lasting impact so that import prices are also sticky. The same would apply if imported goods are used as inputs in domestic production, or if domestic wage formation depends on expectations of total inflation and not only domestic inflation.[9]

In practice, no central bank targets optimal indexes of rigid prices or only domestic prices. For the public, it could be difficult to understand what an optimal index of sticky prices is, and the price increase they experience may deviate from the rate of increase of the optimal index. However, the indexes tend to be used as indicators of underlying inflation.

As to the question of stabilising domestic inflation versus the total CPI, there are several features of the Norwegian economy that suggest that the latter should be chosen. First, empirical studies show that it takes time before changes in the krone exchange rate pass through to prices for goods imported to Norway.[10] Second, there

5 Nominal rigidities are also used in more traditional monetary policy models. The difference is that in New Keynesian models, the rigidities are explicitly modelled.
6 See Woodford (2003) and Aoki (2015). Erlandsen (2014) presents such an index for Norway.
7 More precisely to which extent imported inflation influences firms' marginal costs.
8 See Clarida, Gali and Gertler (2001), Corsetti and Pesenti (2005) and Corsetti et al (2010).
9 See Campolmi (2014).
10 Naug and Nymoen (1996) find that the pass-through to import prices is 63% in the long-term. Ulvedal and Vonen (2016) find about the same percentage pass-through to import prices in the CPI-ATE.

is a large share of imported goods in domestic production. Third, in wage negotiations the social partners take into account developments in total consumer purchasing power, not only domestic cost inflation. The two latter factors also mean that most often there is not a clear distinction between imported inflation and "pure" domestic inflation.

3.1.3 Choice of target index and real stability considerations

The literature distinguishes between strict and flexible inflation targeting. Strict inflation targeting means that monetary policy is solely oriented towards stabilising inflation at target within the shortest possible time horizon. In order to prevent pronounced effects on output and employment, it may then be an advantage for the central bank to target a measure of inflation that is strongly correlated with real activity. In that way, the central bank can stabilise inflation while contributing to real stability.

In principle, the central bank should then choose to stabilise the target index that, if kept at target, delivers the highest possible degree of real stability. In its basic version, this is called a *stability price index.*[11] The main feature of a good stability price index is that prices for goods and services in the index (i) are closely correlated, (ii) are to a limited extent exposed to sectoral shocks (iii) change infrequently (so-called sticky prices).

The weights used to construct such an index will normally deviate considerably from the weights that are relevant for constructing a cost of living index. A drawback associated with stability price indexes may thus be that the central bank ends up stabilising a measure of inflation that is not relevant for households and firms. Alternatives to a pure stability price index can be to choose nominal wage growth, the GDP price deflator or a measure of underlying inflation as a target index.

Norwegian data show that of these indexes nominal wage growth and the rate of increase for domestically produced goods and services have historically shown the highest degree of correlation with the real economy (Table 2). As labour costs make up a relatively large share of total production costs, the rise in prices for domestically produced goods and services will share a range of properties with nominal wage growth.

Nominal wages

Stabilising nominal wage growth is a special case of inflation targeting where all weights in the target index are placed on one price series. In practice, this entails

11 See Mankiw and Reis (2003).

Table 2. Correlation between capacity utilisation and wage and price inflation 0 to 6 quarters ahead. Correlation is measured on quarterly data over the period 2001 – 2016

	CPI	CPI-ATE[2]	Domestic CPI-ATE[2]	Aggregate GDP deflator	GDP deflator for mainland Norway	Nominal wages
Current quarter	0.0	0.0	0.0	**0.4**	0.5	0.6
1 qtr. ahead	0.1	0.1	0.2	0.3	**0.5**	0.7
2 qtr. ahead	0.2	0.3	0.4	0.3	0.5	**0.7**
3 qtr. ahead	0.3	0.4	0.6	0.1	0.5	0.7
4 qtr. ahead	**0.4**	0.5	0.7	0.0	0.4	0.7
5 qtr. ahead	0.4	0.5	**0.8**	-0.2	0.3	0.6
6 qtr. ahead	0.4	**0.6**	0.8	-0.3	0.2	0.5

1 Correlation is a measure of the covariation between two variables and is measured as a coefficient from +1 (perfect positive correlation) to -1 (perfect negative correlation). A coefficient of 0 means there is no correlation between the variables. In the table, the lag length with the highest correlation is indicated in **boldface.**

2 CPI adjusted for tax changes and excluding energy products (CPI-ATE)

Sources: Statistics Norway, Norwegian Technical Calculation Committee for Wage Settlements and Norges Bank

defining a numerical target for wage growth that the central bank seeks to achieve within a given target horizon.

If the central bank seeks to reduce the variability of economic activity, stabilising wage growth may be a better alternative to stabilising inflation.[12] Compared with prices for goods and services, variations in wage growth are to a lesser extent caused by random shocks and to a greater extent by conditions in the real economy. When there is little slack in the economy, wage growth is typically high and vice-versa.

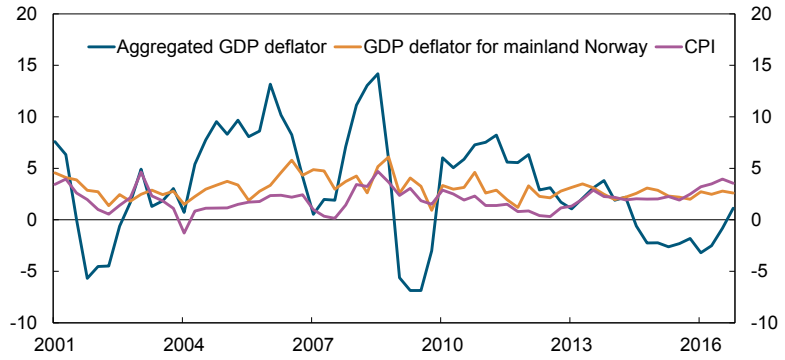
The fact that wage growth is driven to a further extent by real economic activity than the CPI also means that wage growth is more stable than CPI inflation. Nominal wage growth thereby satisfies the three main criteria for a good stability price index and is often described as a good target index for monetary policy in the literature.[13] See also the box in Chapter 2 *Target index for monetary policy in a petroleum economy*.

Stabilising nominal wage growth is, however, associated with a number of challenges and has never been attempted in practice. In Norway, wage statistics are published quarterly with a longer time lag than the CPI and are subject to revision. Moreover, structural shifts in the economy could change the interaction between

12 See Mankiw and Reis (2003).

13 In the New Keynesian literature, it is argued that stabilising nominal wage growth is not an implicit way of taking into account real economic activity, but that nominal wage flexibility is relatively low, see Erceg et al (2000).

Chart 3.1 CPI, GDP deflator for mainland Norway and aggregated GDP deflator . Four-quarter percentage change. 2001 Q1 – 2016 Q4



Source: Statistics Norway

the real economy and wage growth. For example, lower productivity growth, and hence real wage growth, means that inflation must be higher in order to achieve a given target for nominal wage growth. In addition, an explicit wage growth target for monetary policy will be demanding from a political-institutional perspective. Many will likely perceive such a target as interference in the wage formation system.

The GDP deflator

Given that monetary policy should stabilise a broad target index, the GDP price deflator could be an attractive alternative. The GDP deflator measures inflation for all domestic goods and services. Unlike the CPI, export prices are included in the GDP deflator, while the direct effect of import prices is excluded. Compared with strict inflation targeting with the CPI as a target index, stabilising the GDP deflator may thus lead to somewhat more stable real developments. Inasmuch as the GDP deflator captures house price inflation through developments in nominal housing investment, stabilising the GDP deflator may be somewhat more suitable for promoting financial stability.

For Norway, one effect of stabilising the GDP deflator would be that monetary policy would give more weight to oil price-related shocks. Higher (lower) oil prices entail a rise (fall) in the GDP deflator and also in real economic activity. A monetary policy that stabilises the GDP deflator will thus also stabilise the real effects of oil price swings.

Because oil prices vary widely, a drawback of stabilising the total GDP deflator is that oil price developments would dominate information from other prices. The GDP deflator will then to a large extent be exposed to frequent sectoral shocks compared with the properties of a good stability price index.

An alternative could be to stabilise the price deflator for mainland GDP for Norway. Here the direct effect of oil price variations is stripped out. In large parts of the period since the introduction of inflation targeting in Norway, low imported inflation has pulled down CPI inflation (Chart 3.1). All else equal, inflation for domestically produced goods and services must then be correspondingly higher for total inflation to meet the inflation target. This engenders a risk that monetary policy is more expansionary than implied by domestic real and financial conditions. In such a situation, it may be that a monetary policy seeking to stabilise the mainland GDP deflator will produce a better trade-off between price stability and real stability considerations.

A drawback of both the total GDP deflator and the mainland GDP deflator is that they can deviate substantially from the inflation rate facing consumers. For a country with considerable commodity exports, export prices likely reflect to a lesser extent developments in consumer prices than countries that export a basket of goods that is similar to that consumed domestically.[14] The central bank may then end up stabilising a target index that is not relevant for households and firms, and variations in commodity prices and exchange rates could lead to unnecessarily high monetary policy volatility.

There are also a number of practical challenges associated with a monetary policy that is geared towards stabilising the GDP deflator, eg that it is published quarterly with a long time lag and subject to extensive revision at times. See Chapter 2 for a discussion on stabilising nominal GDP.

Indicators of underlying inflation

The effects of monetary policy on inflation and output occur with a time lag and their amplitude may vary over time. In the course of the time it takes for an interest rate change to have an impact, other conditions will also feed through to inflation and output. For example, a transient rise in energy prices as a result of low water reservoir levels may have a clear impact on the total CPI.

If monetary policy were to respond mechanically to all changes in inflation, it could lead to unnecessarily high variability in the interest rate and other macroeconomic variables. Measures to counter temporary changes in inflation today will have to be followed by measures to compensate for delayed effects of monetary policy.

With strict inflation targeting there could in principle be a case for targeting an index that is stripped of temporary shocks, eg a transient rise in energy prices.

14 In addition, commodity prices are normally more volatile than consumer goods prices. Inasmuch as Norwegian export prices are determined in the global market, fluctuations in the krone exchange rate will also result in export price fluctuations.

There is a wide range of methods for constructing such an indicator of underlying inflation. The box *Indicators of underlying inflation* discusses some of the underlying inflation indicators used in Norway. The indicators meet by their construction two of the three main criteria for a good stability price index. They are less volatile than the CPI and less exposed to sectoral shocks. Underlying inflation indicators are normally also more closely correlated with the real economy than the CPI.

3.1.4 Real stability considerations in flexible inflation targeting

In practice, all central banks with an inflation target operate a flexible inflation targeting regime, ie the central bank gives weight to stabilising both inflation and economic activity, rather than focusing solely on inflation (see Chapter 4).[15] Under flexible inflation targeting, the central bank does not seek to bring today's inflation rate towards the inflation target, but gears monetary policy so that inflation forecasts converge towards the target.[16]

By pursuing flexible inflation targeting, monetary policy can target CPI inflation, but still achieve the benefits of stabilising a target index that is closer to the stability price index. There are two reasons for this. First, monetary policy then takes explicit account of variations in output and employment. Second, the flexible target horizon provides room for disregarding certain temporary shocks, eg time-varying exchange rate effects on inflation.

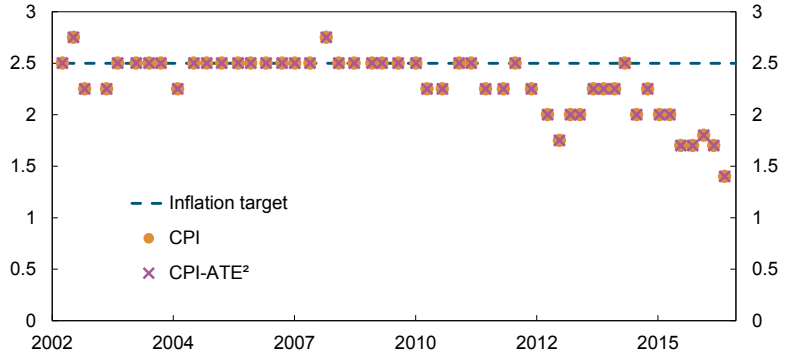
The monetary policy orientation depends at any given time on expected developments in inflation, inflation expectations and output. As temporary shocks to inflation today will not normally influence the inflation forecast several years ahead, the forecasts for the CPI and underlying inflation towards the end of the forecast period will generally be identical (Chart 3.2).[17] Under flexible inflation targeting, stabilising the CPI amounts to the same as stabilising underlying inflation.

Three aspects thus suggest using the total CPI rather than underlying inflation as a target index: The total CPI is more familiar to the public, stabilising the two indexes amounts to the same in practice when inflation targeting is flexible, and it would be difficult regardless to determine what the appropriate measure of underlying inflation is (see box *Indicators of underlying inflation*).

Underlying inflation indicators nevertheless play an important role in the conduct of monetary policy. At a given time, it can be demanding to distinguish between permanent and temporary price changes. Combined with other measures of wage

15 See also Erceg et al (2000).
16 Svensson (1997) calls this inflation-forecast targeting.
17 See also Tura-Gawron (2016).

Chart 3.2 Projections for consumer price inflation at the end of the inflation forecast horizon[1]. Projections from Norges Bank's monetary policy reports. 2001-2017



1) Up to and including *Inflation Report* 2/2003 and in *Inflation Report* 1/2004, the longest forecast horizon was two years. The longest forecast horizon is otherwise three years.
2) CPI adjusted for tax changes and excluding energy products.
Source: Norges Bank

and price inflation, underlying inflation indicators can help to distinguish between the two and to communicate monetary policy.

Internationally it is common practice to use underlying inflation as cross-check of inflation pressures. Most central banks monitor several types of indicators, but the most common approach is to give extra weight to a single indicator in the communication of monetary policy.[18] The Canadian central bank announced recently that it would prefer to use three different indicators, rather than only one, with a view to avoiding the risk of placing weight solely on one indicator that later turns out to have provided a incorrect picture of underlying inflation pressures.[19] No inflation-targeting central bank use underlying inflation as a target index.

3.1.5 House prices and financial stability considerations

House prices are an important variable in the conduct of monetary policy for two main reasons; house prices are important for assessing cyclical conditions, and dwellings as assets influence household saving behaviour and hence the assessment of financial stability. Internationally, there are numerous examples of goods and services inflation remaining low and stable in an environment of rapidly rising house prices. Such periods have often coincided with substantial economic imbalances and have been followed by episodes of abrupt and sharp declines in house prices.

18 Typically an exclusion-based indicator where the historically most volatile CPI components, often food and energy, are stripped out.

19 The Canadian central bank wants to switch from the CPIXE as the preferred measure to three measures, ie CPI-common, CPI-trim and CPI-median, see Bank of Canada (2016b). The corresponding indicators in Norway are CPI-common, trimmed median and weighted median, respectively, see box *Indicators of underlying inflation*.

If the central bank conducts a robust monetary policy and actively seeks to restrain the build-up of financial imbalances, it may suggest that house price developments should be explicitly taken into consideration.[20] In this context, a robust monetary policy means that the trade-offs include the risk of particularly adverse economic outcomes. An unusually fast rise in house prices would suggest that the interest rate be kept higher than normal. Many have therefore argued that house prices should be included directly in a target index for monetary policy.[21]

However, measuring house prices, or owner-occupied housing consumption, is one of the main challenges in constructing consumer price indexes. There is no one answer and various approaches can lead to differences in measured inflation.

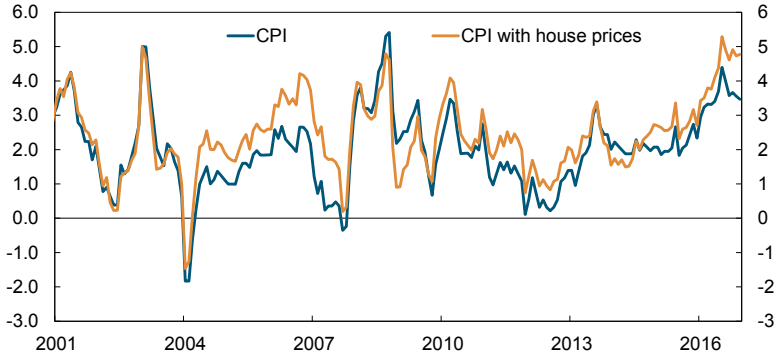
Goods and services prices in consumer price indexes are normally transaction-based prices. In the Norwegian CPI, the exception is owner-occupied housing consumption, which instead is valued based on observed prices in the rental market for comparable dwellings. In a number of other countries, house prices are included directly in the CPI. A third alternative is to include only operating costs for occupying the dwelling.[22] See box *Measuring house price in the consumer price index* for an overview of different approaches to measuring owner-occupied housing consumption.

Compared with today's CPI, an index that includes house prices may to a further extent reflect the rise in prices facing households.[23] For example, a relatively large share of respondents in Norges Bank's Expectations Survey report that they attach considerable weight to house price inflation when they seek to form a picture of general price developments.[24] Since the introduction of the inflation target in 2001, average annual CPI inflation would have been 0.4 percentage point higher had house prices been included[25] (Chart 3.3). The effect is on a par with that found in other European countries.[26]

Monetary policy could conceivably lean against house price inflation even if house prices are not included in the target index that the central bank has chosen to

20 See Goodhart (2001) and Cecchetti et al (2000), and Chapter 5 in this report.
21 See Cecchetti et al (2000), UN (2009) and Bergevin (2012).
22 Beatty et al (2010) present an additional method for including house prices in the CPI.
23 See Røed Larsen (2007).
24 See Erlandsen og Ulvedal (2017) and Chapter 4 in this report.
25 The calculation involves replacing the component imputed rent in the CPI with inflation for existing homes. The weight is given by housing investment as a percentage of total consumer spending, using the net acquisition method (see Eurostat (2012)). New homes make up a small share of the housing stock, and the weights for owner-occupied housing consumption calculated using the net acquisition method are thus normally lower than housing consumption calculated using the rent equivalent method. The appropriate weight depends, however, on the aim of including house prices in the CPI. If the aim is to capture the inflation rate facing households, the weight should reflect the size of the households' housing investment. If the aim is to restrain the build-up of financial imbalances, the weight should conceivably be greater.
26 See Johansen and Nygaard (2009).

Chart 3.3 CPI and CPI with house prices[1]. Twelve-month percentage change.
January 2001 – December 2016



1) Calculation explained in footnote 25.
Source: Norges Bank

stabilise. Large differences between house price inflation and inflation for other prices may then lead to weaker goal performance over time. It has therefore been argued that in order to strengthen the credibility of monetary policy, prices that are included in the target index should reflect the prices that the central bank is actually attempting to stabilise.[27]

In practice, however, it has proved difficult to find a good method for including house prices in the CPI (see box *Measuring house price inflation in the consumer price index*). Flexible inflation targeting nevertheless gives the central bank room to take account of considerations that imply a risk for particularly adverse economic outcomes, including the build-up of financial imbalances. For example, in periods of unusually high house price inflation and debt growth, a robust monetary policy may entail that inflation remains below the inflation target for longer than would otherwise have been the case.

3.2 LEVEL OF INFLATION TARGET

When it comes to the choice of the level of the inflation target, the research does not provide a definitive answer. In theory, there is an optimal inflation rate in the sense that it minimises the social costs of inflation. On the one hand, it is argued that inflation reduces the efficiency of resource use, in particular when inflation is high and variable. On the other hand, too-low inflation can create economic challenges. In practice, most inflation targeting countries target an inflation rate of

27 For example, an evaluation concluded that financial stability considerations had led the Swedish central bank to set the interest rate higher than implied by pure inflation targeting. It was argued that this partly reflected a lack of clarity as to the division of responsibility for financial stability and macroprudential supervision in Sweden (see Goodfriend and King (2016)).

around 2% annually. An important reason for targeting inflation above zero is the existence of a lower bound for the nominal interest rate. When inflation is low and expected to remain low, nominal interest rates will normally be low as well.[28] This limits the extent to which the central bank can lower policy rates. All else equal, a higher inflation target will therefore increase the leeway for monetary policy and reduce the risk of a liquidity trap. Since the financial crisis, interest rates in many countries have been at or close to the lower bound. This has sparked a discussion as to whether the optimal inflation rate is higher than assumed earlier.

3.2.1 Costs of (high) inflation

Inflation is a persistent rise in the general price level. The negative effects of inflation exist even when inflation is low, but increase with rising inflation. This is because when inflation is high, inflation variability generally increases.[29]

For contracts specified in nominal terms, unexpected variations in inflation will entail a random redistribution of income and wealth between creditors and debtors. Uncertainty about the future price level can thereby have a dampening impact on saving and investment because households and firms will be less willing to enter into long-term contracts. The uncertainty may also lead to misallocations of resources, eg considerable resources may be used to hedge against price changes.[30]

Expected inflation can also entail considerable costs. Price movements for individual goods, which are in fact attributable to the general rise in prices, may be misinterpreted as changes in relative demand. The price movements make it difficult for households and firms to base their decisions on market prices, which can lead to a misallocation of resources.[31] To the extent that prices seldom change (are sticky), higher inflation will lead to wider price spreads.[32] This occurs because the relative price of a product will fall in the time period between price changes. Such random changes in relative prices may be perceived as signals of changes in relative demand. Another source of costs from expected inflation is that firms and households must follow and update prices, so-called menu costs and shoeleather costs.

Inflation costs can also be caused by the tax system. The limits in the tax system are normally set in nominal terms. If the tax base increases through the year[33], the real tax burden increases. Such problems can be avoided by allowing the limits in the tax system to depend on inflation. For some income, however, real taxes rise with infla-

28 In a normal situation, the nominal interest rate is given by the neutral real interest rate and the inflation target. The neutral real interest rate is the real interest rate level that is consistent with balanced economic growth.
29 See Okun (1971), Taylor (1981) and Kiley (2000).
30 See English (1996).
31 See Lucas (1972).
32 See Woodford (2003).
33 Eg that wage income rises from below to above the minimum deduction.

tion independently of tax system indexation, eg the taxation of interest income.[34] This may induce investors to demand a higher return, which pulls down investment.

Inflation can also undermine the role of money as a means of payment by functioning as a tax on cash. The higher inflation is, the faster the purchasing power of cash declines. While the alternative cost of holding cash is given by the nominal interest rate, the social costs of producing cash are approximately zero. Since the nominal interest rate is normally positive, the public holds little cash. The optimal inflation rate is the rate that leads to a nominal interest rate of zero. The inflation target must then be equal to the neutral real interest rate level, but with the opposite sign.[35]

3.2.2 Costs of low inflation

Low and stable inflation is a precondition for the efficient use of resources in a market economy. However, there are a several pertinent reasons to prevent inflation from becoming too low.

One reason is that the consumer price index probably overstates actual inflation. If the central bank seeks to prevent falling prices over time, this is a reason in itself to choose a positive inflation target.[36]

One reason to avoid falling prices is *debt deflation*. With falling price levels, nominal asset values typically decline, but the nominal value of debt does not. To the extent assets are debt-financed, the real debt-servicing burden increases. This can lead to a negative spiral, which causes a further fall in asset prices as debtors default or are forced to sell assets in order to service debt. Periods of debt deflation occurred during the Great Depression and more recently in Japan.[37]

Moreover, a little inflation can grease the wheels of the economy. In the event of a need for real wage cuts, ie when nominal wages increase less or fall more than the general price level, a positive inflation target can facilitate the process. With unchanged prices, a reduction in real wages must come through a fall in nominal wages. Studies indicate, however, that nominal wage cuts can in practice be difficult to implement.[38] In the literature, this is referred to as *downward nominal*

34 Higher inflation results in a higher nominal return and hence higher tax. But if the entire increase in nominal return was meant to compensate for higher inflation, the investor ends up with a lower real return (see Feldstein (1997)).

35 See Friedman (1969).

36 The main source of CPI measurement errors is the difficulty of distinguishing between quality improvements and actual inflation over time. If the price of a good or service has increased due to a quality improvement, the price has not actually risen, and the quality improvement is probably not allowed for in the CPI.

37 See Bernanke and James (1991) and Eggertson and Krugman (2012).

38 See Holden and Wulfsberg (2014) for Norway and Fallick et al (2016) for the US. Such rigidities can be explained by different factors, eg wage earners think in nominal rather than real terms (money illusion), and nominal wage growth is customary and expected based on fairness considerations. It is also conceivable that the firms want to avoid wage cuts for fear of demotivating employees.

wage rigidities. Necessary cost cuts can then instead be achieved by reducing the labour stock. With a positive inflation target, real wages fall as long as nominal wage growth is lower than inflation. Changes in real wages and industry adjustments will therefore be easier to achieve with some inflation.

Inflation is also a source of government revenues. Inflation functions as a tax in that it reduces the value of existing assets in the money-holding sector. The lower the inflation target is, the higher other direct and indirect taxes must be to sustain a given level of government revenues.[39]

One factor supporting a positive inflation target, which has received growing attention in recent years, is the *effective lower interest rate bound.*[40] In a normal situation, the policy rate is given by the sum of the neutral real interest rate and the inflation target. The central bank cannot influence the neutral real interest rate, but it can influence the long-term inflation level. The higher the inflation target is, and hence nominal interest rates over time, the more the central bank can lower the policy rate before hitting the lower bound.

3.2.3 The optimal rate of inflation

Different arguments suggest different optimal inflation rates. In a world where price rigidity (sticky prices) is the only source of costs from inflation, an inflation target of zero would be optimal. A stable price level would also be optimal if the costs associated with inflation were due to uncertainty regarding the future price level, menu costs or costs related to the tax system. If, on the other hand, the public's demand for cash were the only source of monetary non-neutrality[41], a negative inflation target would be optimal.[42]

Costs associated with measurement errors is not an argument for a particular level of inflation, only that the probable magnitude of the measurement error must be taken into account in formulating the inflation target.[43] The extent to which downward nominal wage rigidities support a positive inflation target depends on the extent to which the rigidities affect labour market adjustments. According to the classical view, the equilibrium unemployment rate is independent of the inflation

39 See Phelbs (1973) and Bartolomeo et al (2015).

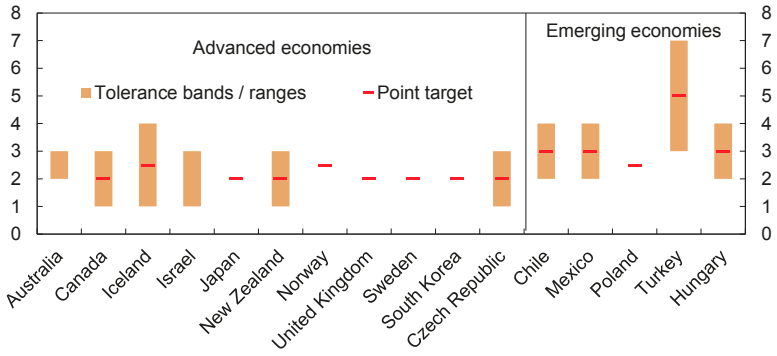
40 This is what Keynes (1936) called the liquidity trap.

41 Monetary neutrality, the notion that changes in the money supply only affect nominal (prices, wages, exchange rates) and not real (employment, output, consumption) variables is important in classical economics. See Schmitt-Grohé and Uribe (2010) for a review of optimal inflation under the theory of monetary non-neutrality.

42 A negative inflation target may also be optimal when wage formation rigidities exist. With falling consumer prices, real wages will then rise, even if nominal wages are unchanged (see Amano et al (2009)).

43 Boskin (1996) finds that annual CPI inflation in the US is overstated by between 0.8 and 1.6 percentage points annually. For Norway, Koht and Sandberg (1997) suggest that the CPI overstates actual inflation, while Røed Larsen (2007) finds the opposite, that actual inflation is higher than the rise in the CPI.

Figur 3.4 Inflation target levels, tolerance bands and target ranges.
Inflation-targeting OECD countries. Percent.



Sources: National central banks

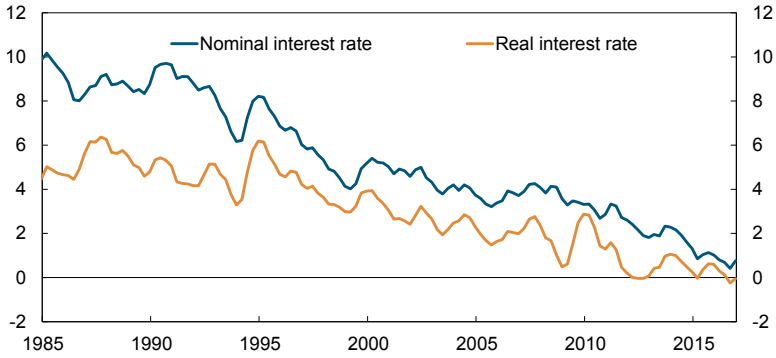
rate.[44] An alternative view is that equilibrium unemployment rises at lower inflation rates because resistance to wage cuts results in real wages that are higher than their optimal level.[45] The empirical literature is unclear about whether such a macro-economic effect exists.[46]

Of the arguments in favour of an inflation target above zero, the effective lower interest rate bound normally receives the most attention. Prior to the financial crisis, empirical studies indicated that an inflation target of around 2% took sufficient account of the risk of hitting the lower bound. Already at 2%, the probability was deemed to be slight. Therefore, the gains from raising the inflation target were assumed to be marginal. On the other hand, for inflation targets below 2%, there was an increased risk of hitting the zero lower bound.[47] However, more recent research shows that if the existence of nominal wage rigidities is also taken into account, the probability of and severity associated with hitting the lower bound may be less than previously assumed.[48]

An inflation target high enough to take into account the lower bound is also high enough to take into account the risk of debt deflation. Debt deflation will only arise if monetary policy (or economic policy in other respects) lacks sufficient room for manoeuvre to stop a fall in prices.

44 See Friedman (1968) and Lucas (1973).
45 See Eckstein and Brinner (1972) and Tobin (1972).
46 Akerlof et al (1996) find that a reduction in inflation from 3% to 0% will increase equilibrium unemployment by between 1 and 2 percentage points. On the other hand, Card and Hyslop (1997), for example, find no particular effect.
47 See Reifschneider and Williams (2000).
48 See Amano and Gnocchi (2017)

Chart 3.5 Long-term interest rates. 14 OECD countries.[1)] Percent. 1985 Q1 – 2016 Q4



1) Austria, Belgium, Canada, Denmark, France, Italy, Japan, Netherlands, Sweden, Switzerland, US and Norway. Unweighted average.
Source: Norges Bank

In practice, price stability is the objective of most central banks. In principle, this might suggest an inflation target of zero, but owing to the drawbacks of very low inflation, price stability in most countries is defined as annual inflation of around 2% (Chart 3.4 and Table 3.1). Of the advanced economies with an inflation targeting regime, eight out of 11 have chosen 2% as a point target for inflation.[49] The monetary policies of the US and the euro area are not defined as inflation targeting, but both the Federal Reserve and the ECB aim for inflation at 2% and "close to, but below" 2%, respectively. Only three of the advanced economies have chosen an inflation target above 2%. Norway and Iceland have point targets of 2.5%, while Australia has a target range[50] where 2.5% is the midpoint rate.

3.2.4 The optimal rate of inflation in the light of experience since the financial crisis

In the wake of the financial crisis, policy rates in many countries have been close to or below zero for many years. This indicates that the probability of the policy rate hitting the lower bound may be greater than previously assumed. In this regard, some have advocated higher inflation targets.[51] The argument has been that a credible increase in the target will anchor inflation expectations at a higher level. For a given real interest rate, this suggests that the nominal rate may be set correspondingly higher over time. The distance to the lower bound for the policy rate is therefore greater, and the central bank could have reduced the policy rate more and made the real rate more negative before the lower bound is reached.

49 Israel has a target range, where 2% is the midpoint rate.
50 See below for a review of the difference between point targets and target ranges.
51 One specific proposal has been to raise the inflation target to 4% (see Blanchard et al (2010), Krugman (2014) and Ball (2014)).

One possible reason for the higher probability of hitting the lower bound is that the level of the neutral real interest rate has fallen (Chart 3.5). A lower real interest rate implies a lower average nominal interest rate. This entails less room to cut the policy rate before the lower bound becomes binding. Another reason may be that the empirical studies from before the crisis were based on data from a period of relative economic stability and thus underestimated the probability of episodes of pronounced economic weakness.[52] More recent work, which includes the post-crisis period, finds that the probability of experiencing long periods where the lower bound is binding may be more than twice as high as previously assumed.[53] In isolation, this may suggest that the inflation target should be raised. Estimations from the Bank of Canada indicate that an increase in the inflation target from 2% to 3% may be enough to counteract the higher probability of reaching the lower bound associated with the decline in the neutral real interest rate.[54]

On the other hand, the introduction of negative policy rates in a number of countries in recent years has shown that the lower bound for policy rates is lower than many previously assumed. This reduces the probability that the lower bound for the policy rate will be reached and weakens the argument for a higher inflation target. Furthermore, experience since the financial crisis suggests that other unconventional monetary policy measures may be effective in a situation where the central bank cannot or will not lower the policy rate further. This reduces the costs associated with hitting the lower bound. Also what is called "forward guidance" has been used effectively in situations with a very low policy rate. The Bank of Canada cites these arguments when advocating that its inflation target be kept unchanged when the bank's mandate was last renewed.[55] The costs associated with the lower bound also depend on fiscal policy leeway.

At the same time, raising the inflation target may entail costs (see the discussion above). Given that a tendency towards higher inflation also implies more variable inflation, some have also raised doubts as to whether average inflation of 4%, for example, will anchor inflation expectations.[56] Some argue that inflation of 2% is likely so close to price stability that households and firms can largely disregard inflation, especially when measurement problems are taken into account.[57]
A transition to permanently higher inflation will also entail a one-time cost (for creditors) in the form of a reduction in the real present value of financial claims.

52 See Williams (2014).
53 See Chung et al (2012) and Gornostay (2016).
54 See Bank of Canada (2016b), Box 2 page 12.
55 See Bank of Canada (2016b).
56 See Bean et al (2015), Branch and Evans (forthcoming) and Ascari et al (2017).
57 Se Bean et al (2015). See also Yellen (2015): The Chair of the Federal Reserve is of the view that targeting inflation at 4% or higher "would 'stretch' the meaning of 'stable prices' in the Federal Reserve Act".

Some have pointed out that the costs of higher inflation from raising the inflation target would be ongoing, while the costs associated with the lower bound on interest rates will only arise during the relatively limited periods when monetary policy hits the lower bound.[58] Empirical estimates for the ongoing costs of inflation differ considerably, with results depending on the method employed. The literature on the relationship between inflation and real economic growth across countries typically finds no negative effect, except when inflation is very high.[59] Furthermore, new research casts doubt on whether price dispersion between product categories actually increases when the inflation rate rises.[60] On the other hand, others find considerable costs associated with the response of households and firms to inflation.[61] Moreover, in larger New Keynesian models, even moderate levels of inflation may entail substantial welfare costs.[62]

A number of central banks point out that in the current situation, where inflation in many countries is below target, announcing an increase in the inflation target may lack credibility.[63] If the inflation target is to be raised, a likely premise for attaining credibility is doing so in a situation where capacity utilisation is close to normal and where inflation is not too far from the previous target. It is also argued that the inflation target will not function as a nominal anchor if it can be adjusted as necessary, reducing the credibility of the inflation target. This may heighten the uncertainty regarding future inflation because the public will suspect that the target might also be changed in the future. Without anchored inflation expectations, the ability of monetary policy to stabilise the real economy may weaken.

3.3 POINT TARGETS OR TARGET RANGES FOR INFLATION

In Norway, the inflation target is specified by a point value, ie a specific numerical value for the annual change in the target index. In this case, the objective of monetary policy is normally for inflation to reach the point target by the end of the target horizon and for inflation over time to be close to the point target. Some central banks set a tolerance interval, or band, around the point target. The band communi-

58 Bernanke (2016).

59 Barro (2013) finds, on the basis of a dataset for 100 countries in the period 1960–1990 that 10 percentage point higher average inflation per year reduces annual per capita GDP growth by only 0.2–0.3 percentage point. Bruno and William (1996) find no relationship between inflation and economic growth for annual inflation rates below 40%. Sarel (1995) finds, on the basis of a dataset for 87 countries in the period 1970–1990, a structural break when the inflation rate is 8%. Below 8%, inflation has no (or a positive) effect on economic growth. Above 8%, inflation has a significant and noticeable negative effect on economic growth. IMF (2005) finds no relationship between inflation and economic growth in emerging economies.

60 See Nakamura et al (2016).

61 Dotsey and Ireland (1999) show in a general equilibrium monetary model how inflation distorts a number of marginal decisions.

62 Ascari et al (2015) find that an upward adjustment of the inflation target from 2% to 4% will entail significant welfare costs.

63 See Skingsley (2016), Bank of Canada (2016b) p. 15, Yellen (2015), footnote 14. See also Bean et al (2015).

cates the central bank's ambition level and shows that the inflation projections are uncertain. In addition, the band may be part of the central bank's accountability, in which case inflation outside the tolerance band will lead to sanctions against the central bank.

The alternative to a point target is a target range for inflation. In this case, the actual inflation target is specified as a range for the annual change in the target index. The objective of monetary policy is then normally for inflation to be within the target range by the end of the target horizon and for inflation over time to be within the target range. A target range may be appropriate if those tasked with determining the level of the inflation target agree on what constitutes inflation that is too high or too low, but hold differing views on the appropriate point target for inflation.[64] As is the case with a tolerance band, deviation from the target range may result in sanctions against the central bank.

Common to both target ranges and tolerance bands is the existence of an area where the central bank does not attempt to fine-tune inflation. They are therefore normally viewed as something providing greater freedom in the conduct of monetary policy.[65] For central banks with a short target horizon and a strict inflation targeting regime, they can provide scope for allowing inflation to vary around a point target or the mid-point of the target range. Compared with point targets, target ranges can, in principle, also provide greater scope for incorporating structural shocks.[66]

For central banks with longer time horizons and a more flexible inflation targeting regime, the leeway for allowing inflation to vary around the target is provided by the fact that the forecasts for inflation are to be on target, not current inflation.[67] In the event of prolonged shocks, it can also be appropriate to allow inflation to deviate from the point target over a longer period.

With regard to anchoring inflation expectations, there are factors that suggest that credible point targets may be better than target ranges.[68] Point targets are precise, provide a clear signal regarding monetary policy objectives and communicate symmetry[69]. With a target range, inflation expectations can theoretically become anchored at any point within the range.[70] Nevertheless, in practice there is reason to believe that the central bank prefers the midpoint rate as that is where the probability

64 See Riboni and Ruge-Marcia (2008) and Orphanides and Wieland (1999).
65 See Heenan et al (2006) and Hammond (2012).
66 For example, a period of inflation in the lower segment of the tolerance band/target range owing to a shift in imports towards low-cost countries.
67 The uncertainty inherent in the forecasts and outlook must then be communicated in other ways, eg through fan charts.
68 See Tetlow (2008).
69 Too-low inflation is just as inappropriate as too-high inflation.
70 For example, in response to surprisingly weak economic developments, inflation expectations may become anchored at the bottom of the range. All else equal, this may reduce the effectiveness of monetary policy,

is lowest that unexpected events will push inflation outside of the range (see box *Target ranges and uncertainty*). In this way, the policy stance under inflation range targeting approaches the policy stance under point targeting. Since inflation expectations will in principle become more concentrated the narrower the range, a credible point target will, however, always provide the best anchor on the margin. If the point target is not credible, the opposite situation occurs. In that case, tolerance bands and target ranges with sanctions may be a way to ensure that inflation does not systematically deviate from the target.[71]

Internationally, point targets with tolerance bands are the most common type of target. The UK is unique in that the Bank of England has a point target without a tolerance band, but with an "accountability mechanism" that obliges the bank to explain any substantial deviation of inflation from the target. Norway[72], Sweden[73] and Japan, have point targets without a tolerance band. Australia and Israel have target ranges.

In principle, it is conceivable that the width of the tolerance band should be based on a trade-off between inflation volatility and volatility in economic activity. If the central bank attempts to keep inflation within a too narrow band, this may result in excessive variability in economic activity. If the band is too narrow, but the central bank chooses to allow frequent instances of inflation outside the band, this may conceivably harm the central bank's credibility. Countries that are more prone to fluctuations in inflation should in principle opt for a wider band.[74] This applies especially to small, open economies like Norway.[75]

In practice, the choice of the width of the band appears to be based on convention rather than country-specific characteristics. The most common width by far is 2

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because the real interest rate cannot be lowered to the same extent as when inflation expectations are higher (see Mishkin (2008)).

71 In the literature, the phenomenon of non-credible point targets, owing to systematic deviation from the target, is known as the time-inconsistency problem (Kydland and Prescott 1977). Time-inconsistency describes a situation where the central bank has incentives to promise low inflation in the future, but does not deliver when tomorrow comes, because this would entail costs in the form of lower economic activity. If, on the other hand, sanctions are imposed on the central banks when inflation moves outside the limits of the tolerance band or target range, there will also be costs associated with deviating from the inflation target. In this case, the central bank will aim for inflation at the middle of the range and inflation expectations will be anchored there. Mishkin and Westelius (2008) show that ranges/bands with sanctions are a subcategory of optimal inflation contracts.

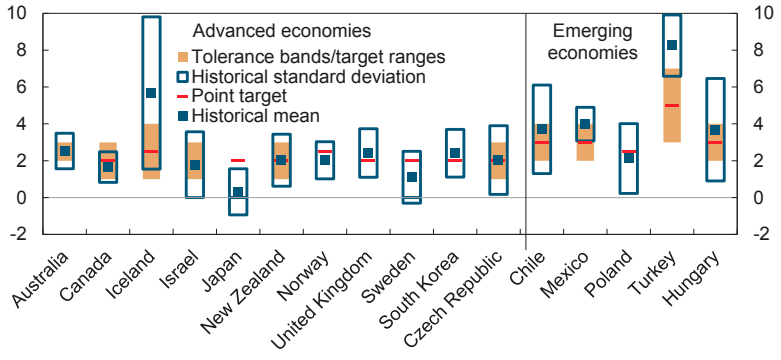
72 Report No. 29 to the Storting (2001) states that "It is expected that as a main rule consumer price inflation will be within a range of +/- 1 percentage point around the target". In a letter to the Ministry of Finance on 27 March 2001, Norges Bank stated that "[i]f there are significant deviations between actual price inflation and the target, the Bank will provide a thorough assessment in its annual report. Particular emphasis will be placed on any deviations outside the interval +/- 1 percentage point". In practice, inflation measured by the CPI has remained within this range for 60% of the time since 2001. This is less than expected, but Norges Bank has normally not been asked to account for the deviations.

73 Sweden had a tolerance band up until 2010.

74 Erceg (2002) shows that the level of the unemployment gap volatility rises with the variability of purchasing power and domestic productivity, with trade openness and with the degree of nominal wage rigidity.

75 See Hunt (2006).

Chart 3.6 Inflation targets with tolerance bands/target ranges.
Compared with actual average for and variation in inflation over the past 10 years.



Sources: National central banks

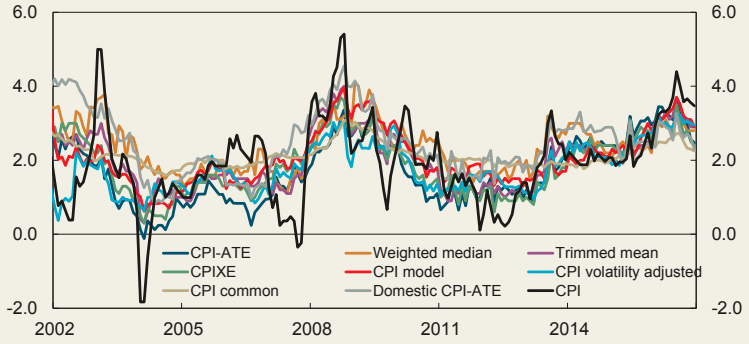
percentage points. In most of these countries, inflation varies by more than indicated by the band and is more often outside the band than within it (Chart 3.6). This suggests a low degree of concern about the loss of credibility but rather that the width of the bands has been chosen with a view to anchoring inflation expectations. In that sense, the bands may appear to be primarily a tool communicating that inflation will vary around the target rather than a signal about how much it will vary.

Indicators of underlying inflation

A good indicator of underlying inflation must have certain statistical properties (not deviate systematically from the CPI, be less volatile than the CPI and be able to predict future CPI inflation), it must be published at the same time as the CPI, must not be revised and should be easy for the public to understand. In addition, it is an advantage for it to be published by an independent institution.[1]

Norges Bank uses a range of indicators of underlying inflation (Chart 1):

Chart 1: CPI and indicators of underlying inflation. Twelve-month percentage change. January 2002 – December 2016



Sources: Statistics Norway and Norges Bank

- CPI-ATE: CPI adjusted for tax changes and excluding energy products. Published by Statistics Norway.
- CPIXE: CPI adjusted for tax changes and excluding temporary changes in energy prices. Published by Norges Bank.[2]
- Volatility-adjusted CPI: CPI adjusted for developments in the eight most volatile price series at group level[3]. Energy prices are excluded in toto.

1 See Jonassen and Nordbø (2007), Roger (1998) and Wynne (1999) for a detailed discussion of the characteristics of a good indicator of underlying inflation.
2 See Hov (2009).
3 At group level, the CPI is divided into 39 product and service groups. At sub-group level, the CPI is divided into 93 product and service sub-groups.

For the remaining seven[4], the average change over the past six or 12 months is included. Produced by Norges Bank.

- Trimmed mean (20%): Various sub-groups are excluded from month to month. The twelve-month change at sub-group level in the CPI is sorted in ascending order. Then the price series corresponding to 10% of the CPI weights at both the top and bottom of the distribution are removed. Produced by Statistics Norway.

- Weighted median: Special case of trimmed mean. The underlying rise in prices in a given month is specified by the price change located at the fiftieth percentile ranked by the sub-groups' CPI weights. Produced by Statistics Norway.

- CPI-model: Constructed by changing the weights in the CPI at group level. Each product group is weighted based on how well it has historically forecast total CPI one month ahead. Better forecasts result in a higher weight. Produced by Norges Bank.[5]

- CPI-sticky prices: A measure of the rise in prices for goods and services for which prices change relatively infrequently. The indicator is constructed by excluding price series in the CPI (at group level) that in the period 1999–2004 changed more frequently than every 8.5 months. Produced by Norges Bank.[6]

- CPI-common: A measure of the common trend in the rise in prices across price series in the CPI at group level. A factor model is used to filter out price movements caused by sector-specific factors and find the trend that is common to all goods and service groups. Produced by Norges Bank.[7]

- Domestic CPI-ATE: A measure of the rise in prices for domestically produced goods and services. In principle, it is not an indicator of underlying inflation, but in theory and practice it correlates more closely with domestic resource use than the total CPI. It is thus able to capture price pressures stemming from domestic factors. Published by Norges Bank.

4 Air fares, household textiles, fruit, coffee, tea and cocoa, vegetables, fish, newspapers, books and stationery.
5 See Hov (2005).
6 See Erlandsen (2014).
7 See Husabø (2017).

A general problem associated with indicators of underlying inflation is that it may be difficult *ex ante* to distinguish between persistent and temporary price changes. It may be that series included in the indicator should no longer be included, or vice versa, reflecting structural changes. For example, the CPI-ATE will not capture a change in the trend for energy price inflation.

Table 1 ranks the measures by the extent to which they satisfy the criteria for a good indicator of underlying inflation. None of the indicators is a satisfactory measure of underlying inflation in the sense of performing best in every category in the comparison. This suggests that monetary policy should use a range of indicators of underlying inflation.

Table 1 Ranking of indicators of underlying inflation.[1] The first number indicates the rank; figures in brackets indicate the result of the empirical evaluations. Based on data for the period January 2002 – December 2016

	Deviation from CPI[2]	Deviation from trend CPI[3]	Volatility[4]	Forecasting properties[5]	Easy to understand[6]
CPI-ATE	6 (-0.23)	6 (0.57)	6 (0.27)	3 (0.81)	Yes
CPIXE	**1 (-0.07)**	3 (0.43)	9 (0.35)	6 (0.84)	Yes
Volatility-adjusted CPI	**1 (-0.14)**	4 (0.44)	3 (0.24)	9 (0.87)	Yes
Weighted median	7 (0.42)	7 (0.67)	8 (0.30)	8 (0.85)	Yes
Trimmed mean	**1 (0.05)**	5 (0.48)	5 (0.25)	2 (0.80)	Yes
CPI-model	**1 (0.13)**	2 (0.39)	2 (0.20)	7 (0.84)	No
CPI-sticky prices	9 (0.95)	9 (1.07)	4 (0.25)	4 (0.83)	No
CPI-common	5 (0.21)	1 (0.37)	1 (0.16)	5 (0.83)	No
Domestic CPI-ATE	8 (0.55)	8 (0.83)	7 (0.29)	1 (0.80)	Yes
Mean CPI	(1.91)	(0.97)	(0.56)		

1 See Fastbø and Husabø (2017) for a review of the calculations underlying the table.
2 Average difference between the twelve-month change in the CPI and the indicators. A positive value means that the indicator over time has risen faster than the CPI and vice versa. Figures in boldface mean that the difference was not statistically significant. First place is shared by indicators with a difference from the CPI that is not statistically significant.
3 Deviation between the twelve-month change in the indicator and the trend rise in the CPI (given by RMSE). The trend rise is given by two-sided HP filter (λ =14400).
4 Standard deviation of the monthly change in the twelve-month rise.
5 Average of the accuracy of CPI projections 12, 18 and 24 months ahead. The table shows the ratio of the RMSE from models based on the indicators to the RMSE from an AR(1) process.
6 Assessment based on judgement.

Measurement of house prices in the consumer price index

The literature distinguishes between two types of consumer price index: cost-of-living indexes and pure inflation indexes. The CPI from Statistics Norway is a cost-of-living index. Its purpose is to provide an answer to the question of what income compensation is necessary for an average household to maintain its standard of living when the prices of goods and services change.[1] On the other hand, a pure inflation index simply measures the average price change for a sample of goods and services.

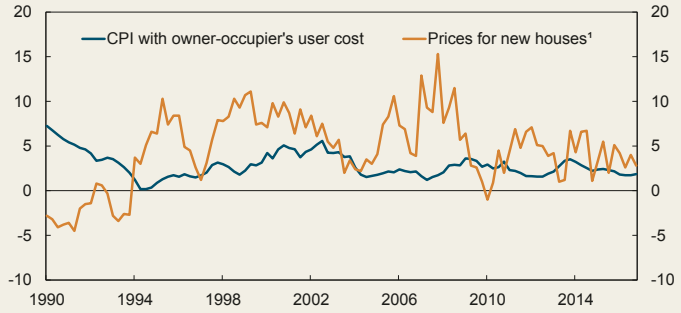
In practice, only the treatment of owner-occupied housing consumption distinguishes the two types of index.[2] For other goods and services, actual transaction costs are used in both cost-of-living indexes and inflation indexes.[3] However, since housing consumption accounts for a large portion of household consumption, the method chosen for constructing the consumer price index may result in considerable differences in measured consumer price inflation.

In a cost-of-living index, the purchase of a dwelling is considered to be an investment in housing capital. Housing capital provides the household with a service flow over the useful life of the dwelling. The cost to be included in the CPI should then be related to the service flow and not to the actual purchase of the dwelling.[4]

The value of the service flow can be measured using two approaches: rental-equivalence or user-cost. In the Norwegian CPI, the rental-equivalence approach is used. Here the price of the owner-occupier's housing costs is assumed to move in parallel with developments for comparable dwellings in the rental market. Alternatively, the user cost can be calculated. This includes interest, expenses associated with maintaining the dwelling, the price of the dwelling and the capital gain associated with owning the dwelling (ie house

1 Johannessen (2014).
2 The harmonised index of consumer prices (HICP) is a pure inflation index. In Norway, the HICP currently accounts for just over 80% of CPI weights. Of the CPI groups excluded from the HICP, imputed rentals for housing, which seeks to measure owner-occupiers' housing consumption, is the most important.
3 For durables, which are acquired at a point in time and provide a service flow, the cost-of-living index should, in principle, measure the value of the service flow. Nevertheless, for practical reasons, the actual rise in prices is used for most durables in cost-of-living indexes too.
4 Johansen and Nygaard (2009).

Chart 1 House price inflation. Four-quarter percentage change. 1990 Q1 – 2016 Q4



1) New detached houses up to 2011 Q4. All dwellings as from 2012 Q1.
Sources: Statistics Norway

price inflation). The user cost is meant to reflect the cost to the homeowner of owning the dwelling compared with an alternative capital investment.

There are well-known problems associated with both approaches. The rental-equivalence principle assumes that rental housing has the same characteristics as owner-occupied housing. There is reason to believe that this is not true for Norway.[5] It may mean that observed rents do not necessarily reflect the value of the owner-occupiers' housing consumption. The way estimated user cost is formulated can lead to unwanted effects. First, rising house prices can result in a fall in prices for an owner-occupier's housing consumption, because house price inflation more than compensates for other costs associated with owning the dwelling. Second, changes in interest rates have a direct effect on measured inflation. If the central bank cuts the interest rate with the aim of increasing inflation, a lower user cost will help to pull down inflation.[6]

Thus, as constructed, cost-of-living indexes do little to capture developments in the house prices faced by the public (Chart 1). If the purpose of the price index is to capture and measure inflation pressures on households in real time, an index based on observed house prices may therefore be preferable.

For pure inflation indicators, the price of an owner-occupier's housing consumption is measured using the net acquisitions approach. Here prices associated with house purchase transactions are used as a price indicator.

5 The rental market is small relative to the owner-occupier market. Renters are concentrated in younger age groups in larger cities. They do not necessarily live in the same types of dwelling as owner-occupiers (see Johannessen 2014).

6 This issue has been relevant for Sveriges Riksbank (see Apel et al (2016)).

Only transactions involving new dwellings (including conversions) from the business sector to the household sector are to be included in the basis for weighting, since transactions between households only entail an exchange of dwellings. Since land is a non-depreciating asset, the price of the site should be excluded from the indicator. Owner-occupiers' costs associated with maintaining the dwelling should be included in the same manner as in the calculation of the user cost. A practical problem with constructing a CPI including house prices in Norway is that monthly data do not exist for prices for new homes, nor for house prices adjusted for site costs.

Practices for including owner-occupiers' housing consumption in the CPI vary across countries (Table 1). The most common one is to do the same as in Norway, to use either rental-equivalence or user cost to find the value of living in a dwelling, or only to include the costs associated with maintaining a dwelling. The UK and the euro area are examples of the latter. Of countries with an inflation targeting regime, only Australia and New Zealand have chosen to include house price inflation directly in the CPI. Both use the net acquisitions approach.

Target ranges and uncertainty

In flexible inflation targeting models, the central bank's task is normally described as minimising a quadratic loss function. Here, a quadratic loss function means that the central bank's trade-off between stabilising output as a deviation from potential output (output gap) and stabilising inflation as a deviation from the inflation target (inflation gap) can be illustrated by the following relationship[1]:

$$L_t = \lambda(\pi_t - \pi^*)^2 + (1\text{-}\lambda)y_t^2$$

Where L_t is the expected "loss" in period t, π_t is inflation, π^* is the inflation target, y_t is the output gap and λ is a value between 0 and 1 that indicates the weight given by the central bank to stabilising inflation relative to stabilising output. With $\lambda = 1$, the central bank only gives weight to stabilising inflation.

Including the gaps in the loss function in quadratic form ensures two important properties: that negative gaps are just as bad for both inflation and output as positive gaps, and that the central banks' losses rise more than proportionally with the size of the gaps. With such a loss function, the central bank will always seek to close both the inflation gap and the output gap. Quadratic loss functions thus exclude the existence of an area where the central bank refrains from fine-tuning inflation. This may make them less suited to describing a monetary policy with the objective of keeping inflation within a certain range. In the following, a loss function is formulated that takes into account such an indifference curve and shows how owing to uncertainty the policy under inflation range targeting approaches that under point targeting.[2]

Under a pure target range regime (without uncertainty), the central bank is indifferent to where inflation lies within the range. The periodic "loss" is the same, regardless of whether inflation is at the bottom, in the middle or close to the top of the range. A loss for the central bank does not occur until inflation moves outside the range. This trade-off can be illustrated by the following adjustment of the loss function:

$$L_t = \lambda\, Z(\pi_t - \pi^*, \varsigma)^2 + (1\text{-}\lambda)y_t^2$$

1 The loss function is illustrative. The central bank may take into account considerations other than those included here.

2 The presentation follows Orphanides and Wieland (1999).

Chart 1 The central bank's loss when deviating from inflation target indicated by different loss functions. Inflation gap in percentage points.

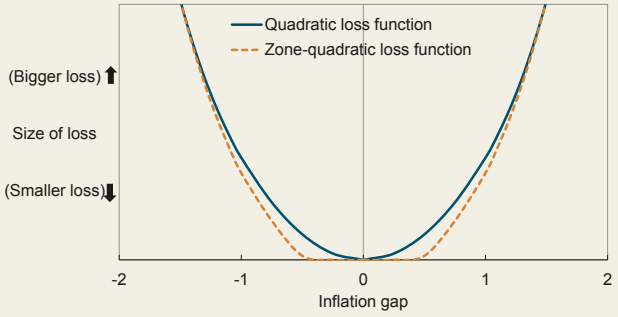
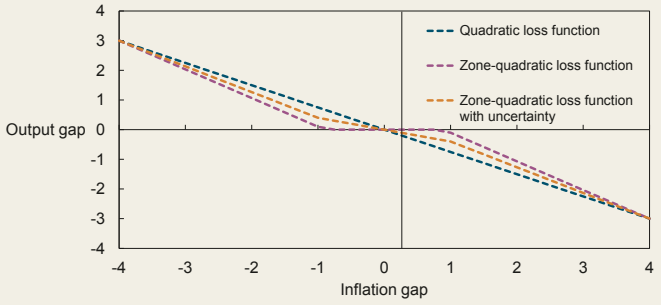


Chart 2 Illustration of optimal policy with different loss functions. With and without uncertainty. Inflation gap and output gap in percentage points.



Where $Z(\pi_t - \pi^*, \varsigma)$ is a function that is zero for an area of width ς and linear otherwise. The area ς reflects the size of the target range. As long as inflation is within the range, the periodic loss is equal to zero in such a *zone-quadratic* loss function (Chart 1). Chart 2 illustrates the differences in the central banks' trade-offs. The solid line in the chart shows that with a linear-quadratic loss function the central bank faces a linear trade-off between an inflation gap and an output gap. The broken line shows that with a zone-quadratic loss function a zone exists where the optimal policy for the central bank is to close the output gap without giving weight to the inflation gap.

The dotted line in Chart 2 shows the optimal policy under uncertainty with a zone-quadratic loss function. Here, uncertainty means that unexpected events can affect prices and demand. Owing to uncertainty, in practice, the central

bank prefers the middle of the range, even though in principle it is indifferent to where in the interval inflation is. The intuition is that in an uncertain world, there is always some probability that an expected event will push inflation outside of the target range. The central bank can minimise the probability of this happening by keeping inflation close to the midpoint of the range. To move inflation towards the middle of the target range, the central bank will have to accept a cost in the form of a gap between actual and potential output. With an ordinary quadratic loss function, this uncertainty has no effect on the central bank's trade-offs.

Owing to uncertainty, monetary policy under a target range regime approaches that under a point target. The narrower the range is, the greater the similarities are. Nevertheless, with an inflation range target, an area will exist where the central bank is less willing to accept changes in output to bring about a given change in inflation than under a pure point target.

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4 Flexibility, credibility and accountability

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While Chapter 3 discussed the design of the inflation target itself, this chapter will focus on intentional deviations from the inflation target, ie *flexible inflation targeting*. All central banks conduct flexible inflation targeting in the sense that the central bank takes stability in the real economy (output and employment) into account when assessing how quickly it should seek to bring inflation back to target after the shocks that have led to the deviation.

Various factors related to flexibility are discussed here: how real stability can be measured, the weight that can be given to this consideration, including the choice of target horizon, and how accountability can be achieved under flexible inflation targeting. The degree of flexibility and transparency also has implications for credibility, and the last part of the chapter examines the anchoring of inflation expectations during the flexible inflation targeting period.

4.1 REAL STABILITY

4.1.1 Introduction

Under flexible inflation targeting, the central bank, in addition to stabilising inflation around the target, seeks to stabilise developments in output and employment. Just as how inflation should be measured is not a given, as discussed in Chapter 3, how stability in output and employment should be measured is not self-evident. The basic premise for such a measurement is that it should capture the extent of slack in the economy, ie *the output gap*. Output as well as unemployment and employment, measured as the *gap* between the actual and the equilibrium levels, can potentially serve as indicators of capacity utilisation in the economy as a whole.

It has been argued that the unemployment gap should be the only indicator of capacity pressures in the economy.[5] Unemployment provides a direct estimate of the extent of slack in the economy, and the use of unemployment as an indicator

1 Section 4.1. We thank Anne Kari Haug for valuable comments.
2 Sections 4.2 and 4.3.
3 Section 4.4.
4 Sections 4.2 and 4.3.
5 Svensson (2011) and Olsen et al (2003).

could facilitate a continuous external evaluation of the central bank's assessments and reduce the risk of adjustments made by the central bank in its assessment of overall capacity being perceived as arbitrary.

Which unemployment measure to use is not an obvious choice. In most countries, there are two main measures of unemployment: unemployment as measured by the Labour Force Survey (LFS) and unemployment as registered by the employment offices. LFS unemployment normally varies somewhat more in the short term than registered unemployment, but includes figures for unemployed persons who for lack of incentive or for other reasons do not register as unemployed at the employment offices.

At the same time, the relationship between unemployment and capacity utilisation in the economy can change. If the flexibility of the labour supply changes over the business cycle, unemployment will not in itself provide a good assessment of spare capacity in the economy.[6] This indicates that it may be appropriate to use several different indicators to measure capacity utilisation in the economy as a whole.

In economic theory, the consideration of stability in output and employment is often formulated by including the *output gap* in the central bank's target function. The output gap is the difference between actual and potential output:

$$ygap_t = y_t - y_t^*$$

where $ygap_t$ is the output gap, y_t is actual output and y_t^* is potential output. Potential output indicates the maximum level of sustainable output, while the output gap provides an estimate of the extent of available resources in the economy.

Potential output cannot be observed and must be estimated. Various methods of estimating the output gap are described in the box below. Potential output is determined by developments in productivity and labour supply. The potential growth in these factors is in turn affected by elements such as demographic conditions, immigration, labour qualifications, wage formation, the tax system and the financial system.

ReFIT project research has focused on how two of these factors, labour migration and financial conditions, can influence the output gap.

4.1.2 Labour migration and the output gap

With the possibility of labour migration, potential output can be fairly elastic. Increased immigration when overall capacity utilisation is high will in isolation

6 Erceg and Levin (2013).

have a dampening effect on cyclical fluctuations. At the same time, immigration also increases domestic demand, which pulls in the opposite direction. It can also take time for higher labour demand to affect immigration. The possibility of labour migration will not therefore eliminate cyclical fluctuations in the economy.

Furlanetto and Robstad (2016) show in a VAR model estimated on Norwegian data that an (exogenous) increase in labour immigration leads to lower unemployment, even among the non-immigrant population. This may indicate that capacity utilisation increases, possibly reflecting that the increase in labour supply is offset by higher demand from immigrants. The effect on potential output of the increase in labour supply is to some extent counteracted by a fall in labour productivity growth. This is the result of lower capital intensity. At the same time, growth in total factor productivity (TFP) edges up, possibly because immigration leads to a higher degree of specialisation and thereby more effective utilisation of the labour force.

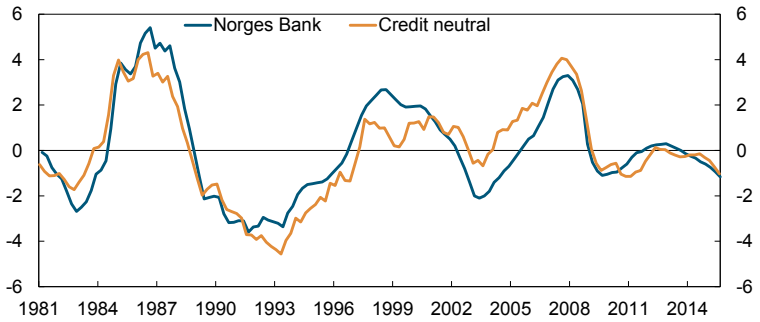
Natvik and Sveen (2017) analyse the effects of labour immigration in an open economy with search frictions in the labour market. Labour immigration allows monetary policy to have an effect through the supply side of the economy, as the exchange rate channel affects immigration. Unless the degree of substitutability or complementarity is very high among immigrants and the wider population, immigration has little effect on GDP and inflation dynamics in the economy. Traditional measures of overall spare capacity in the economy, such as unemployment and de-trended GDP, will then function equally well with or without immigration. If substitutability is high, ie that domestic workers can easily be replaced by foreign workers, expansionary demand shocks will to a lesser extent lead to a fall in unemployment than would be the case without immigration. In the model, potential growth is not affected by temporary movements in the labour supply. Unemployment would not then be suitable as an indicator of overall spare capacity when demand shocks occur. But for this effect to be quantitatively important, a higher degree of substitutability between domestic and foreign labour would be required than in the typical findings of empirical studies.

4.1.3 Financial conditions and the output gap

Prior to the financial crisis, financial imbalances built up that would sooner or later have to be corrected. This indicated that output growth was higher than the rate that would be sustainable over time, even though other indicators of the output gap did not suggest the same. The financial crisis led to increased international focus on the information provided by financial variables with respect to potential output[7].

7 Borio et al (2013) and Borio et al (2014). See also Berger et al (2015), Melolinna and Tóth (2016).

Chart 4.1 Output gap. Credit neutral and Norges Bank's projections. Percent



Variables such as credit or asset prices can contribute to long-term, substantial fluctuations in the real economy. An upswing in output driven by non-sustainable growth in financial variables can lead to an overestimation of potential growth. This can occur in situations where nominal variables provide little information about pressures in the economy, for example when inflation expectations are well anchored.

Hagelund (2016) examines the relationship between financial variables and capacity utilisation in the Norwegian economy. His analysis suggests that overall credit growth in constant prices and real house prices provides information about overall capacity utilisation, but that house prices provide little additional information when overall credit growth is included in the calculations. An *output gap* is said to be *credit neutral* if credit growth is included in the calculations and *finance neutral* if both credit and house prices are included. The output gap for 2002–03 and the years preceding the financial crisis indicate that the economy was operating at somewhat higher capacity than suggested by Norges Bank's estimates of the output gap and that during the banking crisis the economy was operating at somewhat lower capacity than suggested by Norges Bank's estimates (Chart 4.1).

In line with international findings, the calculations for Norway suggest that output gaps based on financial variables also have better real-time properties than a GDP gap based on a pure HP filter (see box). Financial variables provide a better indication of capacity utilisation in the economy in real time and are subject to less revision, reflecting in particular the lower level of uncertainty associated with trend estimates towards the end of historical series when several variables are taken into account.

Methods of estimating the output gap

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There is no broad consensus on the best method of estimating the output gap. No method is without its drawbacks, and all involve the use of judgement. The academic literature offers a range of approaches building on different statistical methods and different economic theories with regard to the factors driving the business cycle.[1]

Single-variable methods

One method of estimating potential output is based on the assumption that the economy, on average and over time, operates at normal capacity. Potential GDP can then be estimated by smoothing actual GDP. Examples are linear trend estimates[2], Hodrick-Prescott (HP)[3] and Band Pass (BP) filters[4]. Such techniques are simple to use in practice and provide a useful basis for estimating potential output or employment. A mechanical use of such filters, however, has well-known drawbacks.[5] The methods use information provided by only one, albeit very important, variable. Trend estimates based on a single variable are also very uncertain towards the end of the period and are sensitive to new data. This can to some extent be offset by extending the data with projections, but the estimates will then depend on how good the projections are. An important judgement to be made when using the HP filter is also how smooth the trend is assessed to be. The smoother the trend, the larger the fluctuations in the business cycle will be. It has also been shown that the HP filter can show business cycles in series where there are no such variations. Using the BP filter requires choosing the length of the business cycle.

Production function method

A firm's output depends on the number of hours worked, the firm's real capital stock and the technical production structure. Output also depends on how efficiently the firm combines labour, real capital and production structure – total factor productivity (TFP). Potential output for the economy as a whole can be derived by estimating the normal levels of the production factors and

1 For an overview, see for example Canova (1998), Hjelm and Jönsson (2010), IMF (2015), Murray (2014) and Proietti (2008).
2 De Brouwer (1998).
3 Hodrick and Prescott (1997).
4 Baxter and King (1995).
5 See for example ECB (2000) and Hamilton (2017).

TFP. Variants of the production function method are used by many institutions.[6]

An advantage of the production function method is that it describes the most important factors driving potential growth, such as labour supply, the capital stock and productivity. However, the method is based on fairly strict assumptions. For example, it is based on the assumption that output in the economy can be described by a relatively simple production function and that the factor input can be estimated based on aggregated figures for the capital stock and hours worked. It is also difficult to estimate equilibrium values for the labour supply, the capital stock and productivity growth. Output gaps that are driven by differences between actual and estimated potential TFP are particularly uncertain.

Multivariate filters and models

These methods seek to identify potential output through empirical relationships between the output gap and variables such as inflation and wages (Phillips curves), unemployment (Okun's law), and firms' investment share and capacity utilisation. These methods are based on multivariate filters and structural vector autoregressive models.[7]

Compared with single-variable methods, these methods are more laborious to implement, and in practice assumptions must be made as to how smooth the trend in the various variables should be. The economic relationships the estimates are based on can change. At the same time, it is an advantage that these methods utilise information from economic theory, and the use of multiple variables can reduce the uncertainty with regard to the trend at the end of the period.

DSGE-based output gap

In a DSGE model, a distinction can be made between two types of potential output.

First, trend growth can be determined by developments in "permanent" productivity growth. Past experience has shown that such model calculations

6 See for example Agopswicz et al (2016), Congressional Budget Office (2001), De Masi (1997), Havik et al (2014), Lienert et al (2015) and OECD (2015).

7 See for example Apel and Jansson (1999), Blagrave et al (2015), Blanchard and Quah (1989), Cerra and Saxena (2000), Clark (1989), Doménech and Gómez (2006), Kuttner (1994) and Laxton and Tetlow (1992).

estimate potential growth close to the results of simple models such as the HP filter.

DSGE models also provide a basis for estimating other, more theoretical types of output gap.[8] Potential output can be estimated as the level of output in the economy if prices and wages were flexible. Such output gaps can deviate somewhat from traditional estimates of the output gap, partly because potential output in these estimates can change considerably over the more traditionally estimated business cycle. This is because potential output can be affected by both temporary and permanent shocks, such as changes in productivity or changes in the trade-off between work and leisure. Changes in actual output will thereby not necessarily lead to changes in the output gap as potential output may also have changed.

The advantage of using DSGE models to estimate potential growth is that the calculations are performed within a consistent model framework. The disadvantages are that the results depend to a great extent on the model used. It is difficult to distinguish between shocks that affect potential output and those that do not. Furthermore, the output gap from such models does not seem to provide a better explanation of inflation developments than the output gap based on more traditional models.

Direct indicators of capacity utilisation

Uncertainty about estimates of potential output in the economy indicates that is may be useful to look at a single indicator of resource utilisation in order to estimate the output gap directly. Unemployment is one such indicator. There is a close relationship between the output gap and unemployment.[9] Unemployment varies relatively little from quarter to quarter, the statistics are not subject to significant revision and are published frequently. Unemployment can therefore capture the underlying utilisation of resources in real time.

Available labour market resources do not provide a complete picture of capacity utilisation in the economy. Company surveys provide direct information about resource utilisation in firms. In a downturn, firms can choose to hoard labour for a period. This will dampen the rise in unemployment, but will be matched by spare capacity in firms.

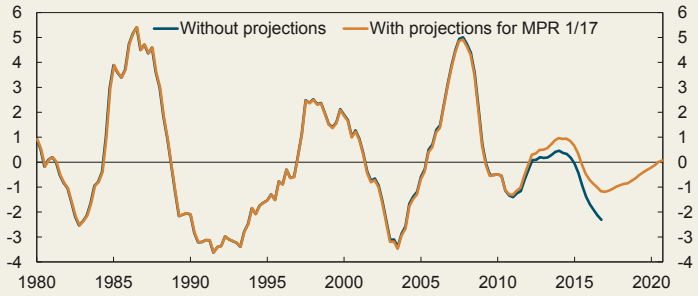
8 Vetlov et al (2011) and Woodford (2003).
9 Okun (1962) and Ball et al (2013).

Norges Bank's estimates of the output gap[1]

Kåre Hagelund

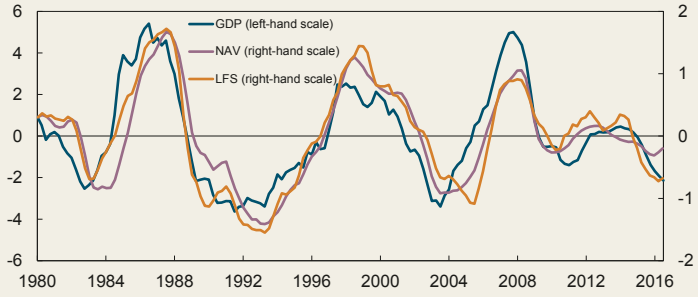
Norges Bank utilises a broad set of analytical tools in its assessment of the productive capacity of the economy. The starting point for the assessment is a trend estimate (HP filter) of mainland GDP (Chart 1). As shown in the chart, the trend estimate and the output gap are very uncertain towards the end of the historical series. These estimates have therefore been adjusted based on other important information regarding potential growth and spare capacity in the economy.

Chart 1 Output gap. Percentage deviation from potential GDP. Hodrick-Prescott filter



In our analyses, particular weight is given to labour market developments. Unemployment fluctuates in pace with GDP (Chart 2) and is an important indicator in the assessment.[2] The relationship varies somewhat over time, however, and the different measures of unemployment can provide different signals about the output gap.[3]

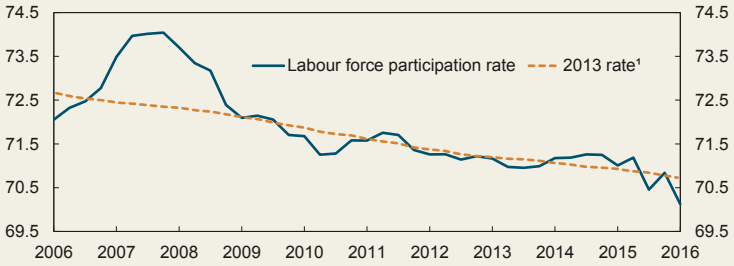
Chart 2 Output gap. GDP-gap and inverted unemployment gap[1)]



1 See Sturød and Hagelund (2012).
2 For more details, see Norges Bank (2015).
3 See Norges Bank (2016) and Nordbø (2016).

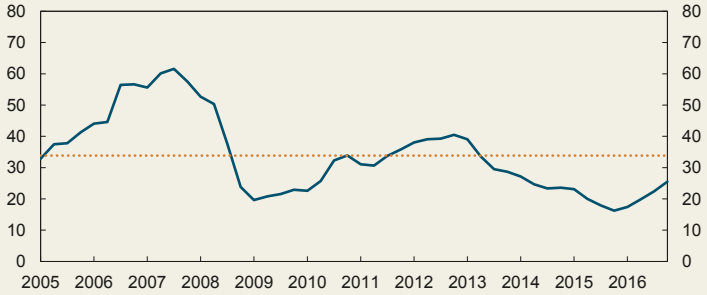
Available resources in the labour market are therefore also assessed in relation to normal labour participation and employment rates. Labour force participation has trended down over the past 15 years as a result of population ageing (Chart 3). The estimate of the output gap must also capture any spare capacity in firms. Norges Bank's regional network reports on the share of firms that will have some or considerable difficulty accommodating a rise in demand (Chart 4).

Chart 3 Labour force participation rate. Labour force as a share of the population (aged 15-74). Percent



1) Developments in the labour force participation rate for the population (aged 15-74) at constant 2013 rates for each age cohort. The line slopes downward because a growing number of persons are entering age groups with lower labour force partcipation rates, owing to population ageing. 2013 is chosen because capacity utilisation is deemed to be close to a normal level that year.

Chart 4 Capacity constraints as reported by regional network[1]. Percent



1) Share of contacts that will have some or considerable problems accommodating an increase in demand.

The production function method can provide a cross-check of spare capacity in both the labour market and firms (Chart 5). Available resources in the labour market are captured by the estimated deviation from the normal level of hours worked, while spare capacity in firms can be estimated based on a lower-than-normal level of productivity.

Chart 5 Output gap – production function method. Percent of potential GDP. Annual numbers

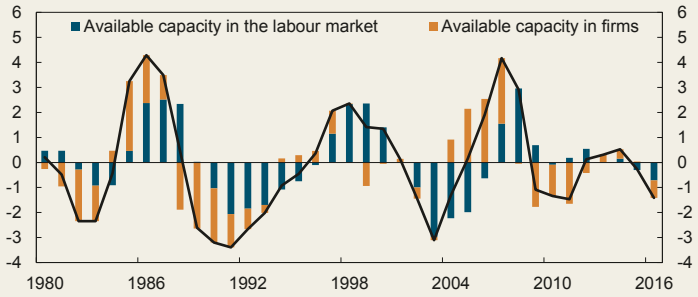
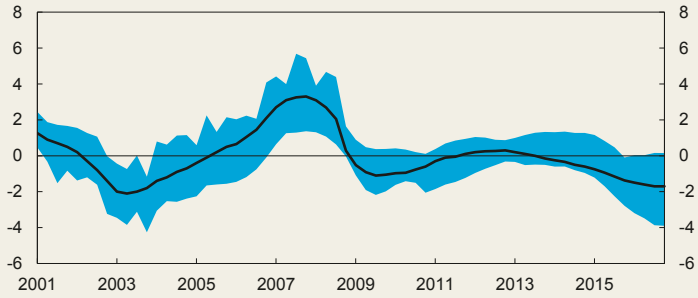


Chart 6 shows 14 capacity indicators and models that are regularly used in assessments of overall spare capacity and Norges Bank's output gap.[4] The chart illustrates the uncertainty related to estimates of spare capacity in the economy.

Chart 6 Output gap – cross-check[1)] and Norges Bank's projections. Percent of potential GDP



1) The blue band represents the highest and lowest projections at each point in 14 different models. See footnote 4.

4 The indicators/models include the HP filter (Lambda = 40000 and 1600), the Band Pass filter (Baxter and King (1995) and Christiano and Fitzgerald (1999)), the production function model and various "state space" models (Watson (1986), Clark (1989), Apel and Jansson (1999), Blanchard and Quah (1989), Cerra and Saxena (2000), Doménech and Gómez (2006), Kuttner (1994) and Hagelund (2016)).

4.2 HOW MUCH WEIGHT SHOULD BE GIVEN TO REAL STABILITY?

4.2.1 What does the literature tell us?

With the evolution of New Keynesian theory, inflation targeting received a solid theoretical foundation. This theory is based on many of the same assumptions as Real Business Cycle theory. Macroeconomic effects are derived from the micro-foundations of households' and firms' decisions. But in contrast to the Real Business Cycle theory, New Keynesian theory assumes that there are market imperfections in the form of monopolistic competition and wage and price stickiness. The concept of flexible inflation targeting can be defined based on a standard monetary policy loss function. The trade-off between price stability and real stability is often described in the theoretical literature as minimising a loss function, where output variability and inflation variability are both included. The central bank then chooses the interest rate path ahead that minimises the discounted "losses" in all future periods. Michael Woodford has been the most influential contributor to New Keynesian theory.[8] An important result of his research was that monetary policy would deliver the highest possible welfare, in terms of the utility of the representative consumer, by minimising the following "loss function":

$$L_t = \pi_t^2 + \lambda y_t^2 \qquad (1)$$

where π_t is inflation[9] and y_t is the output gap[10]. λ indicates the relative weight given by the central bank to output stability and inflation stability. With strict inflation targeting, $\lambda = 0$, while flexible inflation targeting is defined by $\lambda > 0$. Even though the loss function has two elements, both of which are given weight, there is, however, a fundamental difference in that the monetary policy authorities can choose the inflation target but not potential output.

The loss function (1) is based on a simple model where there is seldom any conflict between output stability and inflation stability because inflation only depends on the output gap.[11] Monetary policy can therefore concentrate on stabilising inflation, and as a result, output will always be at the socially optimal level. This result is often called "divine coincidence"[12]. In more realistic models, "divine coincidence" no longer holds, and monetary policy is faced with a short-term trade-off between price stability and real stability.

8 Woodford's main contribution to this theory is summarised in his book *Interest and Prices*, published in 2003.
9 In Woodford's model, the optimal inflation rate is zero. More generally, π in equation (1) can be interpreted as the inflation gap, ie the deviation between actual inflation and the inflation target.
10 The output gap is measured here as the deviation from the level it would have had if all nominal variables were completely flexible and if there were also a subsidium to ensure that equilibrium output did not become too low as a result of monopolistic competition.
11 A conflict can arise, however, if firms' market power is subject to stochastic shocks (mark-up shocks).
12 This expression was first used by Blanchard and Galí (2007).

In more realistic models with a number of market imperfections, the welfare loss function is also more complicated than the simple loss function in equation (1). In addition to inflation and the output gap, unemployment, wage growth, the real exchange rate and financial stability can also be included in the welfare loss function.

These results from more recent monetary policy research do not argue against inflation targeting as inflation is still an important variable to stabilise. But the results indicate that it is important for inflation targeting to be flexible and to take sufficient account of output, employment and other relevant variables if it is to contribute to the highest possible welfare of households and businesses. However, a target function for monetary policy that specifies the variables it is intended to stabilise makes it more challenging to ensure central bank accountability.

4.2.2 Relationship between lambda (λ) and the horizon

According to theories on optimal monetary policy, the horizon should vary and partly depends on the magnitude and duration of shocks to the economy. This applies even if λ is constant. For some shocks, for example demand shocks, it may be optimal to bring inflation to target relatively quickly. For other types of shock, for example cost shocks, a longer horizon may be optimal, given that confidence in monetary policy is not at risk. Even though the horizon, according to theory, shouldbe variable, a reasonably fixed horizon has some advantages. In order to foster confidence in monetary policy and contribute to its credibility, it is essential that the public and market participants understand how the central bank sets the policy rate.

The central bank's inflation target horizon is an implicit expression of the magnitude of λ in the loss function (1). A central bank that places considerable weight on inflation and little weight on the real economy will choose a short horizon (ie a λ close to zero). A central bank that places considerable weight on the real economy will choose a long horizon (ie $\lambda > 0$).[13] The longer the horizon, the greater the flexibility the central bank will have with regard to pursuing other short-term objectives such as, for example, output and exchange rate stability. However, a longer horizon can reduce the credibility of the inflation target.

How quickly inflation should be brought back to target will depend on the type of shock to which the economy has been exposed. For example, a fall in overall demand could pull down inflation, output and employment to a level that is too low. Correct monetary policy would then involve keeping the policy rate low in order to boost both demand and inflation in the short term. There are no trade-off

13 See for example Smets (2000).

conflicts.[14] However, other shocks, such as supply-side shocks, can create a conflict between price stability and stability in the real economy in the short term. Supply-side shocks in the form of, for example, cheaper imports reduce inflation while pushing up output and employment. A more expansionary monetary policy will then exert upward pressure on inflation, but will also be able to provide a further boost to output and employment. The central bank then faces a trade-off between the gaps in the loss function (1). This is the reason why supply-side shocks are often difficult to neutralise, both because the output gap and the inflation gap require different approaches, but also because supply-side shocks can change the trend in potential output. As a result, estimation of the output gap is more uncertain. Supply-side shocks therefore imply a longer horizon than demand shocks.

The magnitude and duration of the shocks to which the economy is exposed will also affect the horizon. If the shock is small, the central bank will be able to bring inflation back to target fairly quickly, while it will need more time if the shock is large. The longer the duration of the shock, the longer the optimal horizon chosen by the central bank will be. A more persistent shock will have a greater immediate effect on inflation: as forward-looking firms take into account that inflation will be low for a long period, they already set lower prices today.[15]

4.2.3 Dual mandate

In the debate on the monetary policy framework, some have argued that central banks should have a dual mandate that gives equal weight to price stability and real stability.[16] As discussed by Andersson and Claussen (2017), operating under a dual mandate is not obviously different from flexible inflation targeting. According to Svensson (2004), distinguishing between a hierarchical and a dual mandate serves no purpose as central banks operate a policy that can be characterised in the form of a loss function, a policy pursued by the Federal Reserve and other inflation targeting central banks, according to Svensson.

Those in favour of a dual mandate, however, emphasis that a downturn can have long-term or permanent effects on employment if monetary policy does not actively contribute to pushing the level of activity back up. They argue that it is not sufficient to aim for *stability* in the real economy, but that the goal should be the highest possible level of employment, as formulated in the mandate for the Federal Reserve – referred to as a dual mandate.

14 There could still be a trade-off between short- and long-term stability if a low policy rate leads to increased financial instability.
15 See for example Røisland and Sveen (2006).
16 See for example Friedman (2008), Wren-Lewis (2013) and Holden (2017).

According to Holden (2017), Norway should have a dual mandate for monetary policy, where the objective of low and stable inflation is combined with an objective of high and stable output and employment. He argues that the risk of high inflation is far lower than previously due to more permanent structural changes in wage formation and in the monetary policy framework. In almost all the advanced economies, wage earners hold a far weaker position in wage formation than previously, and the central bank has been given increased independence and a clear objective to keep inflation low. Holden also argues that even if expansionary monetary policy is not able to keep GDP above its equilibrium level on a long-term basis, monetary policy can still influence average GDP over time by counteracting persistent and deep downturns. Holden's point is that business cycles are not a zero-sum game – downturns are as a rule deeper and more persistent than upturns.

In principle, such considerations can also be taken into account under flexible inflation targeting. The main question is probably not whether or not real stability and price stability are given equal weight, but how real stability is defined more explicitly in the mandate.

4.2.4 International inflation targeting practices

Over time, there has been a tendency for inflation targeting countries to extend the target horizon. This change does not seem to be a result of a change of opinion regarding how quickly monetary policy has an impact, but reflects the authorities' experience and increased understanding of the shocks that can occur. Inflation targeting has become more flexible.[17]

Inflation targeting countries now give more weight to an appropriate balance between stability in inflation and stability in output and employment. This refinement of inflation targeting reflects experience gained over the years. When inflation targeting was introduced, inflation had already declined after many years of rapidly rising prices. Since then, the rise in prices has been low and fairly stable. At the same time, monetary policy has helped to moderate fluctuations in the real economy.

In most inflation targeting countries, the time horizon is currently the medium term (Table 4.1). Generally, a medium-term horizon for achieving the inflation target implies that other objectives are given some weight. A medium-term target horizon has the advantage of being able to anchor inflation expectations and permit short-term deviations from the target when the economy is exposed to shocks.[18]

17 See Paulin (2006).
18 See Hammond (2012).

Table 4.1: Inflation targets and target horizons

Country	Target	Target horizon
Australia	2%–3%	Medium term
Canada	2%	Medium term
ECB	Below, but close to 2%	Medium term
New Zealand	1%–3%	Medium term
Norway	2.5%	Medium term
UK	2%	Depends on the shocks the economy is exposed to
Sweden	2%	Normally two years
US	2%	Long term

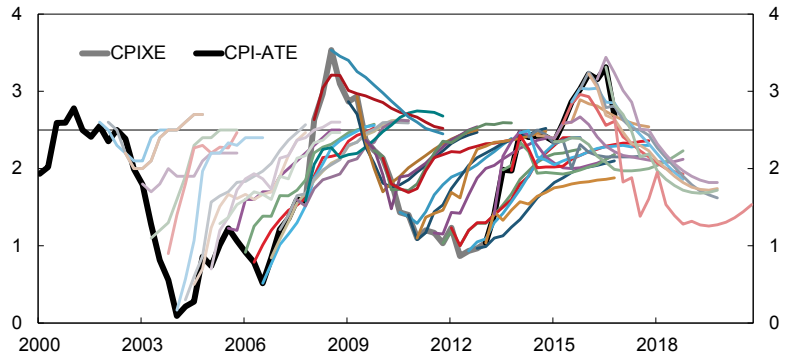
Sources: National central banks

Extending the horizon does not appear in general to have weakened confidence in central banks.[19] Indeed, this change may have been possible because the credibility of the inflation targeting regime has increased over time.

During the period of flexible inflation targeting in Norway, Norges Bank's specification of the horizon for achieving the inflation target has been changed twice. When the inflation target was introduced in 2001, Norges Bank defined a horizon of two years to bring inflation back to target. In *Inflation Report* 2/2004, Norges Bank changed its communication regarding the horizon and wrote that "*Norges Bank sets the interest rate with a view to stabilising inflation at the target within a reasonable time horizon, normally 1-3 years."* In *Monetary Policy Report* 1/2007, the flexibility of the horizon was increased further and the Bank's communication was changed to "*stabilising inflation close to*[20] *the target in the medium term"*. However, the relevant time horizon will depend on the shocks the economy is exposed to and how they will impact the path for inflation and the real economy in the period ahead. Norges Bank's inflation forecasts continued to end at around 2.5% at the end of the projection period of around three years up until 2013. Since then, the Bank's projections have been based on the assumption that it would take somewhat longer to bring inflation back to target. This is illustrated in Chart 4.2. (See also Norges Bank (2017a) for a discussion of changes to the horizon.)

19 See Paulin (2006).
20 This was reversed to *at* the target in *Monetary Policy Report* 2/10.

Chart 4.2 Core inflation. CPI-ATE[1]. Estimates at different points in time. Four-quarter percentage change



1) CPIXE in the period 2008 – 2012.
Sources: Statistics Norway and Norges Bank

These changes may be viewed as a gradual increase in the λ value that best describes Norges Bank's trade-offs. Norges Bank's inflation-targeting practice gradually shows somewhat longer periods of deviation from the inflation target in order to give greater priority to stability in the real economy and to promote financial resilience.

4.3 ACCOUNTABILITY

4.3.1 Theoretical basis

In the interest of democratic governance, transparency is important for ensuring adequate democratic control of the way in which the central bank performs its task.[21] The greater the scope for judgement is in interest rate setting, the more relevant the question of transparency becomes. With an exchange rate target for monetary policy, the scope for judgement is minimal. Monetary policy is more or less mechanical. At any given time, the public can observe the krone exchange rate and thus monitor the central bank's performance of its task.

In a flexible inflation targeting regime, it is not as easy to assess the conduct of monetary policy. The operational implementation of the inflation target requires considerable exercise of judgement. A high degree of discretion entails leeway for the central bank. At the same time, the basis for the central bank's interest rate setting may become less clear to economic agents. Even if the central bank's mandate is clearly formulated and publicly known, it is not necessarily easy to see how the central bank will proceed in practice to achieve the target. With regard to

21 For a detailed discussion of the importance of transparency, see Qvigstad (2009).

the implementation of inflation targeting both internationally and in Norway, the trend has been towards longer time horizons and greater flexibility in achieving the objective of price stability (see Section 4.2.4).

Flexibility has benefits. It enables the central bank to respond to shocks in a manner that provides a good balance between different considerations. It also provides scope for adapting policy to structural changes in the economy.

Too high a degree of flexibility can, on the other hand, involve costs. The formulation of the monetary policy mandate can be viewed as a trade-off between costs and benefits associated with flexibility. If the mandate gives the central bank considerable flexibility in deviating from the target in order to balance different considerations, and it is up to the central bank to make this trade-off, the central bank has, in practice, greater goal independence than if the scope for deviation is limited.

Alesina and Tabellini (2003) point out three conditions that in isolation suggest delegating a policy area to an independent institution: (i) the criteria for good performance can be easily described ex-ante; (ii) performance presupposes some technical expertise; (iii) political incentives are distorted by time inconsistency[22] or short-termism. In any case, the latter two conditions may be said to be largely fulfilled with regard to monetary policy. The extent to which condition (i) is fulfilled is not completely obvious. An "optimal" monetary policy cannot in practice be described in detail, but only in general terms. How the trade-offs should be made is also difficult to describe in detail.

When the authorities have delegated monetary policy to a (partly) independent central bank, the authorities face what is called a principal-agent problem. In standard principal-agent theory, the principal's (in this the case the authorities') problem consists in ensuring that the agent (here the central bank) has incentives to perform at an optimal level and that performance complies with the principal's preferences. That is, the principal must make a trade-off between how much independence the agent will have and the degree of accountability.

In principal-agent theory, it is assumed that the agent (the bureaucrats) has incentives and preferences that may differ from what is in the principal's interest.[23] In the case of monetary policy, preferences must not be interpreted literally. They may also reflect various professional assessments. For example, the central bank may have a different view from the authorities of what the optimal inflation rate is, of what is a

22 The time inconsistency problem appears where the policymaker can maximise performance if she commits to a particular course of action, but one that she has incentives to abandon. See Kydland and Prescott (1977). A discussion of the relevance for monetary policy is found in Qvigstad and Røisland (2000).

23 In some cases, this may be intentional on the part of the principal. For example, Rogoff (1985) showed that it may be rational to delegate monetary policy to a central bank that gives more weight to price stability, and less weight to the stability of the real economy, than indicated by society's preferences.

suitable trade-off between stability in inflation and stability in output and employment or the extent to which monetary policy should address other concerns, such as financial stability.

Because the agent may have incentives and preferences that do not align with the interests of the principal, it is not optimal for the principal (society) to let the agent have full independence and the greatest possible room for manoeuvre. The principal will therefore design various controls to ensure that the agent performs the task in a way that is in greatest alignment with the principal's interests.

The principal has two main categories of controls at his disposal: ex-ante and ex-post controls.[24] Ex-ante controls are intended to influence the agent's decisions before the actual decisions are made. For monetary policy, the most important ex-ante controls are the Norges Bank Act and the mandate for monetary policy. Ex-post controls concern oversight, accountability and sanctions, if necessary. For monetary policy these may involve requirements for transparency, external evaluations of monetary policy, legislative hearings and the like. There may be some substitutability between ex-ante and ex-post controls. The less binding an ex-ante control is, that is the greater the flexibility of the central bank in its conduct of monetary policy, the greater the importance of ex-post controls, and vice versa.

The principal-agent problem becomes more complicated if the principal cannot fully observe the agent's efforts or preferences, or if there are costs associated with this. Thus, the agent has some opportunity to conceal inadequate effort or divergence from the principal's preferences. In the case of inflation targeting, the principal cannot with certainty know the extent to which a deviation in inflation from the target is due to:

a) disturbances that the central bank could not have foreseen (pure shocks),
b) disturbances that the central bank could have foreseen (poor forecasts),
c) a trade-off with regard to other considerations that reflect the principal's weighting (the authorities' λ (equation (1))
d) a trade-off that reflects the central bank's own weighting (ie the central bank's λ).

Lars Svensson (1997) argued that the central bank's inflation forecast can be viewed as a verifiable intermediate target under an inflation targeting regime, just like the role of an exchange rate or money supply target. The interest rate should then be set so that the forecast for inflation at a given time in the future would be equal to the target. In principle, the principal (eg with the aid of external experts) can evaluate the central bank's inflation forecast in order to distinguish between a) and b). Even so, in practice, judging the quality of forecasts is not a simple matter.

24 See Elgie (2002).

Different institutions' forecasts must be compared over a sufficiently long period of time to obtain such knowledge. There will also be some disagreement among experts on what the reasonable assumptions behind the forecast are, and there is rarely a formula for deciding on the best assumptions or the best model.

In addition, it may be difficult for the principal to distinguish between c) and d). Lars Svensson (1997) envisaged a fixed horizon where the inflation forecast would be equal to the target, for example two years ahead. However, many central banks, including Norges Bank, have a more flexible horizon, where the relevant horizon depends on the shocks and monetary policy trade-offs (see Section 4.2.4). The trade-offs are often difficult to describe in detail, since the trade-offs may be between different variables and in different dimensions. For example, there may be trade-offs with regard to stability in output and employment (λ) or trade-offs between expected performance and risk.[25] The inflation forecast can therefore hardly play the same role as a traditional intermediate target, in the manner of a fixed exchange rate or money supply target, even though publication of the forecasts and transparency regarding the assessments naturally contribute to greater accountability.

Inherent in the specification of the target index, the "contract" between the principal and the agent, is a trade-off between accountability on the one hand and flexibility to respond appropriately to economic shocks on the other.[26] A typical intermediate target such as a fixed exchange rate offers little flexibility, but a high degree of accountability. The lack of flexibility has costs in the form of an impaired ability to stabilise the economy. A mandate that gives the central bank considerable flexibility may better enable it to stabilise the economy, but the principal then runs a greater risk that the agent will perform the task in a manner at variance with the principal's wishes. This risk can be reduced with ex-post controls, as mentioned above.

The relationship between flexibility and welfare loss is illustrated in Chart 4.3, where it is assumed that the optimal monetary policy is a (very) flexible inflation targeting regime.[27] Even if, as mentioned above, there are different controls that promote accountability, the degree of accountability in isolation will be greater, the less flexibility the central bank has to deviate from the inflation target. The solid line illustrates the case where the agent does not have his own principles that deviate from the principal's. In that case, less flexibility, in the sense of stricter

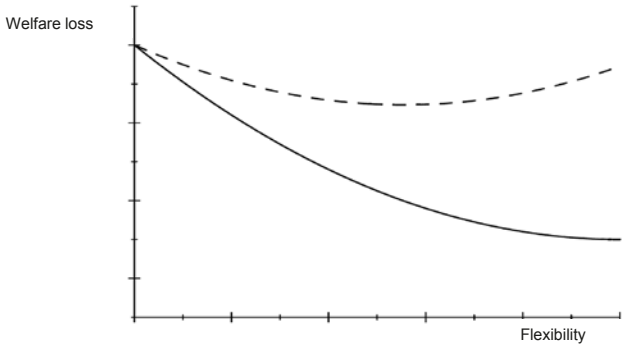
25 The consideration of preventing the build-up of financial imbalances is an example of a trade-off between expected short-term performance and long-term risk.

26 See for example Rogoff (1985), Persson and Tabellini (1993), Walsh (1995) and (2015), Svensson (1997) and Røisland (2001).

27 The chart is based on a simple New Keynesian model and loss function (1), but the qualitative characteristics are not dependent on the model. The broken line, where it is assumed that the central bank has its own preferences, is modelled in the same way as in Walsh (2015), ie as stochastic changes in the targets for inflation and/or output.

inflation targeting (lower λ) than indicated by the true welfare loss function, leads to a higher welfare loss.

Chart 4.3 Relationship between welfare loss and degree of flexibility[1)] in inflation targeting



1) Flexibility is measured by the standard deviation of the inflation gap (deviation in inflation from target). The solid line shows the case where the central bank and the principal have the same preferences. The broken line shows the case where the central bank has its own preferences that differ from those of the principal.

The broken curve illustrates the case where the central bank has a view of the optimal level of inflation and/or output (or the trade-off between them) that may deviate from the authorities' view, which is assumed to represent society's view.[28] In this case, the welfare loss will be higher for a given flexibility. The less flexibility in the inflation target that is specified in the mandate, the less the agent's private incentives and preferences will influence policy, which in isolation contributes to a lower welfare loss. But less flexibility also leads to poorer monetary responses to economic shocks, because it is not possible ex ante to describe an optimal monetary policy response to different shocks. In linear models with quadratic loss functions, it will, under these assumptions, typically be the case that granting the agent less flexibility yields a net welfare gain if the degree of flexibility is very high at the outset, but it yields a net welfare loss if the degree of flexibility is low at the outset. The optimal degree of flexibility will in that case lie somewhere between the end points.

In theories based on a principal-agent approach to monetary policy, as described above, it is common to explicitly focus on, and thus also exaggerate, certain aspects, such as a possible conflict of interest between principal and agent. In practice, such possible conflicts of interest or divergent assessments need not be especially relevant. However, an "optimal" degree of flexibility in the design of an

28 In some of the principal-agent literature that deals with political economy, it is often assumed that the principal's (the government's) incentives and preferences do not necessary reflect those of society, since they have incentives to be re-elected or to tie the successor government to a policy. See for example Eggertsson and Borgne (2010) for an analysis of delegation of monetary policy where it is assumed that the authorities also have their own incentives that may be at variance with society's interests.

inflation target need not be based on an assumption that the central bank has its own incentives or different assessments from the principal's. If monetary policy faces a time inconsistency problem, either of the "classical" or of the "New Keynesian" type[29], the relationship between welfare loss and flexibility in inflation targeting will follow the same pattern as illustrated by the broken curve in Chart 4.3. In that case, the principal should also formulate the mandate in such a way that the consideration of stabilising inflation around the target is given somewhat more weight than indicated in isolation by the welfare loss function.[30]

4.3.2 Transparency and accountability in practice in other countries

As discussed above, flexibility and independence give central banks more freedom with regard to choice of monetary policy strategy, while transparency is a means of communicating the purpose of the strategy to the market, thereby amplifying the policy's effectiveness. Independence shields central banks from political pressure, but transparency regarding central banks' intentions and actions is a way to hold them accountable to the public for their decisions (see the discussion of ex-post controls in 4.3.1).

Considerable changes have taken place in central bank communication in the direction of greater transparency. Central banks give weight to openness to the public, and they publish much of the basis for their monetary policy decisions (Table 4.2). Transparency regarding the decision process, the various trade-offs and forecasts are also viewed in modern monetary policy as important for effective policy implementation. For monetary policy to be most effective, economic agents need to understand the central bank's intentions in its interest rate setting. In addition, it is important for the central bank to make its response pattern known, so that economic agents react to new information in a stabilising manner. Modern monetary policy theory therefore states that the central bank should communicate its response pattern and expectations for developments in the interest rate and the economy.[31] [32]

The central bank's view of the economic situation and developments ahead is expressed in inflation reports and monetary policy reports. Some central banks make the assessments underlying interest rate decisions known in press releases and at press conferences. These include the ECB and the central banks of Sweden

29 The classical time inconsistency problem originates in the fact that the socially optimal level of output (employment) was higher than the equilibrium in the economy. The New Keynesian time inconsistency problem results from the fact that monetary policy will be able to stabilise inflation better if it can commit to overshooting the inflation target in the future in the event of a deviation today. See the box "Optimal policy, commitment and discretion" in Chapter 2 for a detailed discussion.

30 See Randoff (1985) and Clarida, Galí and Gertler (1999).

31 This line of reasoning is conditioned on the fact that the central bank's forecasts are not, on the whole, less accurate than those of other economic agents.

32 See for example Woodford (2005) and Svensson (2007).

and Norway. Other countries' central banks issue shorter press releases, and provide further information regarding the assessments in detailed minutes of monetary policy committee meetings. This pertains to the Bank of England (BoE) and the Federal Reserve (Fed), which only hold press conferences when the *Inflation Report* (BoE) and economic forecasts (Fed) are presented.[33] In the minutes, the voting of individual members is published. Common to central banks that publish minutes and voting is that monetary policy decisions are made by committees with members who work at the central bank or on monetary policy matters on a full-time basis. The Bank of Canada and the Reserve Bank of New Zealand, where the governor formally makes the decision, do not publish any kind of minutes.

A number of countries also address the issue of democratic governance by requiring their central banks to report in various ways to political authorities. In the case of Norway, Norges Bank's annual report is submitted to the Ministry of Finance Norge, presented to the King in Council and communicated to the Storting in the Government's *Financial Markets Report*. The governor also appears at an open hearing of the Storting Standing Committee on Finance and Economic Affairs in connection with deliberations on the *Financial Markets Report*. The Swedish central bank must submit a report to the Riksdag Committee on Finance at least twice a year. In connection with these reports, the central bank governor appears at hearing in the Riksdag. In the UK, the governor of the Bank of England and members of the Bank's Monetary Policy Committee appear in Parliament at regular hearings on the Bank's inflation reports. The Bank of England must also write an open letter to the Chancellor of the Exchequer if inflation deviates from the target by more than one percentage point, explaining how and how quickly the Bank intends to return inflation to target. Twice a year, the Chairman of the Federal Reserve must appear at a Congressional hearing to report on the economic situation and the conduct of monetary policy. At the same time, a report must be submitted to Congress.

There is considerable public interest in monetary policy. It is continually being discussed in the media and among financial market participants. Many financial institutions assess current economic developments and possible consequences for monetary policy. In a number of countries, monetary policy is also evaluated by independent groups of experts. In the US, a group of independent economists called "the Shadow Open Market Committee"[34] has evaluated US monetary policy since 1973. Another example is the ECB, where independent economists and market participants discuss euro area monetary policy in a series of conferences

33 Both the Federal Reserve and the Bank of England hold eight monetary policy meetings a year. An inflation report or economic forecasts are presented at every other meeting.. Four press conferences a year are held in connection with the monetary policy meetings.

34 See http://shadowfed.org/.

called "The ECB and Its Watchers"[35]. In Norway, monetary policy is evaluated annually by "Norges Bank Watch"[36].

As the literature recommends, it is international practice for central banks to be transparent, and this transparency has increased in recent years. However, countries practise transparency differently. Dincer and Eichengreen (2014) find in a sample of more than 100 central banks that the most transparent in 2010 were Sveriges Riksbank, the Reserve Bank of New Zealand, the Central Bank of Hungary, the Czech National Bank and the Bank of Israel. On the basis of 15 questions, they construct a "transparency index"[37] with a maximum value of 15 and a minimum value of zero. Sweden's index value is 14.5, while Norway's index value is 10[38].

There has been some convergence with regard to central bank communication. Most central banks report on the monetary policy framework and their objectives. They also communicate their analyses of the economic situation, including the outlook for growth and inflation and the most important risks to the outlook. Most of them explain the reasons for policy decisions. The biggest difference with regard to communication strategy lies in how much information is disclosed regarding the decision makers' viewpoints and how much "forward guidance" is given on monetary policy[39]. In countries such as Sweden, New Zealand and Norway, the central banks publish their own forecasts for policy rates in the period ahead. The Federal Reserve publishes individual Federal Open Market Committee (FOMC) participants' projections for the federal funds rate, but the Fed does not have an official interest rate forecast.

Some central banks publish both voting from and minutes of their monetary policy meetings, and members of monetary policy committees are also able to make public statements. This may render communication unclear, because the central bank speaks with too many voices.[40] At the same time, detailed minutes will enable each member to largely be held accountable. On the other hand, such transparency may inhibit the actual monetary policy discussions.[41]

35 See https://www.ifk-cfs.de/events/conferences/ecb-watchers.html.

36 Norges Bank Watch reports are available here: http://www.bi.edu/research/research-centres/Centre-for-Monetary-Economics-CME/Norges-Bank-Watch/. Norges Bank Watch is partly funded by the Ministry of Finance.

37 The questions cover: transparency regarding the objectives of monetary policy, transparency regarding economic data/forecasts underlying the decision, transparency regarding the decision-making process, transparency regarding the actual decision, with an explanation of indications of future policy and transparency regarding whether objectives have been attained and the effects on macroeconomic variables.

38 Norway comes out less favourably partly because Norges Bank does not publish either the minutes of or voting at monetary policy meetings.

39 See Hammond (2012).

40 See Blinder (2006).

41 See Meade and Stasavage (2008).

Table 4.2: Transparency and accountability at selected central banks

	Parliamentary hearings	Press release/ press conference	Minutes	Voting	Monetary policy report/ inflation report	Own interest rate forecast
Reserve Bank of Australia	Yes	Press release	Yes, anonymised minutes after two weeks	No	Yes	No
Bank of Canada	Yes	Press release after each interest rate decision, but a press conference only in conjunction with publication of the monetary policy report	No[1]	No	Yes	No
Bank of England	Yes	Press release after each MPC meeting, but a press conference only in conjunction with publication of the inflation report	Yes, anonymised minutes after one day. Complete transcript after eight years	Yes, published in the press release and minutes	Yes	No
ECB	Yes	Press release and press conference after each monetary policy meeting	Yes, anonymised minutes after four weeks	No	No, but publishes macroeconomic forecast four times a year	No
Federal Reserve System	Yes	Press release after each FOMC meeting, but a press conference only in conjunction with publication of economic forecasts	Yes, anonymised minutes after three weeks. Complete transcript after five years	Yes, published in the press release and in the minutes	No, but FOMC participants issue their own economic forecasts four times a year	No official interest rate forecast, but publishes FOMC participants' projections for the fed funds rate ahead, as well as the median of projections
Norges Bank[2]	Yes	Press release and press conference after each monetary policy meeting	No	No	Yes	Yes
Reserve Bank of New Zealand	Yes	Press release after each interest rate decision, but a press conference only in conjunction with publication of the monetary policy report	No[3]	No	Yes	Yes
Sveriges Riksbank	Yes	Press release and press conference after each monetary policy meeting	Yes, minutes including names of participants after two weeks	Yes, published in the press release and in the minutes	Yes	Yes

1 By law, the governor is responsible for monetary policy, but in practice, the decision is made by consensus by the Governing Council.

2 On 3 May 2017, Norges Bank's Executive Board decided to publish summary minutes of monetary policy meetings as from the meeting on 21 June 2017. The number of monetary policy meetings will be increased from six to eight per year from 2018. A press conference will only be held in conjunction with the publication of the *Monetary Policy Report*.

3 By law, the governor is responsible for monetary policy, but in practice, the decision is made by consensus by the Governing Committee.

Sources: National central banks

4.4 THE IMPORTANCE OF INFLATION EXPECTATIONS FOR MONETARY POLICY

4.4.1 Anchoring inflation expectations is important for economic stability

Inflation expectations play an important role in many economic decisions[42] including price-setting, wage formation and financial asset prices. In addition, inflation expectations can influence consumption and investment decisions through the effect on the real interest rate.

Anchored inflation expectations make it easier for monetary policy to fulfil the objective of price stability and contribute to stable developments in output and employment.[43] Inflation expectations are often referred to as anchored when medium-term and long-term inflation show little response to new information[44] and remain at a stable level close to the inflation target.[45] Poorly anchored inflation expectations could lead to instability in prices, wages and demand.[46]

When inflation expectations are anchored, a given change in the central bank's policy rate will result in a stronger and more predictable change in the real interest rate, which is the most important rate for most economic decisions. Monetary policy could be more actively used to address considerations other than price stability, such as stabilising output and employment, if inflation expectations are firmly anchored. At the same time, the anchor risks slipping if monetary policy is overly geared towards considerations other than price stability.[47] Anchoring inflation expectations is therefore both a precondition for the implementation of flexible inflation targeting and a constraint on how flexible inflation targeting can be.

In an environment of very low interest rates, it is particularly important to ensure that inflation expectations are firmly anchored to the inflation target.[48] Were inflation expectations to fall and stabilise at a low level, the likelihood would increase that the lower bound for nominal interest rates would become fixed. Traditional monetary policy could then no longer be used to stimulate the economy.

In addition to enabling monetary policy to stabilise developments in output and employment, firmly anchored inflation expectations will also have a stabilising effect on actual inflation. When agents are confident that the central bank will bring inflation back to target, it is reasonable to assume that a temporary deviation in

42 See for example Woodford (2005).
43 See Woodford (2003).
44 See for example Bernanke (2007).
45 See for example Ball and Mazumder (2015).
46 Mehrotra and Yetman (2014).
47 See for example Levin (2014).
48 See inter alia Bernanke (2017) and Kiley and Roberts (2017).

inflation from the target will to a lesser extent lead to changes in inflation expectations than when agents believe the central bank will not bring inflation back.[49]

Anchored inflation expectations may slip if there is a lack of confidence in the nominal anchor for monetary policy, or if there is uncertainty regarding what the central bank's inflation target is. Agents may then to a greater extent base their expectations of future inflation on historical inflation. In a certain respect, inflation expectations become more retrospective. Research suggests that this was the case in the 1970s and 1980s when inflation was high and unstable in many countries.[50] The cost of inflation expectations fixed at such a high level was experienced when many central banks, with the Federal Reserve at the forefront, began pursuing a policy of disinflation in the beginning of the 1980s.[51] It was only after the central bank increased nominal rates more than the increase in inflation expectations, that it was able to bring inflation under control through increased real interest rates.[52] The result is important and is referred to in the literature as the Taylor principle.[53]

Firmly anchored inflation expectations do not necessarily imply that inflation expectations for the coming years are in line with the target. Inflation will often deviate somewhat from the target as a result of shocks that occur. If the central bank's own projections deviate somewhat from the target in the short term it can therefore be advantageous if the public's expectations largely move in line with the central bank's projections. If the central bank, for various reasons, seeks to maintain a lower level of inflation in the short term, while the social partners expect inflation to be near target, real wage growth can be higher than intended. This can lead to weakened competitiveness and higher unemployment.[54]

Research shows that inflation targeting has proved to effectively anchor inflation expectations at a low and stable level.[55] A credible and clearly communicated inflation target creates a nominal anchor that economic agents can use to navigate.

4.4.2 Ensuring stable and well-anchored inflation expectations

Not only are anchored inflation expectations important for the conduct of monetary policy – they are also an indication of whether monetary policy fulfils its primary

49 See for example Gali and Gertler (1999), Kiley (2007), and Smets and Wouters (2007).
50 Several studies have estimated the US Phillips curve, which explains the relationship between inflation and unemployment, and found that inflation developments were highly dependent on historical inflation in the period between 1976 and 1995, but not in the period between 1995 and 2014 (see for example Ball and Mazumder (2015), Stock and Watson (2009), Kiley (2015), and Coibion and Gorodnichenko (2015)).
51 See for example Goodfriend and King (2005).
52 See Clarida et al (2000).
53 Taylor (1993). To ensure that inflation expectations do not become self-fulfilling, the Taylor principle must be fulfilled.
54 See Svensson (2015).
55 See inter alia, Gürkaynak et al (2006), Davis and Presno (2014), Ehrmann (2015) and Gaspar et al (2016).

objective. The central bank's awareness of how expectations are formed is therefore important in the conduct of monetary policy.[56] This can be challenging because inflation expectations are not directly observable. To measure them, two conditions in particular need to be addressed.

First, it is important to clarify whose expectations will be measured. Different types of agents may have different inflation expectations, partly reflecting the difference in importance that future inflation may have for different groups. It would, for example, be more important for financial market participants to form accurate expectations of future inflation and thus future monetary policy than it would be for households. It is reasonable to assume that economic experts, such as financial economists and those employed by the social partners, would use consumer price inflation (CPI) as the basis for their expectations because it is both relevant with regard to the purchasing power of the groups they represent, and because they know that Norges Bank uses the CPI in its inflation targeting regime. In forming inflation expectations, it would make more sense for business leaders and households to give weight to the prices they most often face.[57]

Choosing which agents' expectation to which the central bank should give the most weight in its analyses depends on the issue at hand. If it is a question of the extent to which the objectives of monetary policy and monetary policy signals are included in financial asset prices, the inflation expectations of financial market participants would be important. With regard to the general confidence that monetary policy will secure low and stable inflation, households are an important group. The social partners' inflation expectations provide an indication of future nominal wage growth. Even if not all the groups include the same information, the flow of information between groups will occur naturally. For example, it is conceivable that communications from the central bank are considered by economic experts, who subsequently speak to the media, which in turn receive the attention of households and businesses. Support for this example can be found in the literature.[58]

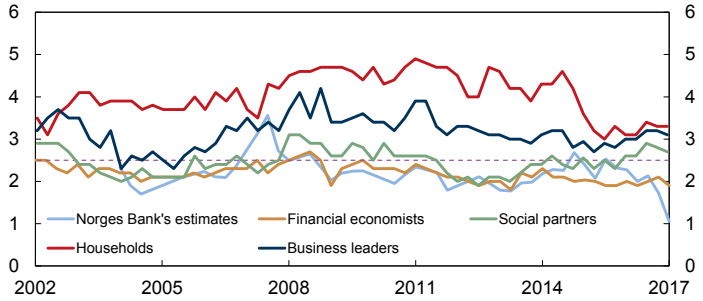
Data indicate that inflation expectations vary between different agents (Chart 4.4). While the inflation expectations of economic experts and the social partners are largely in line with Norges Bank's own estimates, the expectations of business leaders and households are usually somewhat higher. This is also a common finding for other expectation horizons and in other inflation targeting countries.

56 See Bernanke (2007).

57 Afrouzi et al (2015) show that among 15 000 business leaders in New Zealand almost 90% reported personal consumption experience as very or extremely important for the formation of expectations.

58 Carroll (2003) uses a "sticky information" model to show that the projections of professional forecasters Granger-cause the projections in the Michigan Household Survey. Further, Coibion and Gorodnichenko (2015) claim that firms' inflation expectations are formed on the basis of household expectations.

Chart 4.4 Two-year inflation expectations.[1]
Expected twelve-month percentage change in the CPI. 2002 Q1 – 2017 Q1



1) Households were asked about their "2-3 year" inflation expectations.

Sources: Opinion, Epinion and Norges Bank

Second, the method used to measure inflation expectations is significant. Of the empirical methods, two stand out: surveys and information derived from inflation-indexed bonds.[59] No market for such bonds exists in Norway, but there is a rich dataset based on a variety of surveys.[60] The analysis in this chapter only uses data from Norges Bank's expectations survey.[61]

In theoretical models, including the New Keynesian model used in monetary policy, it is assumed that inflation expectations are forward-looking and rational, ie that economic agents' expectations formation is not systematically flawed, but that they are adjusted in line with newly available information.[62]

Empirical studies, however, indicate that inflation expectations are not fully rational, but are formed through complex and heterogeneous processes, with wide variation across groups, time periods and monetary policy regimes.[63] Economic

59 The coupon on this type of bond is linked to a price index, normally the consumer price index. As a result, market prices for these bonds can be used to derive inflation expectations (Anderson and Maule (2014)).

60 Norges Bank's expectations survey, Consensus Economics, the Technical Reporting Committee for Wage Settlements (TBU), Norges Bank's regional network and Statistics Norway's business tendency survey collect data on Norwegian inflation expectations. Of these, the expectations survey has the largest data set and is conducted by Epinion, a market research company, on behalf of Norges Bank.

61 Norges Bank's expectations survey has been conducted quarterly since 2002 Q1. In the survey, a variety of economic agents are asked about their inflation expectations in the short and medium term. A sample of economic experts comprising approximately 30 academics, approximately 50 economists employed by the social partners and approximately 25 financial economists are asked about their one-, two- and five-year inflation expectations; a sample of business leaders, comprising 200 managers from enterprises with over 50 employees, are asked about their one- and two-year inflation expectations; and a sample of 1000 households are asked about their one- and "2-3" year inflation expectations.

62 In the New Keynesian models, the central bank can use the expectations channel to influence short-term inflation expectations in order to stabilise economic developments (see further discussion in Chapter 2).

63 Armantier et al (2012) find wide differences between demographic groups, with most heterogeneity among women, ethnic minorities and the less educated. These groups update their expectations less often, and expectations estimates are also higher (Madeira and Zafar (2012)). On the other hand Andolfatto et al (2008)

agents have been found to update their information bases more often when media coverage of inflation is frequent, which is normally the case when inflation is significantly higher or lower than normal.[64] This type of behaviour indicates that inflation expectations in such periods become more rational, which may in part explain why it could be simpler for the central bank to keep inflation under control in periods of unusually high inflation than when inflation is more moderate.[65] In the opposite case however, in periods of unusually low inflation, it could be argued that expectations can become less rational because agents do not focus on inflation and therefore do not adjust their expectations when inflation changes.[66] This may partly reflect the continued anchoring of inflation expectations at target in a number of countries that have long experienced low inflation.

Since a significant degree of learning has been observed in expectations formation, the central bank can seek to influence inflation expectations by being transparent and consistent in its conduct of monetary policy.[67] If the central bank's response to deviations from the inflation target have previously been strong and clearly communicated, economic agents can also expect strong responses to deviations in the future. Owing to the observed heterogeneity of expectations formation, it is reasonable to assume that the degree to which economic agents understand the central bank's communications will vary.[68]

The more well-informed economic agents are, the more likely it is that rational expectations models are able to capture the actual dynamic of the economy, and the more likely it is that monetary policy will make the best use of the benefits of stable and firmly anchored inflation expectations.

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claim that the skew in inflation expectations does not necessarily mean that expectations are not rational, but that it takes time for agents to adapt to new information, such as a change in the monetary policy regime.

64 See Carroll (2003). The result is supported by Akerlof et al (1996), who find that workers do not find out what the inflation rate is until it becomes too costly to ignore.

65 Sargent (1982) claims that rational inflation expectations were crucial for the rapid dampening of four cases of hyperinflation. In all four of the cases, inflation was abruptly reduced when the real economic situation changed.

66 See Blanchard (2016). Ehrmann (2015) on the other hand claims that inflation expectations become de-anchored and more retrospective with greater disagreement between forecasters when inflation is persistently low.

67 In a survey of inflation expectations, Armatier et al (2012) find that 37.5% of respondents had inflation expectations that were too high. When the same respondents, all of whom were relatively well-informed, were presented with new relevant information, they all reduced their inflation expectations. Different models seek to explain the observed heterogeneity of expectations formation with sticky information and elements of learning (see inter alia Mankiw and Reis (2002) and Branch (2004, 2007)).

68 Ullrich (2008) finds that the inflation expectations of European market participants are strongly influenced by the European Central Bank's (ECB) communications. The study is based on a theoretical model used by Svensson (2003) and asserts that the gap between actual and expected inflation may in part reflect the many economic agents that do not understand the central bank's inflation projections.

4.4.3 Are Norwegian inflation expectations firmly anchored?

The consideration of restraining the build-up of financial imbalances has in recent years been a clearly communicated element of a robust monetary policy.[69] When there is risk of a build-up of financial imbalances, this suggests keeping the key policy rate higher than would otherwise have been the case. The purpose is to mitigate downside risks to the economy. Such a monetary policy approach is often referred to as "leaning against the wind", which over time may result in more balanced developments in inflation, output and employment. One consequence of Norges Bank "leaning against the wind" in recent years is that it takes longer to bring inflation back to target (see further discussion in Chapter 4.2.4 and Chart 4.2).[70]

In this context, it is natural to investigate whether Norwegian inflation expectations are firmly anchored. As mentioned above, inflation expectations are referred to as firmly anchored when medium-term and long-term expectations show little response to new information and remain at a stable level close to the inflation target. This can be investigated in a number of ways. The analyses in this section are based on an established approach, which aims to fulfil the following criteria:[71]

1. Average long-term expectations are near the inflation target;
2. There is little variation among agents;
3. Agents seem certain about their projections;
4. Long-term expectations are formed independently of short-term expectations.

Chart 4.5 shows developments over time with an average of the inflation expectations of economists employed by the social partners, the financial industry and academic experts two and five years ahead. As expressed in the chart, these inflation expectations appear close to the inflation target.

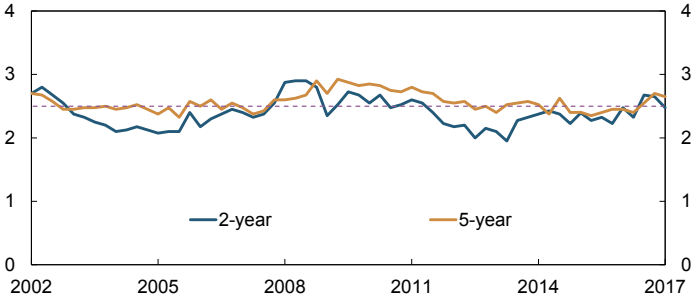
This picture is confirmed by Table 4.3, which shows average inflation expectations for each group of agents since 2002. With the exception of households and businesses, which on average have expectations that exceed the inflation target, the average of agent expectations is near the target.

69 See for example *Monetary Policy Report* 1/17, p 40.

70 Some have claimed that long-term inflation expectations in Norway have declined markedly, and that Norges Bank's increasing focus on financial imbalances is a possible cause (see IMF (2014), Levin (2014), Williams (2014) and The Economist (2014)). The discussion of decline in Norwegian long-term inflation expectations was related to inflation expectations over a 6–10 year horizon recorded by Consensus Economics. It is worth noting that the number of respondents in the Consensus survey reporting on the 6–10 year horizon was "fewer than 8". Results for this horizon should therefore be interpreted with caution.

71 See Afrouzi et al (2015). The authors also include a fifth criterion, concerning whether agents revise their forecasts. To answer this question, surveys would need to use the same sample in several rounds, which is not done for Norwegian inflation expectations.

Chart 4.5 Average of two- and five-year inflation expectations for economists employed by the social partners, and economists in the financial industry and academia. Twelve-month percentage change in the CPI. 2002 Q1 – 2017 Q1



Sources: Epinion and Norges Bank

Table 4.3 Inflation expectations. Variation over time. 2002 Q1 – 2017 Q1

	Average	Std.dev.
2 years ahead		
Financial economists	2.2	0.2
Academics	2.5	0.2
Employee organisations	2.5	0.4
Employer organisations	2.4	0.3
Firms	3.2	0.4
Households[1]	4.0	0.5
5 years ahead		
Financial economists	2.3	0.2
Academics	2.6	0.2
Employee organisations	2.6	0.3
Employer organisations	2.7	0.3

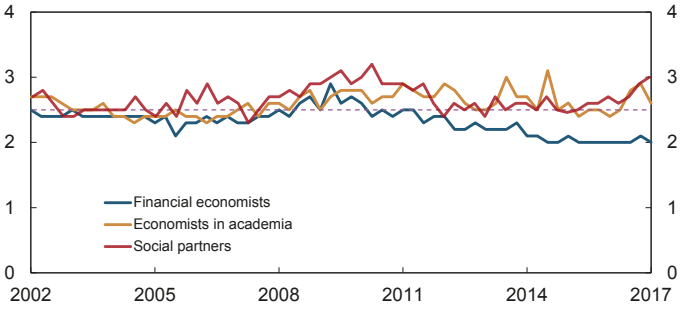
1 Households respond for the time horizon "2–3 years ahead".

Over time, there has been some variation between agents (Chart 4.6). For financial industry economists, long-term expectations have trended down in recent years.

As shown in Table 4.3, there has been little variation within each group of agents over time. With the exception of households and businesses, there is also little variation within each group of agents in the course of one year (Table 4.4). The table shows the average and the variation within each group of agents for 2015 and 2016, respectively.[72] Since households and businesses represent larger and more heterogeneous groups than the economic experts, it comes as no surprise that

72 The years 2015 and 2016 are selected because of the availability of raw data.

Chart 4.6 Five-year inflation expectations.
Twelve-month percentage change. 2002 Q1 – 2017 Q1



Sources: Epinion and Norges Bank

Table 4.4 Inflation expectations. Variation within group. 2015 and 2016[1]

	2015		2016	
5 years ahead	**Average**	**Std.dev.**	**Average**	**Std.dev.**
Financial economists	2.0	0.47	2.04	0.53
Academics	2.48	0.66	2.64	0.7
Employee organisations	2.57	0.54	2.87	0.95
Employer organisations	2.51	0.76	2.73	0.97

	2015			2016		
2 years ahead	**Average**	**Std.dev.**	**>11%**	**Average**	**Std.dev.**	**>11%**
Firms	2.0	0.47	16	2.04	0.53	136
Households	2.48	0.66	169	2.64	0.7	208

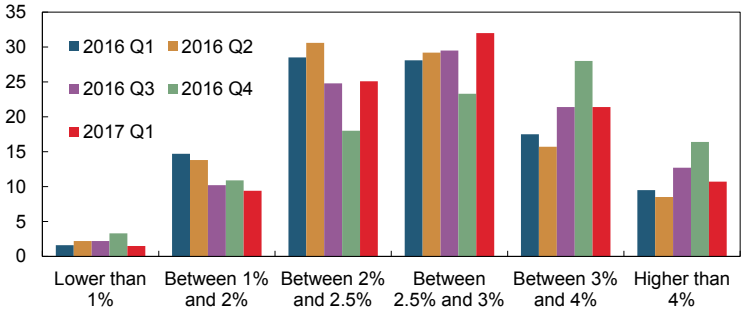
1 An average of the total responses in 2015 and 2016 respectively.

variation is greatest among them.[73] The variation has changed little for all agents. It is however worth noting that the number of extreme values reported by households and businesses increased considerably between 2015 and 2016.[74] These are excluded from the calculations.

73 As mentioned above, economic experts are represented quarterly in the survey by approximately 30 academics, approximately 50 economists employed by the social partners and approximately 25 financial economists. By comparison, approximately 500 business leaders, comprising approximately 200 from enterprises with fewer than 50 employees and 300 from enterprises with more than 50 employees, and 1000 households are surveyed quarterly.

74 Extreme values are defined as higher than 11% of absolute value.

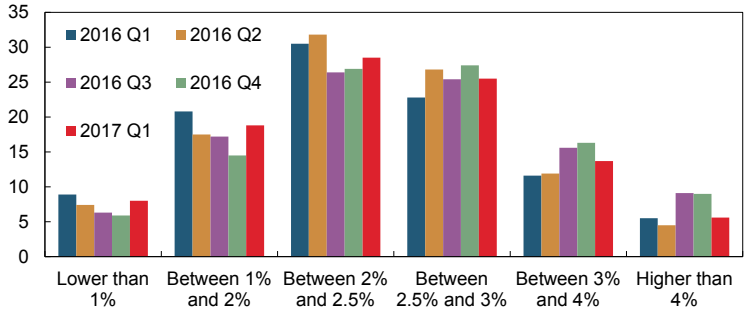
Chart 4.7 Probability assigned to different inflation ranges five years ahead by the social partners.[1] Average probability in percent on the y-axis, twelve-month change in the CPI on the x-axis. 2016 Q1 – 2017 Q2



1) About 50 economists employed by the social partners take part in the survey. Each respondent is asked to assign probability to the six inflation ranges so that the answer sums up to 100.

Sources: Epinion and Norges Bank

Chart 4.8 Probability assigned to different inflation ranges five years ahead by economists in the financial industry and academia.[1] Average probability in percent on the y-axis, twelve-month change in the CPI on the x-axis. 2016 Q1 – 2017 Q1

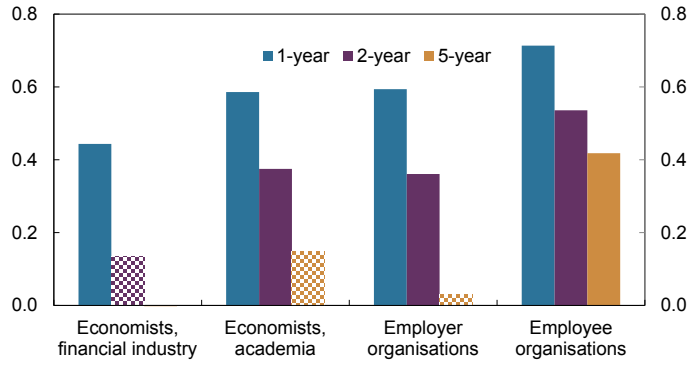


1) Approximately 25 financial economists and 30 academics take part in the survey. Each respondent is asked to assign probability to the six inflation ranges so that the answer sums up to 100.

Sources: Epinion and Norges Bank

As from 2016 Q1, forecast uncertainty has been examined by asking respondents in Norges Bank's expectations survey to assign a probability to different inflation intervals. Charts 4.7 and 4.8 show the results for 5-year inflation expectations for economists employed by the social partners and economists employed in the financial industry and academia, respectively. If inflation expectations are firmly anchored at the inflation target, the distribution will be clearly bell-shaped, with the greatest probability at the two middle intervals. With greater uncertainty among respondents, the distribution becomes more even. Both charts indicate that agents believe inflation will be close to the inflation target five years ahead. The social partners deem it somewhat more probable now than one year ago that inflation five years ahead will be above target (ie that the distribution moves to the right from 2016 Q1 to 2017 Q1), and they seem more certain about the outcome (the distribu-

Chart 4.9 Correlation between different inflation expectations and actual CPI inflation.[1]
2002 Q1 – 2017 Q1



1) Shaded bars illustrate values that are not statistically significant (at 95%).

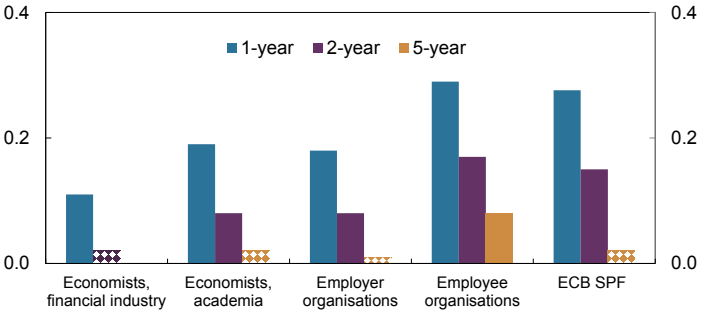
tion is less even). The distribution among economists in the financial industry and academia has also moved to the right, albeit to a lesser extent.

As mentioned, the anchoring of inflation expectations can slip if there is a lack of confidence in the nominal anchor for monetary policy, or if there is uncertainty regarding the level of the central bank's inflation target. Agents may then, to a greater extent, base their future inflation expectations on historical inflation. Agents now deem it somewhat more likely that inflation will be above target in five years than they did one year ago, despite the downward revision of Norges Bank's longest-term projection to well under the inflation target, which may be an indication that they have used the high inflation of 2016 as a basis for expectations formation.

Whether long-term inflation expectations are formed independently of current inflation developments can be examined using different methods.[75] Chart 4.9 shows the correlation between actual CPI inflation and the inflation expectations of different agents one, two and five years ahead. With the exception of the social partners, there are no significant correlations between current inflation developments and the longest-term inflation expectations. The chart also indicates that the two-year inflation expectations of academics and the social partners are both correlated with actual inflation. This result is reflected in Chart 4.10, which shows the empirical relationship between actual inflation and inflation expectations one, two and five years ahead, respectively. Again, there is a significant relationship between developments in actual inflation and the expectations one year ahead for all agents, and between actual inflation and expectations two years ahead for all agents excluding the financial economists, but the coefficient estimates are relatively low. There is no significant empirical relationship between expectations five years ahead and

75 See Łyziak and Paloviita (2017), Ehrmann (2015) and Erlandsen and Ulvedal (2017) for a broader review than provided in this paper.

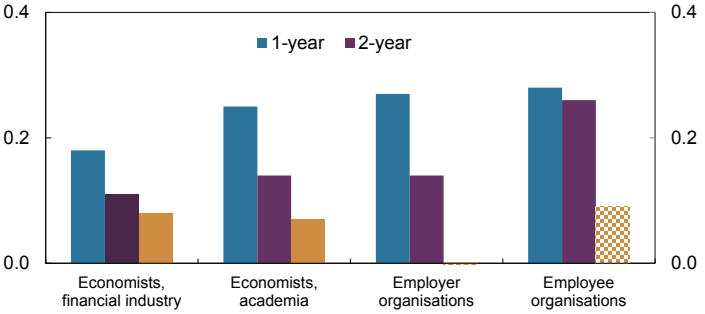
Chart 4.10 Empirical correlation[1] between different inflation expectations and actual CPI inflation.[2] 2002 Q1 – 2017 Q1



1) The chart shows the coefficient estimate of β in the regression $\pi^{e}_{t|t+n} = \alpha + \beta\pi_{t-1} + \varepsilon_t$, where $\pi^{e}_{t|t+n}$ is the inflation expectation in period t for the three different time horizons and π_{t-1} is the latest available observation of the CPI at the time of the survey. OLS with Newey-West standard errors (ie takes into account heteroskedasticity and autocorrelation up to one lag in the error term).
2) Shaded bars illustrate values that are not statistically significant (at 95%).

Sources: Łyziak and Paloviita (2017)

Chart 4.11 Empirical correlation[1] between different inflation expectations and actual domestic inflation.[2] 2002 Q1 – 2017 Q1



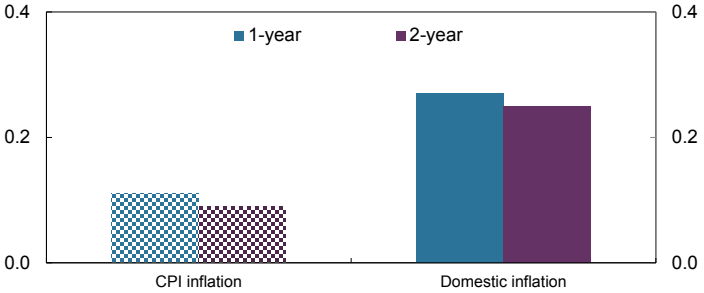
1) The chart shows the coefficient estimate of β in the regression $\pi^{e}_{t|t+n} = \alpha + \beta_1\pi^{i}_{t-1} + \beta_2\pi^{imp}_{t-1} + \varepsilon_t$, where $\pi^{e}_{t|t+n}$ is the inflation expectation in period t for the three different time horizons and π_{t-1} is the latest available observation of the CPI at the time of the survey. OLS with Newey-West standard errors (ie takes into account heteroskedasticity and autocorrelation up to one lag in the error term).
2) Shaded bars illustrate values that are not statistically significant (at 95%).

actual inflation developments.[76] As indicated by the bars furthest to the right, this is approximately in line with results from the euro area.[77]

The empirical relationships appear to be driven by developments in domestic inflation (Chart 4.11).[78] This result is particularly apparent for firms' inflation expectations (Chart 4.12). A similar regression exercise conducted for household

76 The coefficient estimate for labour organisations five years ahead is significant, although very low (0.08) and with low R^2 (0.114).
77 Łyziak and Paloviita (2017). ECB SPF refers to the ECB's own survey of professional forecasters.
78 The simple regression analysis presented in Chart 4.11 provides no significant results with regard to the importance of imported inflation.

Chart 4.12 Empirical correlation[1] between firms' inflation expectations and actual inflation.[2] 2002 Q1 – 2017 Q1



1) The chart shows the coefficient estimates of β (correlation with CPI inflation) and β_1 (correlation with domestic inflation) from the regression expressions described in Charts 4.10 and 4.11, respectively.
2) Shaded bars illustrate values that are not statistically significant (at 95%).

expectations shows no significant relationship between expectations formation and developments in actual inflation. Since developments in household expectations differ from those of other agents, they are discussed further in the box *Household inflation expectations*.

In sum, Norwegian long-term inflation expectations continue to appear firmly anchored. For shorter forecast horizons, inflation expectations are most closely correlated with developments in actual domestic inflation.

Household inflation expectations

Nina Larsson Midthjell

At first glance, developments in household inflation expectations may indicate that inflation targeting has not quite succeeded in anchoring these expectations: expectations have over time hovered substantially above the inflation target (Chart 1).

Chart 1: Households' two-three year inflation expectations. Twelve-month percentage change in CPI. 2002 Q1 – 2017 Q1

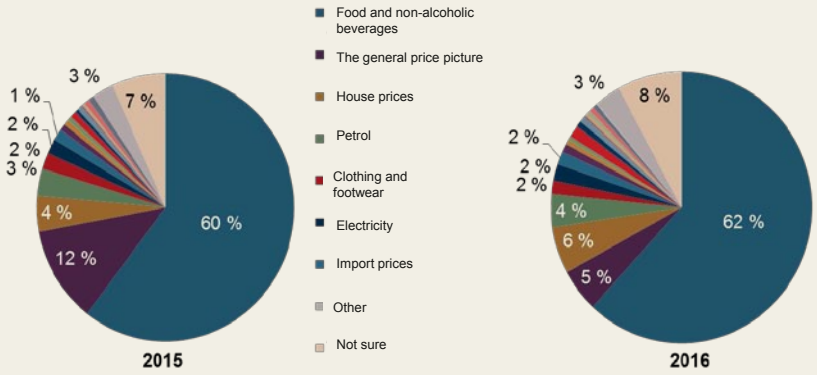
Sources: Opinion and Epinion

One interpretation may be that households misunderstand the survey questions, and that consequently expectations cannot be given weight in the monetary policy analysis. However, research indicates that households make decisions based on their own experience of inflation expectations,[1] which may be based on another basket of goods than the one used in the consumer price index, and that these goods prices influence financial decisions, consumption, wage formation and house purchases.[2] Enhanced understanding of household expectations formation may in that case augment the accuracy of monetary policy.

There are two possible reasons why Norwegian household inflation expectations have hovered well above the inflation target throughout the period of inflation targeting. First, the household survey questions have been unclear. From 2015 Q1 the question asking what households believe inflation will be 2–3 years ahead was changed to what they believe *annual* inflation will be 2–3 years ahead. The time of the change is indicated by a red line in Chart 1.

1 See Armatier et al (2011).
2 See Blanchflower and Kelly (2008), and MacDonald and Winson-Geideman (2012).

Chart 2: The price category given most weight by consumers when formulating their inflation expectations. Four-quarter average. Percentage of total responses.



Sources: Epinion and Norges Bank

From being stable between 4% and 5%, which is a reasonable estimate if inflation is measured from the present time to 2–3 years ahead, household inflation expectations have stabilised at close to 3% after the question change.

The second reason is that households give considerable weight to house prices in forming their expectations. Chart 2 provides an overview of the prices to which they give most weight when responding to the expectations survey. About 60% give most weight to food prices. A rising share, however, also give weight to house prices. When asked which three prices to which they give most weight, an average of a fifth responded house prices.[3] House prices are not directly included in the consumer price index in Norway, which is Norges Bank's target variable for inflation, and which has risen more rapidly than other measures.[4] If households give considerable weight to this measure in forming their expectations, it will push up overall inflation expectations.

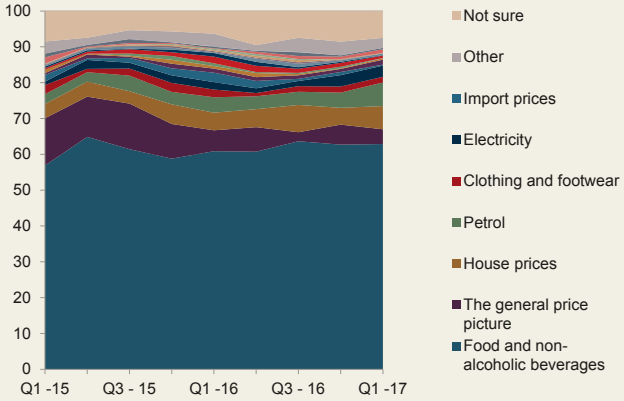
Adjusting for these two factors, household inflation expectations are considerably closer to the inflation target.

Economic agents appear to update their information more frequently when inflation receives frequent media coverage, which is normally the case when

3 There are 1000 respondents in the survey, which is conducted quarterly.

4 The value of housing consumption for home-owners is calculated indirectly using the rental equivalence approach, which is based on measuring prices for housing service on the basis of the alternative costs that owners themselves would incur in order to rent their own dwellings. In recent years, house price inflation has been substantially stronger than the rise in rental prices.

Chart 3: The price category given most weight by consumers when formulating their inflation expectations – developments over time. Percentage of total responses. 2015 Q1 – 2017 Q1



Sources: Epinion and Norges Bank

inflation is either substantially higher or lower than normal.[5] This also seems to be the case for Norwegian households. Chart 3 shows which price groups to which households give most weight in forming expectations and how the distribution across price groups has developed over time. There are several points worth noting. First, the share citing food prices as the most important price factor increased in 2015 Q2 in response to a widely covered food price debate.[6] Second, the share citing house prices as the most important price factor increased in pace with the rise in house prices. Third, the share citing "the overall price environment" as the most important factor fell markedly between 2015 and 2016, which indicates that households respond more concretely after they have been made aware of higher prices.[7]

The study of household inflation expectations in Norway indicates that there are still important gaps in our understanding of expectations formation. How inflation expectations influence the economic behaviour of households is an interesting question and a subject for further research.

5 See Carroll (2003). The result is supported by Akerlof et al (1996), who finds that workers do not find out what the inflation rate is unless it becomes too costly to ignore.

6 The survey was conducted just after the television show "Brennpunkt" aired an episode about supermarket power, which led to substantial debate regarding food prices, with the focus being that supermarkets had outpaced suppliers in raising their prices.

7 The high inflation of 2016 was widely discussed in the media. The "overall price environment" would have initially been a good answer to the question of which prices households give most weight in their expectations for the consumer price index, since agents should optimally use the entire consumer price index as their basis. That the share declines following heightened media attention however suggests that the "overall price environment" as an answer is more of an alternative to "I do not know" than indicative of households actually considering the overall price environment.

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5 Financial stability considerations

Ragna Alstadheim

5.1 INTRODUCTION[1]

Normally, there is no conflict between financial stability and more general macroeconomic stability, but it is acknowledged that low and stable inflation and a normal activity level do not *suffice* to safeguard financial stability. Periods of low inflation, low interest rates and a normal activity level can occur at the same time as an underestimation of risk and a build-up of financial vulnerabilities.[2] In the literature, the implications and conclusions drawn from this differ.[3]

After reviewing interest rate channels and their effect on financial stability in Section 5.2, Section 5.3 discusses the extent to which monetary policy should "lean against the wind" (LAW). Section 5.4 discusses constraints on the central bank's *possibility* of leaning against the wind. One such constraint is the central bank's leeway in a small open economy. Finally, Section 5.5 discusses the interaction between monetary policy and macroprudential instruments.

5.2 INTEREST RATE EFFECTS ON FINANCIAL STABILITY

New theoretical and empirical research on the relationship between monetary policy and financial stability has been ongoing since the latest global financial crisis, but it may take time before consensus is reached on new models that are suitable for the practical conduct of monetary policy.[4]

The approach of central banks has been to assess how monetary policy influences *financial vulnerabilities*, which empirically are closely associated with financial stability[5] since:

1 Norges Bank's role in the area of financial stability is well established along many dimensions. For a broad review of Norges Bank's overall role in the financial sector area in the period 1945–2013, with particular emphasis on financial stability, see Haare et al (2015).

2 See, eg, ECB (2016). IMF (2017), Chapter 2, presents a strucutural perspective on how low interest rates for a long period can influence financial sector profitability and stability.

3 See Smets (2014).

4 See Yellen (2016) for a discussion on research following the financial crisis. For research at Norges Bank on themes relating to monetary policy and financial stability before the latest financial crisis, see, e.g., Akram et al (2006) and (2007).

5 A quantifiable and general definition of financial stability is needed when assessing how monetary policy can contribute to financial stability. But, for example, the definition of financial crisis established by the government-appointed Financial Crisis Commission (see NOU 2011:1 (2011)), points to some challenges: "A financial crisis is severe stress in financial markets, typically associated with sharply falling asset prices and insolvency among borrowers and financial undertakings, which spreads through the financial system, disturbs the market's

- Financial vulnerabilities have been shown to be related to the probability of a financial crisis.[6]
- Financial vulnerabilities appear to influence the *depth* of crises.[7]

Financial vulnerabilities or financial imbalances[8] are measured by various indicators, such as the level of household and corporate debt, or debt growth, the level of different asset prices and banks' wholesale funding.[9]

Looking at Norway, the distribution of private sector gross debt has been highlighted as a key financial vulnerability. Household balance sheets consist primarily of debt-financed dwellings. Even though the level of household saving has on the whole been solid, the net wealth and debt-servicing capacity of many households have become vulnerable to changes in income, house prices and interest rates.[10] Following the latest global financial crisis, the vulnerabilities inherent in the build-up of gross debt and financial risk in individual sectors, and gross capital flows, have received growing attention in the literature.[11] Regarding Norway, banks' foreign funding has also been in focus.

Monetary policy operates through a range of channels, and two broad categories can be defined. The *first* is the set of traditional channels, which consist of the interest rate effect on consumption and investment and the impact via exchange rate effects on trade. These channels are included in simple models and operate also when there are no financial frictions.

The *second* set of channels involves credit frictions and monetary policy's ability to influence funding conditions and private credit growth via effects on collateral values and risk premiums. These mechanisms are often referred to as the "bank

ability to function and leads to pronounced effects on activity and employment." The definition points to conditions that arise when there is a skewed distribution of risk, risk of bankruptcy, contagion effects, mis-pricing, financial market disruption or other financial frictions that have pronounced real effects. Such frictions have traditionally not been included in macroeconomic models for monetary policy analysis. For a discussion of different definitions of financial stability, see Nason and Leeper (2015). For formal definitions of financial stability by central banks, see Kahn (2017).

6 See the "early warning literature", e.g. Anundsen et al (2016). In that literature, historical crisis events are defined and dated ex ante and then used to explore explanatory variables.

7 See Jorda et al (2013). The depth of a crisis si typically defined in terms of the associated real economic loss in the empirical literature and in the LAW literature. If a crisis is defined as a microfounded disruptive event (such as discussed in Nason and Leeper (2015)), one may say that financial vulnerabilities interact with a crisis event to determine the size of the real *implications* of a financial crisis.

8 The concepts financial imbalances and financial vulnerabilities are often used interchangeably. Both concepts can cover a time dimension, e.g. long-term debt dynamics. Financial vulnerabilities can be seen as a broader concept than financial imbalances and tend to include vulnerabilities owing to compositional effects, such as the composition of debt across individuals, or the composition of risk exposures across institutions.

9 See, eg, Norges Bank (2016c), page 46. For a discussion of debt growth and crisis probabilities, see e.g. Schularick and Taylor (2012).

10 See Norges Bank (2016a) and IMF (2015b).

11 See Forbes and Warnock (2011).

lending channel" or "the balance sheet channel".[12] This second set of channels also includes a "risk-taking channel" for monetary policy, ie that the willingness to take risk can increase when nominal interest rates are low – for example in order to achieve nominal rate-of-return targets or because of short-sighted behaviour.[13] It is this second broad set of channels that is generally assumed to link monetary policy with financial vulnerabilities.

Alstadheim et al (2017) study interest rate effects on indicators of financial imbalances and the overall probability of a financial crisis in Norway. They confirm and supplement earlier studies, finding that an interest rate increase dampens both the rise in house prices and commercial property prices and banks' wholesale funding ratio.[14] They calculate the combined impact of monetary policy on crisis probability through asset prices, banks' funding and credit. The size of the impact of monetary policy is much larger than what Svensson (2017) and Gerdrup et al. (2017) base their LAW analyses on (see section 5.3). But like in other studies, the interest rate effect on credit relative to income is small in Alstadheim et al, and that channel thus makes only a small contribution to mitigating the risk of a financial crisis.

Gelain et al (2015) set up a structural model to analyse the effect of the interest rate on debt dynamics when agents have long-term debt with a long repayment period. In the model, debt relative to income first increases and then falls moderately in the medium term in response to an unexpected interest rate increase. Initially, debt relative to income increases, because income falls more than debt. Debt will fall more over time after an interest rate increase if the loan contracts are typically annuity loans. The reason is that with annuity loans, the speed of debt repayment on each loan increases over time. With a decrease in new loans raised, the vintage of the average loan is older and thus average repayment speed increases.

Research on the risk-taking channel is generally based on microdata. Karapetyan (2016) conducts a panel data study of the monetary policy effects on Norwegian banks' issuance of high-risk corporate loans. He finds that Norwegian banks issue corporate loans to businesses with ex ante low credit ratings *with a higher probability* when the interest rate is low. This effect is very small, however. Moreover, the author finds that the interest rate effect on this type of risk-taking is smaller for well capitalised banks. Based on this analysis, the conclusion cannot be drawn that excessive risk-taking is an important channel for monetary policy in Norway.

12 See references in eg Adrian og Liang (2016). There are some parallels between this literature and earlier literature's focus on monetary and credit aggregates in monetary policy, but the understanding of the bank credit channel has changed considerably in the light of how modern monetary policy is conducted (se Disyatat (2011)).

13 See Borio and Zhu (2012).

14 The interest rate effect of property prices and banks' balance sheets are consistent with a bank credit channel for monetary policy in Norway (see also Halvorsen and Jacobsen (2016)).

5.3 DIFFERENT VIEWS ON WHETHER MONETARY POLICY SHOULD "LEAN AGAINST THE WIND"

The question of whether monetary policy should take into account financial stability and "lean against the wind" was also discussed at central banks and among economists before the latest global financial crisis. At the time, the question of "leaning" centered on whether monetary policy should seek to stabilise *asset prices*.[15] The "Jackson Hole Consensus" was the view that monetary policy should not lean against the wind.[16] It was assumed that rapid increases in asset prices would typically be associated with high inflation, and it was argued that it was too difficult to identify unsustainable asset price inflation and that monetary should instead seek to dampen the effects of a crisis.

The recent global financial crisis rekindled the discussion on whether monetary policy should react to financial indicators.[17] The more recent discussion came in a situation with limited monetary policy leeway in many countries, so that dampening downside risks may be regarded as more important.

In the literature, a clear distinction is not always made between the variables monetary policy should *react to* and policy *objectives*. A simple monetary policy rule describes what the policy rate reacts to, ie it explains the response pattern, while monetary policy objectives can be much narrower. With for example the (sole) objective of low and stable inflation and stable output, monetary policy should (under "optimal policy") in principle *react* to all variables to the extent that they affect the outlook for inflation and output. Monetary policy should in that case also take into account any macroeconomic effects, via eg credit growth, on crisis probabilities since crises can have an impact on inflation and output further out. But to capture this, the model used must include the risk of a financial crisis and a long time horizon for monetary policy goal attainment.

In the theoretical literature on financial frictions, welfare and hence economic policy objectives will naturally depend (also) on the financial frictions specified in any particular model, not only on inflation and output. A challenge of operationalising such welfare-based objectives is that the empirical relevance of each type of friction may vary across countries and over time. Empirically, it can be demanding to distinguish between different financial frictions. The model of Curdia and Woodford (2016) is a starting point for a number of useful analyses of credit frictions in an otherwise standard New Keynesian model, and in their model, financial frictions are included in the authorities' welfare-based loss function.[18] The model does not,

15 See Langbraaten (2001) and Smaghi (2009).
16 See description of the "Jackson Hole Consensus" in Bean et al (2010).
17 See Smets (2014) for a description of the debate after the latest financial crisis. The question was also discussed in Akram and Eitrheim (2008).
18 See also Nisticò (2016).

however, incorporate microfoundations for financial crises, any form of market failure with a substantial build-up of credit and subsequent credit tightening at the aggregate level, or bankruptcy risk. A technical challenge is that the derivation of a welfare-based loss function in practice only can be done in linearised models, while non-linearities and tail risks are key concerns in the context of financial stability.

A simple alternative to incorporating the possibility of a financial crisis (or other kinds of financial friction) in monetary policy models used to analyse financial stability considerations is to assume directly that the central bank follows a monetary policy rule that includes a response to financial imbalances, or include the stabilisation of financial variables directly as an operational objective.

Depending on the modelling approach, LAW policy can alternately be described as a monetary policy with an extra long time horizon, a policy where the reaction function contains a response to financial imbalances, or as a monetary policy where stabilising financial variables has been included as a new (operational) objective. The definition used is typically linked to the operational framework one has in mind, and the model frameworks in use are all "reduced-form" frameworks. No matter the approach used, LAW will involve a reaction function with a more important role for financial variables than without LAW, and hence weaker stabilisation of output and/or inflation in the short term.

No clear consensus has been established around LAW in monetary policy among central banks or international institutions, but the analyses of LAW policy in Svensson (2017) and Pescatori and Lasèen (2016) are consistent with a prevailing view. They conclude that the gains from "leaning" in the form of the reduced probability and severity of a crisis are most likely lower than the costs of such a policy.[19] An IMF staff report[20] also concludes that the reaction pattern of monetary policy should probably *not* be adjusted to take account of financial stability: First, the report argues that the interest rate is too blunt an instrument for this purpose; second, the report concludes that most often there will not in any case be a conflict between the objectives of stable output and inflation and the objective of financial stability. The report also emphasises that it is not always easy to determine the strength of an economic upturn.[21] The IMF report thus suggests that improved measurement of economic fluctuations could have resulted in interest rate setting that would have mitigated the risk of financial stability to a greater extent. The IMF report indicates that macroprudential instruments and structural instruments – not

19 See further references to literature that discusses LAW in box on page 148.

20 IMF (2015a).

21 See IMF (2015a), figure 6 on page 20 and box 2 on page 32. The IMF analysis shows that there is less conflict ex post than in real time between the objectives of stable output and inflation on the one hand and financial stability on the other. Good real time estimates of the economic situation can thus to some extent reduce the apparent conflict between financial stability and more general economic stability in the short term.

monetary policy – should be used to safeguard financial stability, but that further research in the field is needed.

The conclusion drawn by the Bank of Canada, in connection with a review of the central bank's mandate, is similar to the view reflected in IMF research. Nonetheless, the Bank of Canada finds that monetary policy should to some extent acknowledge financial vulnerabilities through an extended time horizon for the achievement of its objectives.[22] Yellen (2014) concludes that monetary policy should not be formulated with a view to contributing to financial stability, but that exceptions may occur under certain circumstances.

On the other hand, BIS research supports the view that monetary policy should focus more, and in a systematic manner, on counteracting financial imbalances.[23] It is argued that financial imbalances may be building up slowly in the background as the business cycle is shifting. Moreover, the BIS points out that as the costs of a crisis can be a permanent decline in the level of output, the gains of avoiding a crisis are considerable. Monetary policy's ability to serve as a shock absorber after a crisis has occurred is also questioned. The BIS points out that there is solid empirical documentation showing that monetary policy influences debt and house prices, and that high debt accumulation and assets prices can in turn imply increased risk of a financial crisis.[24]

Gerdrup et al (2017) illustrate the impact of different assumptions on the effects of a LAW policy (see also box on page 148). In their model (calibrated to Norwegian data), a crisis can occur in the form of very low demand and a low activity level. Monetary policy can be used to influence the probability of a crisis by restraining credit growth. The depth of the crisis (unemployment) can also be influenced by how high the debt level is at the start of the crisis. If economic agents do not acknowledge that a crisis may occur and do not save for a rainy day, it will be appropriate in this case for the central back to lean to prevent excessive credit growth by increasing the interest rate more when credit growth is high than it would otherwise have done. The cost comes in the form of higher unemployment and a more pronounced deviation from the inflation target than in normal times, while the benefit is fewer and less severe crises. The conclusion that it is appropriate to lean is sensitive to the assumptions in the model and may change if, for example, the agents in the model anticipate that a crisis may occur and prepare for it.

In Gerdrup et al (2017) the effect of an interest rate increase on crisis probability works through reduced credit growth alone. The empirical effect of the interest rate

22 The Bank of Canada concluded in 2011, and again in 2016, that the role of monetary policy in addressing financial stability is provided for through a flexible horizon. See Bank of Canada (2016).

23 See Borio (2014) and Juselius et al (2016). See also Borio (2016) (speech) and Filardo and Rungcharoenkitkul (2016).

24 See, eg, Jorda et al (2015).

on debt growth is assumed to be fairly small, and in line with results in the literature. It has been documented that increases in house prices and banks' wholesale funding can also increase the probability of a crisis,[25] and some argue that a broader approach to the question of the effects of monetary policy on financial imbalances could strengthen the arguments in favour of LAW.[26] Alstadheim et al (2017) find that when taking account of the overall effect of monetary policy, including through property prices and banks' wholesale funding, the interest rate effect on crisis probability will be far stronger than otherwise. The findings in Alstadheim et al (2017) may thus in isolation reinforce the conclusion in Gerdrup et al (2017), that LAW policy may lead to better goal performance for the central bank.

5.4 LEEWAY FOR SETTING THE INTEREST RATE TO SUPPORT FINANCIAL STABILITY

A current topic of discussion is whether the room for manoeuvre in monetary policy for small open economies is now restricted and that the trade-offs between the various objectives are more demanding than earlier.[27] Recalling the active stabilisation policy of the 1970s, which failed to meet widely held expectations by not resulting in lower unemployment – but led instead to a period of high inflation – some have raised the question of whether a systematic financial stability-oriented monetary policy is too *ambitious*.[28]

First, whether a monetary policy tightening strengthens or weakens financial stability is state-dependent: High household debt ratios indicate a high vulnerability, which one might consider dampening by tightening monetary policy. But once house prices and credit have reached very high levels, and there are other signs of imbalances, a point might be reached where an adjustment is considered necessary, allowing monetary policy to act as a buffer rather than being tightened further. A tightening could be counterproductive and trigger a crisis. An interest rate response to financial indicators should therefore probably be state-dependent.

Second, to be effective in *dampening* the effects of a crisis, monetary policy must have established a response pattern where inflation is well anchored around the target. If inflation expectations are not firmly anchored, monetary policy will not be able to influence the real interest rate and thereby stimulate the economy. Flexible inflation targeting countries fared relatively well during the latest crisis.[29] This suggests that excessive weight on financial stability considerations can in principle

25 See Jorda et al (2015) and Anundsen et al (2016).
26 Adrian and Liang (2016).
27 For different perspectives, see Obstfeld (2015), Aizenman et al (2016), Rey (2016) and Corsetti et al (2016).
28 Orphanides (2013) has this perspective.
29 See Williams (2014) and Corsetti et al (2016).

lead to more severe financial crises than otherwise if the credibility of the inflation targeting regime thereby is imperilled.

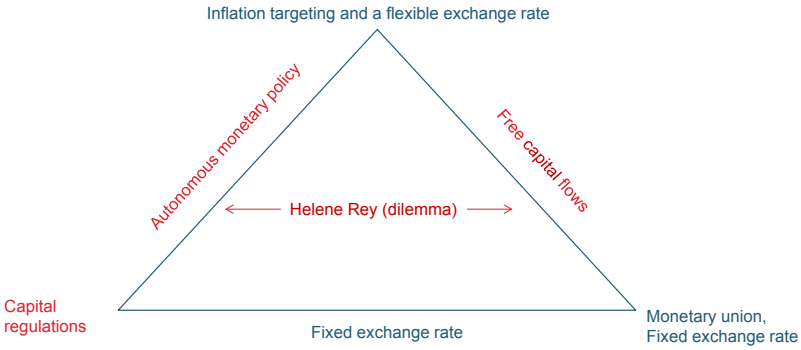
Third, the long-term average nominal interest rate level is determined by inflation and the neutral real interest rate. Consequently, the interest rate cannot systematically be kept higher than implied by the neutral real interest rate and the inflation target over time in order to dampen the risk of a crisis permanently. A higher nominal interest rate in the long run will instead require a higher inflation target.[30] It is therefore presumably difficult to use the interest rate systematically to reduce financial vulnerabilities by keeping the interest rate high on average (if the inflation target is not raised). Moreover, Gerdrup et al (2016) and Alpanda and Ueberfeldt (2016) find that a symmetrical monetary policy that responds to financial imbalances does not reduce the likelihood of a crisis. But an *asymmetrical* monetary policy response, where monetary policy is tightened more in response to high credit growth than it is reduced in response to comparably lower growth, is likely to reduce the likelihood of a crisis over time. Under discretionary monetary policy however, there is still a risk that such an asymmetrical response could result in inflation that is below target in the long term (see Røisland (2017)).

Fourth, while the interest rate cannot systematically lie above its equilibrium level, it might be that a more *stable* nominal rate could instead contribute to financial stability. Periods of very low interest rates might then be shorter and less frequent. The findings of Alstadheim and Røisland (2017) are relevant regarding this point: They find that central banks should respond strongly with rate cuts to negative shocks – *particularly* if the aim is to reduce the interest rate variance. This is counterintuitive, but the economy then can be better stabilised with *less* use of low interest rates over time. The mechanism is that if the economic shock is long-lasting, a *too small* rate cut in a situation with low inflation will result in an even longer period of low inflation, and a correspondingly higher real interest rate. An even lower nominal rate may then be required in the next round to boost the economy. If the interest rate is lowered sufficiently immediately, the persistent weakness can be alleviated faster through high inflation and thereby a lower real rate. This may allow a more limited actual variation in the interest rate over time, and a shorter low-rate period.

The globalisation of capital markets may place other constraints on the room for manoeuvre in monetary policy in a small open economy. Rey (2013, 2016) argues that international credit cycles to a large extent determine credit conditions in small open economies. Her study documents a correlation between gross capital movements, asset prices and the VIX index. The VIX index measures expected volatility

30 But Juselius et al (2017) argue that monetary policy may also influence the real interest rate and thereby the nominla level in the long term even if the inflation target is kept unchanged.

Chart 5.1 Trilemma, not dilemma, in Norwegian monetary policy.



in US equity prices.[31] When risk is perceived as low (the VIX is low) and global financing costs are low, capital flows tend to be substantial and global asset prices high. Rey argues that monetary policy may now be facing a "dilemma" rather than a "trilemma" (see Chart 5.1).[32] The potential dilemma consists of a choice between the use of macroprudential instruments to dampen capital flows on the one hand (which provides autonomous monetary policy and financial stability), and a system that is more vulnerable and where monetary policy is "imported from abroad" on the other. The author maintains that flexible exchange rates are not sufficient to provide autonomous monetary policy. And without autonomy in monetary policy, the interest rate cannot contribute to financial stability.

Rey's analyses have been nuanced by other researchers. The IMF finds that small open economies have a high level of self-determination with respect to financial conditions. IMF (2017) explores what share of each country's "financial conditions" that is typically determined by national monetary policy, relative to the share determined by global factors. A financial conditions index is estimated for each country, based on a range of financial variables. Regarding Norway, the IMF finds that a higher interest rate in Norway can substantially tighten the local financial conditions index.[33] Others have pointed out that under an autonomous monetary policy, the exchange rate is generally allowed to act as a buffer even though the policy rate is influenced by external rates.[34] A general finding is that economies

31 Chicago Board Options Exchange Volatility Index. VIX measures the level of expected volatility of the S&P 500 index.

32 The concept of the "trilemma" in monetary policy is an illustration where each possible policy regime occupies one of the angles in a triangle. Each policy regime can have the properties described by the two associated legs. For example, with inflation targeting, one can have free capital flows and autonomous monetary policy, but not a fixed exchange rate.

33 See figure 3.12 on page 97 in IMF (2017).

34 See Murray (2013) and Corsetti (2016).

with flexible exchange rates may be less vulnerable to crises.[35] Disyatat and Rungcharoenkitkul (2016) point out that there is a distinction between monetary policy independence and autonomy – monetary policy is influenced by global shocks and is not independent, but it is autonomous in its response to shocks.

Alstadheim and Blandhol (forthcoming) study whether Norwegian banks' foreign borrowing can be linked to a global credit cycle represented by the VIX index. They find that monetary policy in Norway responds to shocks to the VIX index and other uncertainties in a stabilising fashion – the exchange rate is allowed to depreciate. Moreover, they find that banks' foreign funding does not fall when the VIX index rises, as it would if borrowing followed a global credit cycle.

Alstadheim and Blandhol (forthcoming) also find that monetary policy in Norway, even though banks in Norway rely on international capital markets for a large share of their funding, can be tightened without having a procyclical effect: banks will not increase their funding in foreign currency when the interest rate is increased in Norway. Consequently, there is leeway for increasing the interest rate to promote financial stability without an increase in capital inflows. In some countries, there have been concerns that the interest rate could have such procyclical effects when activity levels are high. One factor that may be significant in this context is that exposure to foreign currency risk appears to be low in the private sector in Norway (including banks). Domestic monetary policy impacts banks' borrowing costs, regardless of the funding source, as banks hedge foreign currency exposure.

5.5 MACROPRUDENTIAL SUPERVISION AND INTERACTION WITH MONETARY POLICY[36]

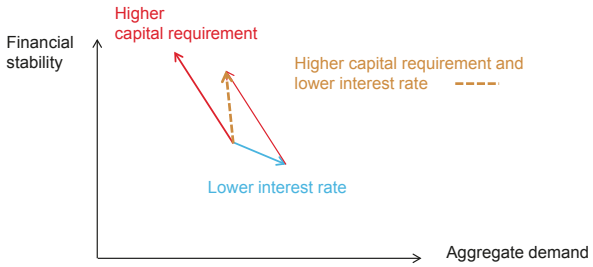
New macro- and microprudential instruments have been introduced following the financial crisis, and they are typically regarded as the first line of defence in safeguarding financial stability (see IMF (2013)).

Since these instruments have been developed within a framework of international cooperation, at least some of the instruments can be taken as a given from a monetary policy perspective. This can in theory be seen as a source of a financial trilemma, see eg Obstfeld (2015). Obstfeld argues that countries must adapt to a common international financial standard if they are to both safeguard financial stability and operate in an environment of free capital movements.

35 See Ghosh, Ostry and Quinchy (2015).

36 An overview of macroprudential instruments can be found in Claessens (2014). An overview of the instruments used in Norway can be found in Norges Bank (2016a). See also Borchgrevink et al (2014) and Galati and Moessner (2013).

Chart 5.2 Comparative advantage for macroprudential policy in establishing financial stability.



But the regulatory framework is also intended to allow for local adaptations, and research indicates that the picture is more nuanced than indicated by Obstfeld. Instruments that are oriented towards the asset side of banks' balance sheets, such as lending practice requirements for new loans to households (loan to collateral value requirements or loan to income requirements), can for example be used with a larger degree of national autonomy than equity capital requirements or liquidity requirements.[37] In theoretical models, macroprudential instruments can be fine tuned and work with great precision, which typically implies that they alone are sufficient to safeguard financial stability. This would imply that LAW is unnecessary.

However, the literature also finds that financial regulation can become less effective over time because financial institutions adapt and credit provision can take on new forms to circumvent regulations. Monetary policy has the advantage of potentially influencing all credit provision in domestic currency: "it gets in all of the cracks" as stated in Stein (2013). In practice, macroprudential instruments can affect monetary policy objectives, and monetary policy can affect financial vulnerabilities. The question is if and how the instruments should be coordinated.

Collard et al (2017) establish a structural model where they study when it is best to dedicate macroprudential instruments to financial stability and monetary policy to stabilising output and inflation. Their main model indicates that full separation is best[38], but if monetary policy influences banks' risk behaviour, for example, a full separation of tasks is no longer optimal in their model.

Røisland (2017) also explores how monetary policy should be coordinated with macroprudential policy within an analytical modelling framework, where financial stability is a separate term in a loss function for the authorities and where there is no separation of tasks. One question that is analysed is whether monetary policy

37 See Buch and Goldberg (2016).
38 The model can then be said to support the "modified Jackson Hole Consensus" described in Smets (2014), and not LAW.

and macroprudential policy should pull in the same direction, or whether they should pull in opposite directions, when financial imbalances increase. If there is a high degree of certainty about the effect of policy instruments, and there are no substantial costs associated with using them, the instrument that has the greatest effect on financial imbalances should be tightened – ie the instrument with a comparative advantage (Chart 5.2). The result is in line with with that found by Collard et al. The chart illustrates the comparative advantage of higher capital requirements in safeguarding financial stability, as shown by the red arrow's steeper slope in relation to the blue arrow. As both instruments are assumed to influence the activity level and/or inflation, the policy instrument that is least effective in counteracting financial imbalances must then be oriented in a more expansionary direction in order to achieve both real and financial stability. If macroprudential instruments are most effective in counteracting financial imbalances, the interest rate must then be lowered in response to an increase in financial imbalances.

However, if there is a high degree of uncertainty about the effect of the instrument, eg the extent to which tighter macroprudential instruments reduce financial imbalances – or there are costs associated with active use of macroprudential policy – Røisland (2017) finds that monetary policy should pull in the same direction as macroprudential policy. This will give the best possible overall effect.

With a common (identical) loss function for the various policy authorities, as discussed above, there will not be any *strategic* aspects related to the use of instruments – even if coordination may be necessary. On the other hand, when the minimization of *parts* of the loss function is delegated, situations with strategic use of instruments may arise – although not necessarily: the "Tinbergen principle" states that with as many instruments as objectives (here the objectives correspond to the terms in the loss function), all objectives can be achieved (the loss is zero). In such cases, objectives from a standard loss function can be delegated without strategic interaction arising – all decision-makers then have an incentive to contribute to full achievement of the objectives, as illustrated in, eg, the model in De Paoli and Paustian (2017).

However if there are fewer instruments than objectives (as is typically the case), trade-offs must be made. Delegating objectives can then create strategic interaction. Carrillo et al (2017), like Paoli and Paustian, study strategic interaction between macroprudential instruments and monetary policy instruments. The authors show that the loss without coordination can prove considerably higher than if the instruments were coordinated and oriented towards minimising a standard loss function. The instruments can be strategic complements so that, eg, increased weight on financial stability in monetary policy leads to (too) strong a use of other instruments. The situation may also be the opposite, so that LAW in monetary policy gives too weak a use of macroprudential instruments in support of financial stability**.**

Should central banks lean against the wind?

Karsten R. Gerdrup, Frank Hansen and Tord Krogh

Gerdrup et al (2017) present a model that can be used to carry out analyses of the extent to which the central bank should respond systematically to financial imbalances.[1] The model takes account of potential financial crises and builds on inter alia a similar exercise by Ajello et al (2015). Important differences are that the Norges Bank study uses a multi-period model (instead of two periods) and that the model is for a small open economy (instead of a closed economy). In the model, high credit growth will increase the likelihood of a financial crisis and lead to a sharp fall in output in the event of a crisis.[2] Credit growth depends in turn on the interest rate and economic growth. A key model assumption is that households and firms systematically underestimate the risk of a financial crisis.

In the model, the central bank makes a trade-off between the aim of stabilising output as deviation from potential output, inflation as deviation from the inflation target and interest rate changes. The central bank's trade-off can be illustrated mathematically by the following loss function:

$$L_t = E_t \sum_{k=0}^{\infty} \beta^k [(\pi_{t+k} - \pi^*)^2 + \lambda_y y_{t+k}^2 + \lambda_i (i_{t+k} - i_{t+k-1})^2], \quad (1)$$

where L_t is total expected loss, π_t is inflation, π^* is the inflation target, y_t is the output gap, i_t is the nominal policy rate and β is a discount factor. E_t expresses expectations based on information that is available at time t and can be interpreted as the central bank's forecast. As (1) shows, the farther away actual inflation and output are expected to be from the respective targets, the higher the expected loss is. The last term is included because central banks often change the interest rate less than may be implied by a pure technical modelling exercise with a standard loss function that only includes inflation and the output gap. The qualitative results in the study are not influenced by this term. The deviations enter quadratically, ie the central bank's loss increases with large deviations from the targets, in both directions.

1 The model and estimation methods are further described in Gerdrup et al (2017). Other studies of systematic monetary policy are Alpanda and Ueberfeldt (2016) and Filardo and Rungcharoenkitkul (2016).

2 There is empirical support for these assumptions, as documented in Gerdrup et al (2017). See also Jorda et al (2013) for results based on longer historical data.

The central bank reacts to all types of shocks that influence the outlook for the target variables of monetary policy. When the economy is exposed to shocks that imply a lower interest rate, eg as result of lower international interest rates, a stronger exchange rate or lower wage growth, a trade-off arises. When the interest rate is reduced to stimulate the economy, credit growth increases, which increases the risk of a sharp downturn further ahead in time. For other types of shocks, eg increased demand, such a trade-off does not arise. Higher output pushes up credit growth. Both factors imply a higher interest rate, even if the build-up of financial imbalances may imply a somewhat stronger interest rate response.

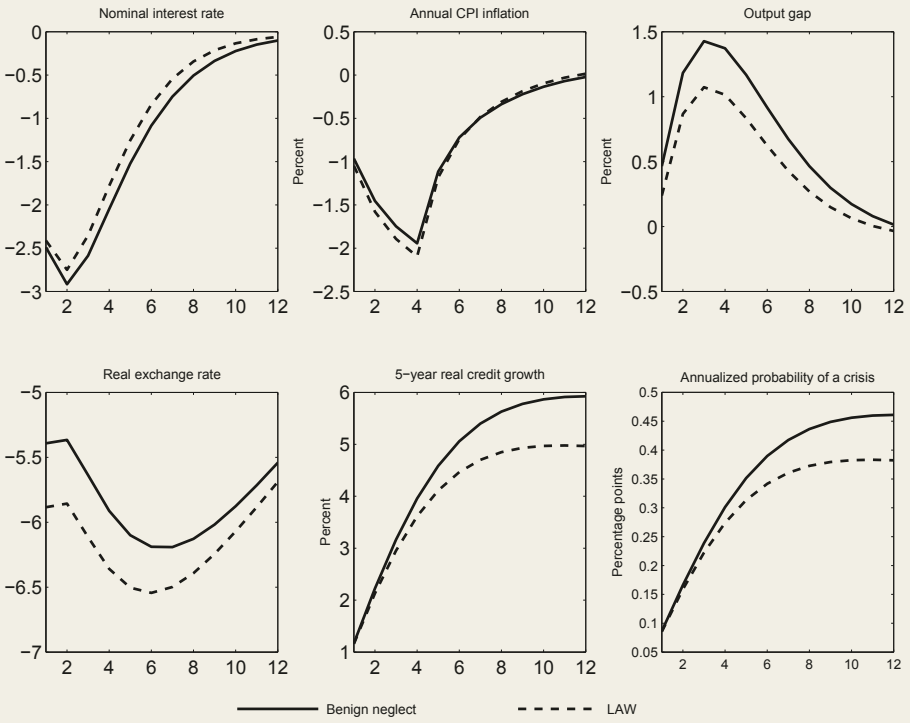
Gerdrup et al (2017) attempt to find an optimal monetary policy rule[3] when the central bank takes account of potential crises (leaning against the wind, abbreviated LAW). The rule is compared with a baseline alternative where the central bank does not take potential crises into account, which can be said to represent a view of the economy and model practices prior to the global financial crisis (denoted here as benign neglect). The authors find the value of the coefficients in a simple Taylor rule that minimises the loss function (1) in the model. The Taylor rule includes the interest rate in the preceding period (i_{t-1}), the inflation gap, the output gap and credit growth (c_t):

$$i_t = \rho i_{t-1} + (1-\rho)[\theta_\pi \pi_t + \theta_y y_t + \theta_c c_t)] \quad (2)$$

It is assumed that the central bank only reacts to positive credit growth, and that it does not lean against the wind when the economy is in a crisis regime. A minimisation of the loss function (1) implies in this framework that the central bank should give some weight to credit growth in the Taylor rule when it takes potential crises into account. As a result, the central bank conducts a somewhat tighter monetary policy when credit growth is positive than otherwise. The central bank also responds relatively more to changes in the output gap. Inflation variability increases somewhat because less weight is given to stabilising inflation. The gain comes in the form of reduced frequency of deep financial recessions. The severity of the crises that occur is also reduced. Overall, the variation in output is lower over time when the risk of financial recessions is taken into account in the conduct of monetary policy.

3 The analysis is restricted to looking at optimal simple rules.

Chart 1 The path of macroeconomic variables and crisis probabilities in the event of an international interest rate decline



To illustrate the mechanism in the model, Chart 1 shows the path of economic variables in the event of a sharp fall in the international interest rate level when monetary policy is conducted as in the baseline alternative and LAW. It is assumed that a crisis does not occur within the horizon in the chart. The objective of stabilising inflation implies that the central bank lowers the interest rate to restrain a currency appreciation. This stimulates aggregate demand and credit growth accelerates. This will over time increase the probability of a financial recession. When the central bank takes account of this, it will cut the interest rate somewhat less than in the baseline alternative. This dampens the rise in output and credit growth, and hence the increase in the probability of a crisis (and crisis severity) at the cost of a stronger exchange rate and somewhat lower inflation.

Chart 2 illustrates output gap uncertainty in the event of the same fall in the international interest rate level as in Chart 1 when the only shock source is that a crisis may occur. A crisis may occur at any point in time. When the

probability of a crisis increases, as shown in Chart 1, the downside economic risk increases. It takes time for a crisis to be phased out of the economy, but after the occurrence of a crisis the possibility of the economy returning to more normal business cycles will always exist. This give rise to an upside risk, which in the simulations will first occur after about six quarters. The chart shows that the tail risk is somewhat lower when monetary policy leans against the wind. A decrease in tail risk entails a substantial gain as the output gap enters quadratically in the loss function.

Chart 2 Output gap uncertainty in the event of a sharp international interest rate decline. Only uncertainty is the possibility of a crisis. Shows 95- and 99-percentile.

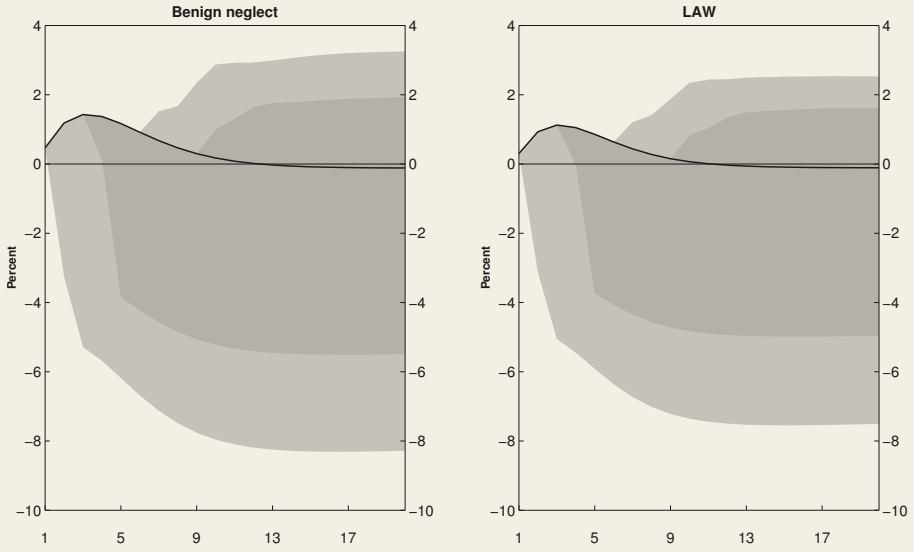
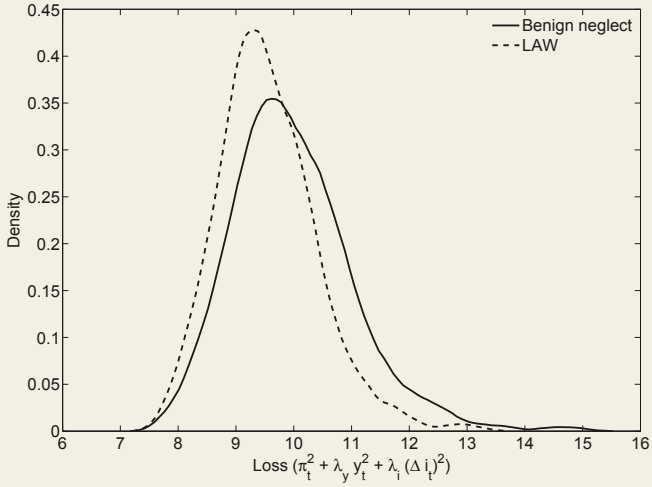


Chart 3 shows a distribution of economic loss as measured in equation (1) when a large number of model simulations are carried out where all types of shocks that are modelled hit the economy each quarter. The loss distribution in the baseline alternative shows a higher frequency of large losses because crises are extra costly. When weight is systematically given to credit growth in the reaction function, the tail risk declines. Lower output variability could therefore compensate for higher inflation variability.

Chart 3 Simulated losses in the model



Estimations of benefits and costs are highly uncertain. This is partly because periods of financial instability occur relatively infrequently, and owing to different structural conditions in the economy and the financial system across countries, the risk of financial instability also varies across countries. Owing to alternative assumptions concerning economic relationships and estimated interest rate effects on the output gap and inflation on the one hand and financial imbalances and crisis severity on the other, the results in the literature differ.[4]

The article by Gerdrup et al (2017) includes several sensitivity analyses. The basic version of the model finds that the central bank achieves benefits by reacting to credit growth. It is fairly uncommon to find a positive effect of LAW in the literature (even if the benefit is moderate). An important reason for this is that Gerdrup et al take into account the relationship between financial imbalances and crisis outcomes. If crisis severity is assumed to be independent of the level of financial imbalances or that the relationship is weak, the benefit of leaning is reduced. The optimal coefficient on credit

4 The BIS is of the view that the benefits of leaning can be substantial, particularly when leaning occurs early in a period of strong growth in asset prices and credit (see 86th *Annual Report*, 2015/16, Bank for International Settlements). See also Filardo and Rungcharoenkitkul (2016). Svensson (2016) and Ajello et al (2015) find small or negative net benefits of LAW. The latter study finds that the central banks should systematically react to credit if it wants to conduct a robust policy that recognises that crises may be more severe than in their baseline alternative. Adrian and Liang (2016) explore Svensson's framework more closely in the light of alternative assumptions.

growth is then close to zero or negative.[5] This is more in line with the findings of other studies, and shows the importance of assumptions about the relationship between financial imbalances and crisis outcomes. In addition, the benefit of leaning may prove lower than the cost of leaning if the probability of a crisis is considerably lower than in the basic version of the model.

5 When credit growth accelerates and the probability of a crisis increases, it may be preferrable to reduce the interest rate somewhat (or raise it less) to stimulate economic activity. The economy will then be better poised to face a crisis, which may occur regardless, and which will then result in output and inflation far below the targets.

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