NORGES BANK

ØYVIND EITRHEIM AND JAN FREDRIK QVIGSTAD (EDS.)

NORWAY'S ROAD TO INFLATION TARGETING

OVERCOMING THE FEAR OF FLOATING – COUNTERFACTUAL ANALYSES OF FOUR EPISODES

NORGES BANKS SKRIFTSERIE OCCASIONAL PAPERS NO. 56

Norges Banks skriftserie / Occasional Papers can be ordered by e-mail:
facilityservices@norges-bank.no
or from
Norges Bank, Facility Services
P.O. Box 1179 Sentrum
N-0107 Oslo

NORGES BANK OCCASIONAL PAPERS No. 56

Norway's road to inflation targeting

Overcoming the fear of floating – counterfactual analyses of four episodes

Øyvind Eitrheim and Jan Fredrik Qvigstad (eds.)

Oslo 2020

Contents

Preface

In 1990 Norway rejoined the European efforts of stable exchange rates and pegged the Norwegian krone to the European Currency Unit (ECU). In late 1992 the breakdown of the European Monetary System (EMS) led to the adoption of a managed float regime which lasted until the turn of the century. Norway made the transition to inflation targeting rather late, de facto from 1999 and de jure from 2001, almost a decade after the pioneering countries New Zealand, Canada, UK, Sweden, Finland and Australia. In 2001 Norway also introduced a new fiscal policy rule, which restricted government deficits not to exceed the real return from Norway's sovereign wealth fund.

The background was dramatic. After the credit driven boom-bust cycle of the 1980s came a deep recession with rising unemployment, and a couple of years later a severe banking crisis 1988-1993. The 1990s started with a fresh collective memory of these crises, which paved the way for important structural reforms. The final reminiscences of the old regulatory framework for financial markets, capital controls, disappeared in 1990 and in 1992 there was a major revision of the Norwegian tax system. Equally important was the legislation of the sovereign wealth fund mechanism, which came during the height of the crisis, in 1990, many years before the first capital transfers to the fund from 1996 onwards.

The lessons from the 1990s tell us that the procyclical monetary policy of the early 1990s, exacerbated by the policy tightening in Europe following German unification, was costly. They also provide a useful background for a comparison with the lessons from two more recent episodes, the global financial crisis in 2008 and the fall in oil prices in 2014. In both cases, Norway took advantage of the fact that a credible flexible monetary policy regime with inflation targeting and floating exchange rates was in place prior to the shock.

It is an open question whether the fear of floating exchange rates could have been overcome at an earlier point of time, such as in the midst of the 1990s after countries like New Zealand, Canada, Finland and Sweden had pioneered adopting inflation targeting and floating exchange rates, but the experiences from the past two decades tell us better late than never.

Editors' Foreword

This book contains three chapters.[1] In Chapter 1 we first describe the road towards inflation targeting and a flexible exchange rate regime in Norway, which was established around the turn of the century, first *de facto* in 1999 and thereafter *de jure* in 2001. We then describe the development of inflation targeting in Norway from its juvenile to coming of age (2001-2007), and from 2008 onwards. Here we argue that Norway has been reaping the benefits of having in place a well established and credible monetary policy regime, based on inflation targeting and flexible exchange rates, when we were hit by the global financial crisis in 2008 and the fall in oil prices in 2014. In Chapters 2 and 3 we look at counterfactual analyses of four episodes. More precisely, what might have been the outcomes in 1990 and 1996 under a floating exchange rate regime, and in 2008 and 2014 under a fixed exchange rate regime?[2]

From 1986 onwards Norway was, like many other countries in Europe, including our neighbours Denmark, Sweden and Finland, committed to a monetary policy regime where the central bank set its key policy interest rate with a view to stabilize the exchange rate. This commitment to fixed exchange rates was challenged during the following years, first by

[1] Thanks to professor Jan Tore Klovland, Norwegian School of Economics, for detailed comments and suggestions to the complete manuscript. The views expressed in each of the three chapters are those of the authors and do not necessarily reflect the views of Norges Bank.

[2] The counterfactual evidence we report in Chapters 2 and 3 is based on model simulations using the available macromodelling tools in Norges Bank in the late 1990s and the late 2010s, respectively. Thus, the first set of counterfactual analyses were conducted more than twenty years ago in the late 1990s, and were documented in a previously unpublished paper written by the editors (Eitrheim and Qvigstad, 1999). This paper focused on the years following the German reunification in 1990, analysing counterfactual scenarios where we explored potential benefits had it been possible to decouple movements in Norwegian interest rates from those of European interest rates already in 1990, see also Qvigstad (2001) for a brief discussion. The paper by Eitrheim and Qvigstad (1999), which is reproduced in Chapter 2, indicated that it would have been possible to "build bridges" over the extended recession in 1990-1993. We claim that the conclusions from then have stood the test of time when reexamined two decades later, now equipped with twenty years' of experience with inflation targeting and flexible exchange rates. We provide more context and discussion of these exercises in Chapter 1. Also, for the preparation of Chapter 3, which is co-authored with Erling Motzfeldt Kravik and Yasin Mimir in the bank's model unit, we have collected additional counterfactual evidence based on model simulations using Norges Bank's main macromodelling tool today. Chapter 3 reports results from model simulations where we investigate alternative scenarios had Norges Bank been subject to an obligation to defend the prevailing exchange rate level, and respond according to the old fixed exchange rate framework by tightening monetary policy to withstand krone depreciation, at the time of the global financial crisis in 2008 and the fall in oil prices in 2014, respectively.

the strong economic downturn of the economy of the late 1980s, with falling investments, sluggish growth and rising unemployment, later by the severe domestic banking crisis 1988-1993, which elevated into systemic proportions in 1991-1992.

The lessons from the 1990s tell us that the procyclical monetary policy of the early 1990s, exacerbated by policy tightening in Europe following German unification, was costly. They also provide a useful background for a comparison with the lessons from two more recent episodes, the global financial crisis in 2008 and the fall in oil prices in 2014. In both cases, Norway took advantage of the fact that a credible flexible monetary policy regime with inflation targeting and floating exchange rates was in place prior to the disturbances.

Firstly, it should be stressed that the monetary policy regime of today works because of its established credibility and confidence in the nominal anchor, i.e. that the targeted level of inflation will be achieved in the medium term perspective. It can indeed be questioned whether such credibility was in place as early as in 1990. The accommodating policy of the devaluation decade 1976-1986 had weakened the confidence among the general public that monetary policy would deliver low and stable inflation. However, to actually propose a change in the monetary policy regime in 1990, abandoning the idea of fixed exchange rates and instead moving to floating exchange rates and a promise to meet an inflation target in the medium term perspective, might have been interpreted as a reversion of the policy change four years earlier, and that the government, so to speak, was "throwing the cards".

Secondly, although New Zealand as the first country had introduced inflation targeting effective from February 1990, the inflation targeting regime was in its infancy, and was yet neither well known nor well established as a monetary policy regime alternative. After all, there had been a considerable time for deliberations and maturing the decision to move to inflation targeting in New Zealand, a process which started already in the early 1980s. Canada and Sweden followed suit and introduced inflation targeting as early as in 1991 and 1993 respectively, whereas it took another ten years before Norway introduced inflation targeting *de jure* in 2001.

With hindsight, two decades later, we conclude that the monetary policy regime, based on inflation targeting and flexible exchange rates, has been effective in a period in which the Norwegian economy has been subject to major shocks, like the global financial crisis in 2008 and the fall in oil prices in 2014. However, monetary policy in a small open economy like Norway will always be constrained and the room for manouvre limited. For example, the combination of high oil prices and low international interest rates 2010-2014 turned out to yield procyclical outcomes, notwithstanding the fact that Norges Bank used the freedom to maintain higher interest rates than in the eurozone. But in times of crisis Norway has been well-served by exchange rate flexibility, which made monetary policy more countercyclical when needed, thus providing important relief which helped smooth the process adapting to the global financial crisis in 2008 and the drop in oil prices in 2014.

1

The road to inflation targeting - Overcoming the fear of floating

Øyvind Eitrheim and Jan Fredrik Qvigstad

1.1 Introduction

In Chapter 1 we first describe the road to inflation targeting in Norway, starting with the fixed exchange rate regime introduced in 1986 until its breakdown in 1992, thereafter the developments during the 1990s before inflation targeting and a flexible exchange rate regime was *de facto* introduced in 1999, two years prior to its *de jure* confirmation by the Government in March 2001. We then describe the different steps of the implementation and communication of the inflation targeting regime, and how it has developed over the past two decades. The chapter is mainly organized chronologically. Where applicable we draw on and make references to the more technical analysis of counterfactual monetary policies, which are presented in Chapter 2 and Chapter 3. In Chapter 2 we have assumed that inflation targeting and flexible exchange rates could have been introduced already in the early 1990s, whereas we in Chapter 3 have made the opposite assumption, namely that a fixed exchange rate policy had been effectively pursued in both cases following the global financial crisis in 2008 and the fall in oil prices in 2014, respectively.[1]

Chapters 2 and 3 present the analytical details of these counterfactual analyses. We illustrate the potential gains if Norway had been among the early movers to flexible exchange rates in the early 1990s. The two sets of counterfactual analyses conducted in the 2000s show what Norway has gained from having adopted flexible inflation targeting and floating exchange rates around the turn of the century. The selected episodes also serve as illustrations of how this kind of policy challenges were approached analytically in the 1990s and how similar challenges may be approached analytically today, almost two decades into the 2000s. In both chapters we present analytical results based on the macroeconomic toolkit available to Norges Bank at the time when the counterfactual analyses were conducted, notably in the late 1990s and the late 2010s, respectively.

We have focused particularly on four episodes in this review, in 1990, 1996, 2008, and 2014, respectively. For each episode we analyse the potential effects of a counterfactual monetary policy regime. In 1990 Norway had a monetary policy regime based on fixed exchange rates, in 1996 monetary policy was conducted in a managed float regime whereas we in 2008 and 2014, respectively, had transitioned to an inflation targeting regime with floating exchange rates. During the early 1990s the monetary policy response under the prevailing fixed exchange rate regime clearly contributed to amplify the crisis whereas in the two latter episodes in 2008 and 2014 floating exchange rates served as a buffer and contributed to dampen the effects of the disturbances and lower their costs.

Figure 1.1 illustrates the changes in Norway's prevailing fixed exchange rate regime over the period 1982-1998, starting with four years with a soft peg and frequent devaluations which ended in 1986, then followed by a hard peg period 1986-1992, initially stabilizing

[1] We are grateful for many useful suggestions and comments to previous drafts of this chapter from our colleagues in Norges Bank, Qaisar Farooq Akram, Mats Fevolden, Karsten Gerdrup, Erling Motzfeldt Kravik, Yasin Mimir and Marianne Sturød, and from Jan Tore Klovland, Norwegian School of Economics.

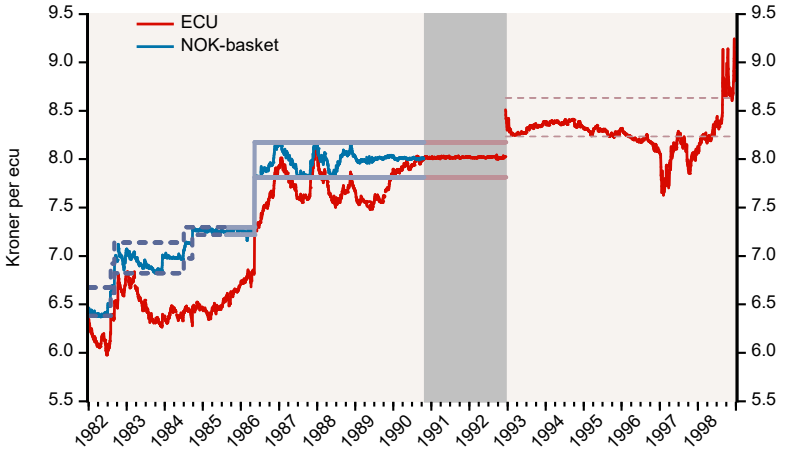


Figure 1.1 Changes in Norway's exchange rate regime, 1982-1998. The red line denotes the ECU exchange rate and the blue line denotes the market value of the different foreign currency baskets used from 1 January 1982 until 21 October 1990. The period with a ECU-peg, from 22 October 1990 to 10 December 1992, is shaded in grey. The relevant foreign currency basket indices are reconstructed from daily exchange rates quoted at Oslo Stock Exchange from 1 January 1982. See Table 1.A.1 in Appendix 1.A for more details on changes in the exchange rate regime during these years. In the figure we have normalized the target value for the foreign exchange basket index prior to the ECU-peg and the target is set equal to the value of the ECU-peg effective from 22 October 1990 (7.9940 kroner per ecu). The fluctuation margins around the target for the exchange rate index were made public only from 9 August 1985 onwards. For the period from January 1982 until August 1985 the fluctuation margins are indicated with dashed lines. During the period with managed or dirty float in the 1990s the exchange rate objective had a more flexible design. Norges Bank's instruments would be used in such a way that the krone exchange rate would be brought back, over time, to its initial range since the krone was floated on 10 December 1992, a range which was unofficially set as indicated with the red dashed lines, cf. Lie, Kobberrød, Thomassen and Rongved (2016, p. 431), Lie (2020) and Kleivset (2012, p. 12) for details.
Source: Norges Bank Historical Monetary Statistics.

the value of a basket of foreign currencies 1986-1990, followed by a period where Norway unilaterally decided to peg the krone to the European Currency Unit (ECU) 1990-1992. When the EMS collapsed in 1992, and after a short period with free floating, a period followed with managed or dirty float where Norges Bank aimed to maintain a stable krone exchange rate against European currencies, anchored more loosely to the initial range of the exchange rate since the krone was floated on 10 December 1992, as formalised in a Royal Decree of May 1994. This period lasted through 1998 and was succeeded by the transition to inflation targeting and floating exchange rates, *de facto* from 1999 and *de jure* from 2001.[2]

[2] Norway has traditionally had a monetary policy regime geared towards exchange rate stability. That has been the ideology ever since the founding of Norges Bank in 1816. There have been shorter periods with a floating exchange rate, but only because it was impossible to maintain stable exchange rates, and these periods were used to reestablish fixed rates. In Norway, as well as in the other Scandinavian countries, the discussion of an alternative monetary policy regime, such as inflation targeting, did not arise until the collapse of the fixed exchange rate regimes in 1992 (Qvigstad and Skjæveland (1994), Eitrheim, Klovland and Øksendal (2016)).

It does of course not make sense to argue that floating exchange rates would have solved all problems during the crisis of the early 1990s. As already mentioned in the Foreword, this would probably have been way too early to introduce a new dramatic change in the monetary policy regime. An attempt to replace the fixed exchange rate regime already in 1990, a regime which had been reinvigorated as recently as in 1986, with a floating exchange rate regime might have triggered speculations that the government stepped back from its promise to stay the course defending the nominal anchor, risking to repeat the mistakes associated with the loss of the nominal anchor in the previous decade.

With hindsight, however, we might ask ourselves if the fear of floating could have been overcome at an earlier stage, allowing Norway to make the transition to inflation targeting in the midst of the 1990s, e.g. in 1996, after countries such as New Zealand, Canada, UK, Sweden, Finland and Australia had pioneered with their transition to inflation targeting from 1990 onwards.[3] For UK, Sweden and Finland this also involved a transition from fixed to floating exchange rates following the European Monetary System (EMS) in 1992. Floating exchange rates was however at that time already in place in countries like New Zealand who let their currency float from 1985 onwards (Sullivan, 2013), Australia from 1983 onwards (Hamilton, 2018) and Canada who has just entered its 50th consecutive year with a floating currency after the Canadian dollar was unpegged from the US dollar in May 1970 (Schembri, 2019).

Surprisingly few Norwegian economists voiced their concern during the early 1990s that Norway would benefit from greater exchange rate flexibility.[4] In hindsight, three decades later, this may seem a bit curious in light of the country's benign experiences with exchange rate flexibility over this period, in particular in connection with the two episodes we discuss in this paper, the global financial crisis in 2008 and the drop in oil prices in 2014.

Two decades ago the editors of this book wrote a paper together, Eitrheim and Qvigstad (1999), providing a counterfactual view on monetary policy in Norway in the 1990s. This paper has previously been referred to in other work, such as e.g. in Qvigstad (2001), but it has remained unpublished until now. We have reproduced the paper *ad verbatim* in Chapter 2, as written in 1999, for the purpose of reporting results from model simulations carried out more than two decades ago, using the bank's main macromodel at the time when the paper was written, to illustrate how the bank's main macromodel at the time could be of use then to shed light on and help us learn more about properties of the prevailing monetary policy regime.

The counterfactual scenarios reported in Chapter 2 address questions regarding how the economy might have reacted differently under alternative assumptions about monetary policy, illustrated by simple monetary policy rules for setting interest rates, had they been

[3] A comprehensive review of the first 20 years with inflation targeting since its introduction in New Zealand in 1990 is given in Cobham, Eitrheim, Gerlach and Qvigstad (2010). The number of IT countries had passed 10 by the late 1990s, and the growth has continued, to 28 countries in 2008 (Schmidt-Hebbel, 2010) and 41 in 2018 (IMF, 2019).

[4] Notable exceptions were for example Jan Tore Klovland (Klovland, 1995), Knut Anton Mork (Mork, 1992) and Erling Steigum (Steigum, 1992).

implemented in 1990. Norges Bank's main macromodel at the time was called RIMINI,[5]. For the counterfactual policy analysis reported in Chapter 2, RIMINI was equipped with equations which endogenised the two main monetary policy variables, the key nominal policy interest rate and the nominal effective exchange rate, respectively. The model was also equipped with a submodel which allowed users of the model to gauge some rough numerical estimates of the potential effects of these counterfactual policy alternatives on the developments in bank losses in light of the 1988-1993 Norwegian banking crisis. More details about RIMINI are presented in Appendix 1.B.1 and in Chapter 2 along with the detailed results from the counterfactual simulations.

The simulations in Chapter 2 confirm that an early counterfactual transition to inflation targeting in 1990 might have rendered the monetary policy stance considerably less procyclical and hence more expansionary (cf. Sections 2.5 and 2.6). Under these assumptions the model simulations indicated an easier recovery from the economic downturn of the late 1980s, which would of course also have been helpful for troubled banks and mitigated the serious banking crisis of the early 1990s. The paper by Eitrheim and Qvigstad (1999) was widely circulated during the fall of 1998 and spring of 1999.[6]

In Chapter 3 we present results from a new set of counterfactual simulations, this time using Norges Bank's current main macromodel NEMO,[7] which we apply to illustrate how developments might have been very different following two more recent episodes of disturbances stemming from, respectively, the global financial crisis in 2008 and the fall in oil prices in 2014. We have used NEMO to analyse the latter two episodes of the 2000s, in an analogous way that we used RIMINI in the late 1990s. More precisely, in Chapter 3 we have analysed possible effects of a simulated counterfactual policy where Norges Bank, in each of the two episodes we look at, had been restricted in its interest rate setting to defend the prevailing exchange rate level, at least for some time, following a negative shock which threatened to depreciate the currency. More details about NEMO are presented in Appendix 1.B.2 and in Chapter 3 along with the detailed results from the counterfactual simulations.

As an additional exercise we have also used NEMO to simulate a counterfactual scenario for the late 1990s, highlighting some potential effects had inflation targeting and floating exchange rates been introduced some years earlier than what actually took place. The transition took place first around the turn of the century (1999-2001), see Section 1.5 below. In 1996 the economic growth in Norway had picked up again and had been on a steady rise since the slump ended in 1993. The oil prices had also grown to a level high

[5] RIMINI is an acronym for a model for the Real economy and Income accounts – a MINI version. RIMINI was used by Norges Bank as a tool for making projections 4-8 quarters ahead as part of the bank's Inflation reports (Olsen and Wulfsberg, 2001; Bårdsen, Eitrheim, Jansen and Nymoen, 2005).

[6] For details see Chapter 2 (page 52).

[7] NEMO is an acronym for the Norwegian Economy MOdel. NEMO is a new-Keynesian dynamic stochastic general equilibrium model (DSGE), which was first introduced in 2006 and is primarily used at Norges Bank for monetary policy analysis and forecasting. See Brubakk, Husebø, Maih, Olsen and Østnor (2006) for an overview of the first version of NEMO. A more comprehensive overview over methodological advances in Norges Bank in the early years of inflation targeting can be found in Berg and Kleivset (2014) (available in Norwegian only).

enough to support the first surplus to be channelled into the sovereign wealth fund in 1996. In a period when rising petroleum revenues were being phased into the economy, it was a challenge for fiscal policy to stabilise the economy. The result was a rising appreciation pressure against the krone. During the prevailing fixed exchange rate regime the key policy rate was lowered to avoid a stronger krone. The effect was clearly procyclical.[8]

1.2 A brief literature survey

Klovland (1995) focused on Norway's historical ties to Europe and the relationships between exchange rate systems, monetary policy and the business cycle since the late 19th century. The strong preference for fixed exchange rates during this period reflected according to Klovland both economic and political arguments. He argued, however, citing Friedman (1953), that fixed exchange rate systems would not necessary guarantee unfettered markets, trade and capital flows. Friedman argued that under flexible exchange rates the intricate web of financial regulations which emerged in the 1930s under New Deal and in the post WW2 period under Bretton Woods would have been avoided. As suggested in Klovland (1995) a Norwegian sonderweg along these lines in the interwar years would, rather paradoxically, have brought Norway closer to Europe, cf. that Spain in the late 1920s and early 1930s had flexible exchange rates and were less affected by the international downturn 1929-1932 than the gold bloc countries. Nominal exchange rate flexibility would facilitate necessary adjustments in the equilibrium real exchange rate and reduce the need for complex regulations of trade and financial markets as well as reduce administration costs.[9]

Following the global financial crisis in 2008 some observers have questioned the value of flexible exchange rates in insulating the domestic economy against external financial forces and providing monetary independence as predicted by classical Mundell-Fleming analysis. Instead they argued that capital controls would prove necessary for emerging-market economies to conduct independent monetary policy. Rey (2016) argues that Mundell-Fleming's trilemma has been reduced to a dilemma between free capital flows or control over domestic monetary policy. The value of flexible exchange rates has also been challenged on the basis of negative effects from excess exchange rate volatility, in particular through the foreign debt channel, and widespread dominant currency pricing, which offsets the benefits of expenditure switching (Gopinath, 2017).

[8] See Christiansen and Qvigstad (1997) for a comprehensive survey which analysed the existing monetary policy framework and assessed possible alternative monetary policy regimes for Norway going forward.

[9] Friedman's argument would of course also apply in the post-war period after 1945. One of the authors of this chapter discussed Norway's monetary policy experiences after the breakdown of EMS in 1992 in a BIS-workshop in 1997 (Nicolaisen and Qvigstad, 1997) and argued that maybe, with the benefit of hindsight, more flexibility in the monetary policy framework could have reduced the tendency of a procyclical monetary policy. A colleague from Bank of Canada recommended in his comments (Murray, 1997) that Norway should consider moving to a flexible exchange rate system and inflation targeting. See also Schembri (2001) who reiterated the case for flexible exchange rates in Canada in a conference in November 2000, marking the fiftieth anniversary of Canada's adoption of a flexible exchange rate, a decision which was applauded by Milton Friedman in his keynote address at the conference.

A recent study by Kalemli-Özcan (2019) finds that spillovers from US monetary policy are larger in Emerging Market Economies (EMEs) than in Advanced Economies (AEs), hence large capital flows working through domestic banks may complicate stabilization mandates for EMEs through international risk spillovers. This may actually enhance the case for flexible exchange rates in these countries according to the author. But reducing the risk-sensitivity of capital flows in these countries would typically suggest improved institutional quality such as transparency, governance, accountability, anti-corruption, integrity, bureaucracy, including central bank independence. See e.g. Tillmann (2016) for spillovers to AEs and Ehrmann et al. (2011) and Bauer and Neely (2014) for spillovers to EMEs. In a recent study Mimir and Sunel (2019) have analysed how monetary policy should respond in an optimal way in EMEs facing such spillovers, with a particular emphasis on situations where both domestic price stability and financial stability are threatened. A study of spillovers from the euro area to Scandinavian countries Norway, Sweden and Denmark has also recently been undertaken in ter Ellen, Jansen and Midthjell (2018). They find evidence that domestic monetary policy is still effective, but that spillover effects, particularly from the ECB's communication, reduce domestic control over long-term interest rates.

Schembri (2019) and Lowe (2019) argue that floating exchange rates have served Canada and Australia well and that the benefits have greatly exceeded costs stemming from increased exchange rate volatility. Schembri (2019) reminds us that Canada's experience with inflation targeting underpinned by a floating currency is an instructive example of the most durable monetary policy framework in the post-war period (Rose, 2014). Flexible exchange rates preserve some degree of monetary independence, even in a low interest rate environment, which facilitates the domestic economy to adjust to external shocks.

Some authors argue that the value of flexible exchange rates depends on whether the shock is domestic or external. Corsetti et al. (2018) has compared evidence from the four Nordic countries Norway, Sweden, Denmark and Finland after the global financial crisis in 2008 to illustrate how their different exchange rate arrangements played a key role in determining the short-term and medium-term impact of the crisis. Two of these countries are small open economies with close ties to, but not being part of, the euro area: Norway and Sweden, both with independent monetary policy regimes, inflation targeting and floating exchange rates, one small economy who is a full member of the euro area: Finland, and one small economy with an exchange rate peg to the euro: Denmark. The recession following the global financial crisis, which originated outside the Nordic countries, turned out to be less persistent in the countries with flexible exchange rates such as Norway and Sweden, compared with the more drawn-out contractions in Denmark and Finland. Corsetti et al. (2018) argued that the exchange rate regime played a major role over the period studied (2008-2012) as both Norway and Sweden benefitted from a sharp although temporary currency depreciation when the financial crisis hit in 2008.

Canada's experience are obviously of relevance for Norway too. As commodity prices are typically hit first as they are traded in global markets where new information rapidly is

embedded in prices. The Canadian dollar tends to move largely in tandem with the index of commodity prices. A recent study by Akram (2019) has compared co-movements between oil prices and the Canadian and Norwegian nominal effective exchange rates and reports similar results, noting that exchange rates of major oil exporters tend to appreciate when oil prices increase and depreciate when they fall (Akram, 2004a). This points to a feature Norway shares with other small open economies with a dominating oil-producing sector, namely that they are exposed to potentially large real shocks, which are related to the world market for oil. These shocks have asymmetric effects on small open economies relative to their core neighbouring central economies like Continental Europe in the case of Norway and the US in the case of Canada. In the early 1990's Norway's business cycle was in fact quite strongly negatively correlated with that of the countries in the European Monetary Union,[10] far from what is prescribed for an optimum currency area.[11]

In this paper we focus on the shock absorbing capacity of the exchange rate in an inflation targeting regime when there is confidence in the regime. However, the exchange rate also plays an important role in the long run when there is a need for structural change in the economy. In Norway today total GDP for Norway supersedes GDP for the mainland economy by a substantial amount. But in the future this difference will be significantly smaller. To facilitate this change the real exchange rate will have to depreciate, see Akram (2004b) for an illustration of this change.

Also, Schembri (2019) reports a similar thought experiment as we have conducted in the case of Norway in Chapter 3, assuming that the Bank of Canada had attempted to hold the Canadian dollar steady in 2014-2015, even when key export commodity prices dropped significantly. Prevention of the 20 per cent depreciation would have required an increase of the policy rate to 6.75 per cent in 2015 and by an additional 25 bp in 2016. These hypotheticals would have had tremendous adverse effects on the real economy, similar to what we have found in a similar thought experiment in Chapter 3.

In Chapter 3 we have also illustrated the challenges with procyclical monetary policy in the fourth episode we have considered in some detail analytically in this paper, making the counterfactual thought experiment that a floating exchange rate regime was introduced already in 1996. At the time the Norwegian currency was appreciating and Norges Bank intervened heavily in the foreign exchange market and cut interest rates significantly although it was recognized by the bank that this contributed to a procyclical policy stance. The appropriateness of the monetary policy framework was around that time also subject to a reevaluation internally in the bank (Christiansen and Qvigstad, 1997).[12] Three of the four

[10] See e.g. Eitrheim, Klovland and Øksendal (2016, p. 562).

[11] Arguments along similar lines were also presented in Haldane (1997, p. 87) who argued that Norway needed nominal exchange rate flexibility in order to cushion against large and asymmetric shocks and structural dissimilarities relative to other European economies.

[12] Christiansen and Qvigstad (1997) contains a survey of analyses of the existing monetary policy framework in Norway in the 1990s and make some assessments regarding possible monetary policy regime alternatives. Several of the contributions to this survey stress the need for Norway to establish tolerance for more exchange rate variability.

main chapters in Christiansen and Qvigstad (1997) concluded that Norway would benefit from a transition to inflation targeting.[13]

In his comprehensive study of exchange rate regimes in twentieth-century Europe Straumann (2010) analysed the transition away from the previous fixed exchange rate regime in a handful of small European economies in the 1990s, in Austria, Belgium, Denmark, the Netherlands, Norway, Sweden and Switzerland. Straumann concluded that for most of the twentieth century these countries were constrained by a distinct fear of floating exchange rates, but that they turned around rather quickly following the crisis in the European Monetary System (EMS) in 1992-1993. These countries typically transitioned along one of two paths, either they eventually adopted the euro (such as Austria, Belgium and the Netherlands) or they let their exchange rate float (Norway, Sweden and Switzerland). Denmark stand out as the only country which has maintained its old fixed exchange rate regime and is today pegging the Danish krone to the euro.[14]

Whereas Finland and Sweden introduced inflation targeting and floating exchange rates as early as in 1993 the transition was delayed until the turn of the century in Norway. This delay has by some observers been attributed to fear of floating (Straumann, 2010, p. 327). Straumann also reminds us that in retrospect, former Norges Bank governor Hermod Skånland, when he looked back on this period, made the observation that "the system of 'flexible stability' of the exchange rate produces more flexibility than stability".[15] Skånland also discussed pros and cons regarding fixed and floating exchange rates in his last annual speech as the bank's governor in February 1993[16] shortly after the krone was allowed to float 10 December 1992. One conclusion we draw from the analyses presented in this work regarding floating exchange rates, is better late than never.

[13] A reviewer of the book noted that the final decision would mainly rest on whether the Ministry of Finance would delegate such power to the Central Bank or not (Vårdal, 1998).

[14] A similar two-path story appeared already in Mussa (1994) where the author concluded that smaller industrial countries essentially faced the choice either to peg their exchange rate to the dominant currency in their natural bloc, or to allow their exchange rate to float without a specific parity against this currency. Furthermore, Mussa argued, countries that chose floating exchange rates would gain some monetary policy flexibility relative to that governing the dominant currency in the bloc, although within certain limits given by the development in this currency's exchange rate over time.

[15] Skånland (1999, pp. 3-4)

[16] Available at https://www.norges-bank.no/globalassets/upload/images/tidslinje/talerartikler/tale1993.pdf

1.3 The fixed exchange rate and its breakdown (1986 - 1992)

Including the devaluation in May 1986 there had been no less than ten devaluations of the exchange rate since 1976. With hindsight we know that the May 1986 devaluation turned out to represent a renewed commitment to price stability through fixed exchange rates that came to stand the test of time. Norges Bank, which was given the task of defending the exchange rate, regained its operational independence with respect to using its key instrument for this endeavour, the bank rate. From 1986 onwards monetary policy was directed towards stabilizing the krone exchange rate and thereby contribute to low and stable inflation, whereas fiscal policy aimed at smoothing fluctuations in production and employment. This division of responsibility became more demanding during the course of the 1990s. In the late 1980s the outcome of the shift in the monetary policy regime change was also uncertain. The policy change of 1986 can be interpreted as a turning point, a credible attempt to reconquer the nominal anchor. A fixed exchange rate became the nominal anchor for an economy that had drifted away from calm waters and let its anchors aweigh.

This shift towards a hard-currency policy undoubtedly carried costs but the social democratic government showed resolve. There was not much help from abroad either. Sweden was entering into muddy waters running large deficits. A procyclical policy was made even worse after 1990 when the leading economy of Europe, Germany, tightened monetary policy in the aftermath of its reunification. A tax reform effective from 1992 significantly reduced the effect of interest deductions. The real after tax interest rates continued to rise until they reached their peak level in 1993.

This development is the backdrop of the analysis in chapter 2 (Eitrheim and Qvigstad, 1999). With hindsight the manifest 'fear of floating' and persistent support for fixed exchange rate regimes, which prevailed in Europe until the breakdown of the European Monetary System (EMS) in 1992, can seem hard to explain today three decades later.[17] This breakdown led to a new situation in many European countries. Some countries like New Zealand, Canada, Finland and Sweden changed their monetary policy regime to inflation targeting in the early 1990s and let their exchange rate float.

In other countries the transition to inflation targeting took longer time, which was the case of Norway. Throughout the 1990s, decisive steps were taken to strengthen Norwegian competitiveness and adjust to a less oil-dependent future. Some of these steps were realised through the implementation of important structural reforms, for example removal of capital controls, the final reminiscence from the old regulatory system, privatisation and other efforts to improve the cost-effectiveness of Norwegian export industries. These structural reforms were successful and laid the foundation for strong economic growth the next decade.

Since 10 December 1992 the krone exchange rate floated freely until a new regulation about exchange rate policy, basically a managed float regime, was introduced in May 1994. The trade weighted exchange rate depreciated by 4-5 per cent in 1993 and during the period

[17] See Straumann (2010) for a detailed analysis of 'fixed ideas' about exchange rate regimes in small states in twentieth-century Europe.

with a managed float from 1994 onwards the krone gradually appreciated back to around its pre-EMS-collapse level in 1991-92. However, as a result of the EMS-collapse in 1992 international interest rates were significantly reduced in 1993 and Norwegian policy rates followed suit and were quite rapidly brought down to a level between five and six per cent. This was of great help of course to better align the monetary policy stance with the domestic economic situation.

Real interest rates in Norway had increased dramatically since the mid 1980s, notably due to higher nominal interest rates and a decline in inflation. The real after tax interest rate increased even more due to the fact that marginal tax rates on income were reduced, in particular by the 1992 tax reform, but also by adjustments made in the years preceding it, which reduced the effects of interest deductions. Figure 1.2 shows real after tax interest rates and unemployment rates in Norway 1980-2000. Figure 1.3 below shows the recorded bank losses for the crisis years 1988-1993.

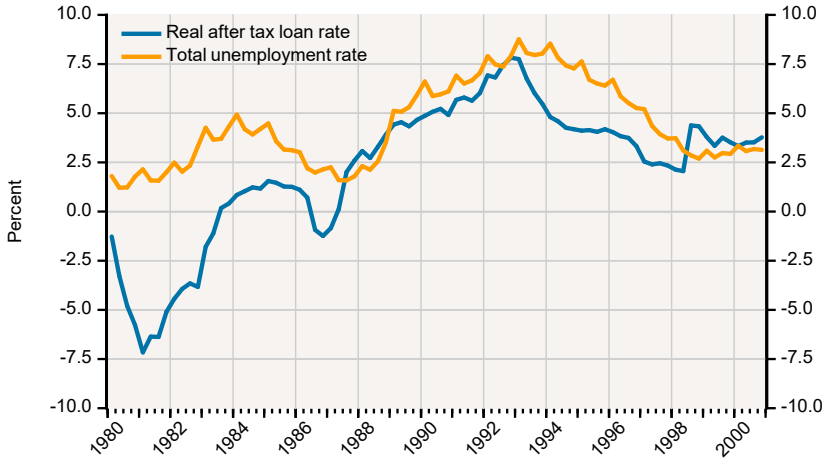


Figure 1.2 Real after tax interest rates and unemployment rates, 1980-2000.
Source: Norges Bank Historical Monetary Statistics.

1.4 The interim - fear of floating (1993 - 1998)

Economic growth picked up rapidly after 1993 and the rate of unemployment declined (Figure 1.4). Towards the end of the 1990s there was also less restraint in wage settlements. Nominal wage growth increased to 4.5 per cent in 1996 and 6.5 per cent in 1998. Although inflation had remained firmly at low levels during these years, around two per cent on an annual basis, the growth in real wages had picked up and increased to 3.2 per cent in 1996 and 4.3 per cent in 1998. The Norges Bank's business cycle reports had been dubbed In-

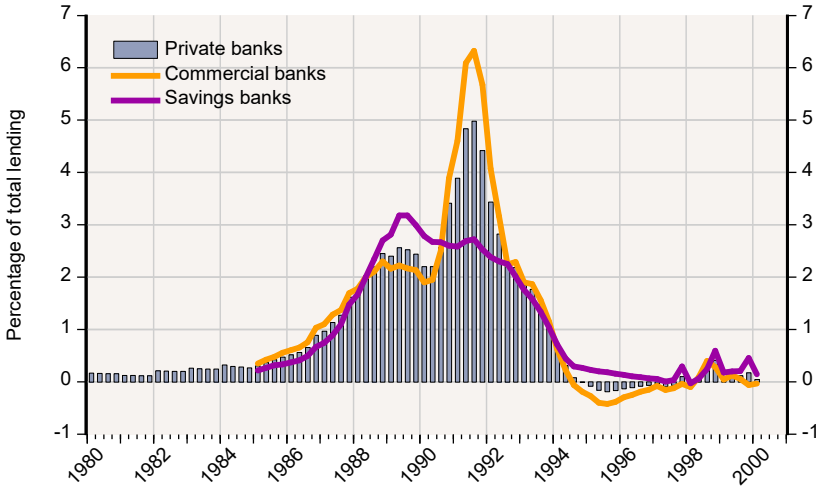


Figure 1.3 Bank losses in percentage of total lending, 1980-2000.
Source: Norges Bank Historical Monetary Statistics.

flation Reports already in 1994 to underscore that the bank emphasised the importance of a credible nominal anchor. From 1994 onwards there were also continuous efforts in the bank to further develop the macroeconomic toolkit for an eventual transition to inflation targeting.

Oil prices had been increasing significantly too, from 14 dollars per barrel in 1994 to 24 dollars per barrel in late 1996 (Figure 1.5). This led to a downward pressure on interest rates in order to avoid currency appreciation, and would create a policy dilemma since it would render monetary policy more procyclical (Figure 1.6). Despite strong growth in demand and an increasingly positive output gap, the key policy rate was reduced on two occasions in 1996 and finally in January 1997 from 4 to 3.25 per cent. With hindsight we must conclude that both monetary policy and fiscal policy contributed to amplify and not dampen the economic fluctuations in this period. At the same time oil prices continued their increase, and the Norwegian krone continued to appreciate despite massive interventions by Norges Bank. In January 1997 Norges Bank announced that it would not reduce the policy rate any further. Norges Bank also temporarily discontinued its interventions to stabilise the exchange rate. The krone appreciation was short lived though, and reverted when oil prices started to decline some months later in 1997.

The fall in oil prices continued in 1998 down to a level around 14 dollars per barrel during the international crises which emerged in Southeast Asia and Russia. The Norwegian krone had now depreciated with more than 6 percent in less than a year. Norges Bank increased its policy rate seven times during 1998, from 3.5 to 8 percent. This approach to stabilising the exchange rate through continued interest rate increases was also brought to an

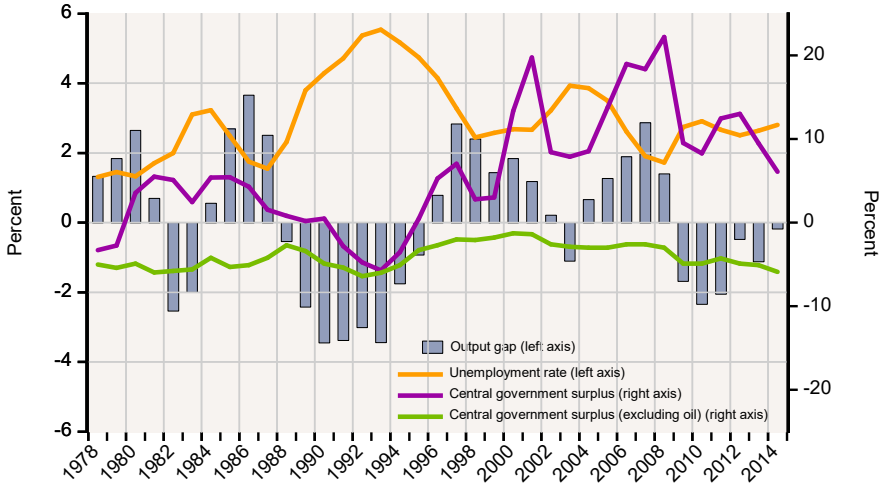


Figure 1.4 Fiscal policy stance and unemployment, 1978-2014.
Source: Norges Bank Historical Monetary Statistics.

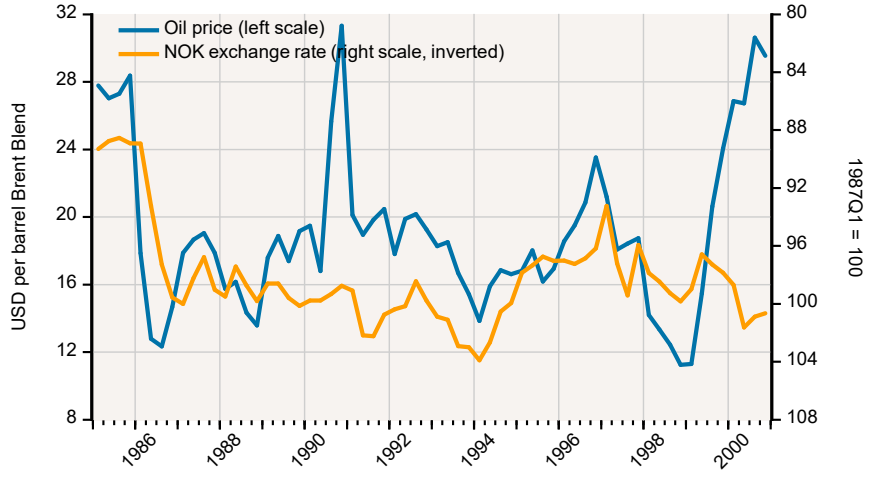


Figure 1.5 Oil prices and exchange rates, 1985-2000.
Source: Norges Bank Historical Monetary Statistics.

end. In August 1998 Norges Bank set the interest rate to 8 percent to prevent further krone depreciation. At the same time the Bank announced that there would be no further changes in monetary policy instruments for the time being. At this interest rate level, the bank said,

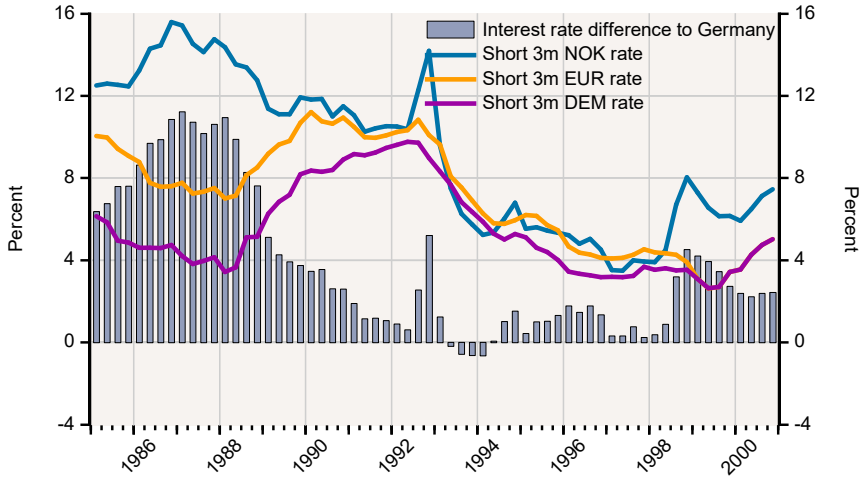


Figure 1.6 Short interest rates, 1985-2000.
Source: Norges Bank Historical Monetary Statistics.

inflation expectations would be constrained and contribute to stabilize the exchange rate. The bank's interventions to stabilise the exchange rate were also temporarily discontinued and the exchange rate was *de facto* allowed to float.[18]

As reported in a previous section the counterfactual analysis in Chapter 2 focused on the developments in the early 1990s. Although the counterfactual analysis reported in Chapter 3 is primarily directed at two episodes in the 2000s, the global financial crisis in 2008 and the drop in oil prices in 2014, respectively, we have also included in Chapter 3 some counterfactual evidence on the episode we have focused on here during the late 1990s. We have considered the case when an alternative monetary policy had been implemented in 1996. What would have been the outcome if Norway had let the exchange rate float, say from 1996Q4, and Norges Bank had followed a simple Taylor-type rule in interest rate setting? The results in Section 3.5.3 in Chapter 3 indicate that monetary policy would then have been somewhat tighter in 1996 and 1997, interest rates would have been maintained at a relatively constant level before eventually some tightening would have taken place although less dramatic than what actually took place in 1998. The exchange rate might have become a bit stronger in the early phase but may be showing less volatility over the entire 1996-1999 period. This illustrates how Norway might have avoided the intense tightening of monetary

[18] Prior to 10 December 1992 when the Norwegian krone was allowed to float after massive depreciation pressures the interest rate had been increased to very high levels in an attempt to make speculation of further krone depreciation costly. The lessons from that episode was that the strategy was not credible since it would entail too high costs for the Norwegian economy. The speculators therefore correctly anticipated that the high interest rates would be only temporary. In 1998 the key policy rate was increased until it reached 8 percent, a level the economy could endure for a longer time. This strategy was therefore considered more credible.

policy through 1998 when Norges Bank increased the interest rate on seven occasions to help stabilize the exchange rate.

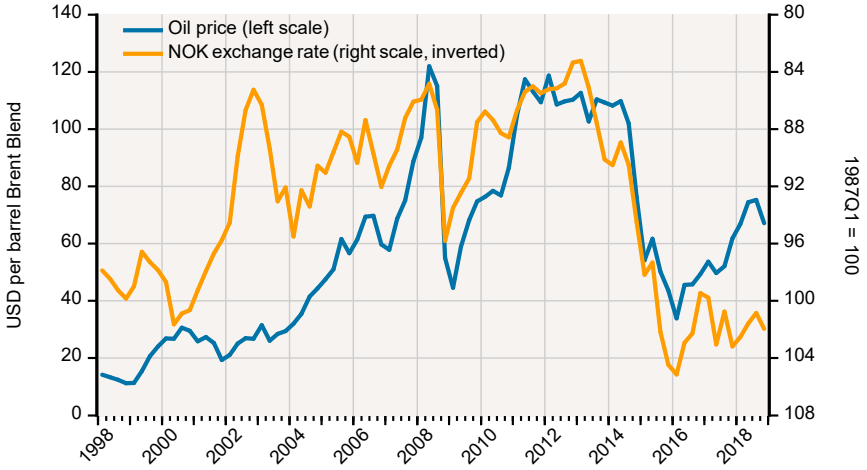


Figure 1.7 Oil prices and exchange rates, 1998-2018.
Source: Norges Bank Historical Monetary Statistics.

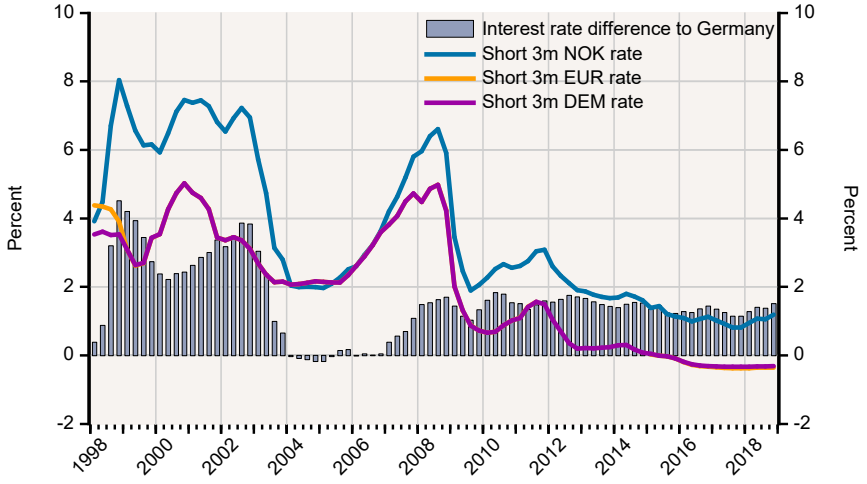


Figure 1.8 Short interest rates and interest rate differences, 1998-2018.
Source: Norges Bank Historical Monetary Statistics.

The counterfactual analysis clearly indicate a somewhat smoother development in

macroeconomic variables such as output, employment and inflation across the 1996-1999 period.

Few if any had anticipated the strong growth in commodity prices, in part driven by strong demand in China, which would take place over the next 10-15 years. Figure 1.7 shows that oil prices rose to a threefold level from the bottom level in late 1998 to late 2000. And from 2004 onwards oil prices contiuned to rise until they reached hitherto unprecedented levels in the first half of 2008. The exchange rate resumed its appreciating trend in 2000. Absent interventions the floating currency continued to appreciate until late in 2002. Figure 1.8 shows that this appreciation went together with increases in the interest rate differential towards Germany. We will return to these developments in Section 1.6 below.

1.5 Fear of floating overcome - transition to inflation targeting (1999 - 2001)

In short inflation targeting has three elements: interest rate setting, communication and formal reporting requirements to the government and the parliament respectively. In January 1999, a new governor Svein Gjedrem took over the helm of Norges Bank and already in his inaugural interview as governor he announced that Norges Bank would set the interest rate such that it would bring inflation down towards the same level of inflation aimed at by member countries in the Euro area, close to two percent at the time. This, he argued, would provide a credible nominal anchor for inflation expectations. At the same time one would make sure that monetary policy itself would not cause downturn and deflation. This change would also be in line with international central bank practice, recognizing that low and stable inflation is most likely the best contribution monetary policy can deliver to the growth and welfare of a country. This represented a change in communication. Norges Bank also underlined that it would not be able to fine tune the exchange rate, from day to day and from month to month. A stable exchange rate was no longer a primary monetary policy target. In practice Norges Bank had left the fixed exchange rate regime and *de facto* introduced inflation targeting and floating exchange rates.

In 1999 this anchoring of inflation expectations facilitated the gradual reduction of interest rates towards a more normal level, quicker than what had otherwise been the case. The labour market was still quite tight however, and the substantial wage increases in the main wage settlements in 1998 and 2000 had contributed a strong increase in relative wage costs and weaker competitiveness. Norges Bank increased its key policy rate by 75 basis points in the spring 2000 and in Inflation Report 2/2000 it was stated that the next interest rate change would more likely be a further increase than a reduction.

The final and formal step in implementing inflation targeting was taken two years later when a new Regulation on Monetary Policy was put in effect on 29 March 2001. The transition to a new monetary policy framework was formally completed *de jure*. The new regulation did not entail a material change in the monetary policy response pattern

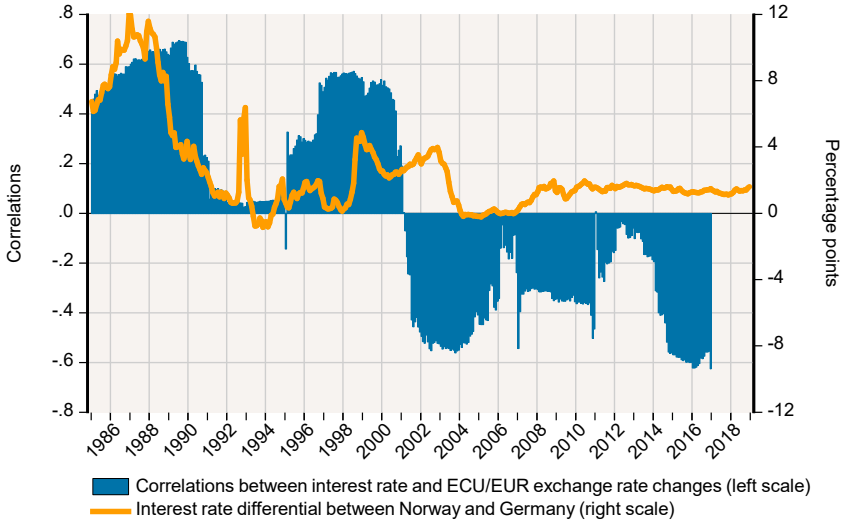
compared with the policy that had been pursued over the previous two years. But the regulation clarified Norges Bank's increased accountability and specified more explicitly the institutional framework for monetary policy including a precisely stated inflation target. According to the new monetary policy target, as the Government's instruction read, Norges Bank should aim of a target level of consumer price inflation, at 2 1/2 percent over time. Simultaneously the government also put in effect new operational guidelines for fiscal policy which prepared for a gradual and sustainable path for phasing in oil revenues into the Norwegian economy.

The transition to inflation targeting around the turn of the century (1999-2001) reversed the causal ordering between exchange rates and interest rates. When the central bank targeted the exchange rate, interest rates were only infrequently used, and typically in situations where the central bank tried to defend the desired exchange rate level after interventions had failed to do so. Under inflation targeting however the exchange rate responds with the opposite sign such that a tightening of monetary policy leads to a currency appreciation, thus rendering monetary policy more effective.[19] Figure 1.9(a) shows notable shifts in the empirical correlations between changes in short-term money market interest rates and changes in exchange rates after the introduction of inflation targeting around 2000.[20] Empirical analyses of the managed float regime prior to 2001 suggest that increases in Norwegian interest rates relative to those of the eurozone tended to go together with a weakening of the krone.[21]

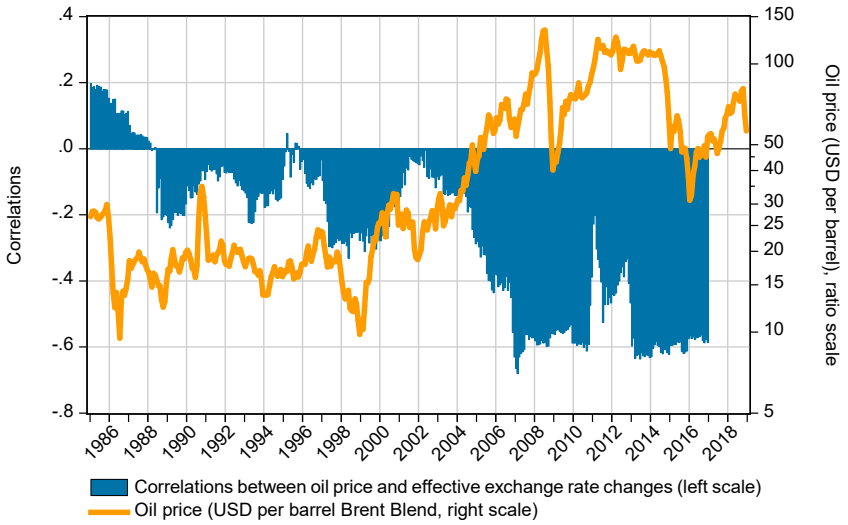
Whereas these correlations tended to be close to zero in the early 1990s when Norway pegged the ECU-rate they turned positive during the years of managed float in the mid 1990s. After the introduction of inflation targeting and floating exchange rates in 1999-2001 the correlations soon changed sign and turned negative. In effect this change implied that under the new regime a tightening of monetary policy was typically accompanied by a currency appreciation, thus making monetary policy more effective. Figure 1.9(a) indicates that this negative correlation seems to have been particularly strong when the interest rate differential was high during the years 2000-2003. Interestingly, the correlation seems to be stronger in periods of falling oil prices, such as in 2008 (rather temporarily) and in 2014 (more permanently).

Figure 1.9(b) shows that the empirical correlations between changes in oil prices and changes in effective exchange rates in the 1990s were slowly increasing in absolute value. A negative value means that positive oil price changes are typically associated with krone appreciation. These correlations fluctuated between -0.15 to -0.20 in the early 1990s and became more negative during the managed float period in the second half of the 1990s. Interestingly these correlations became much stronger, and have fluctuated between -0.4 and -0.6 after oil prices increased to levels above 50 dollar per barrel from 2005 onwards.

[19] Bjørnstad and Jansen (2007)
[20] Also discussed in Eitrheim, Klovland and Øksendal (2016, p. 554-555).
[21] Bjørnland and Hungnes (2006)



(a) Corr $\Delta r3m, \Delta exrat$



(b) Corr $\Delta poil, \Delta exrat$

Figure 1.9 (Top) Empirical correlations between changes in money market interest rates and changes in exchange rates, 1985-2018 (rolling 48-month windows). (Bottom) Empirical correlations between changes in oil prices and changes in exchange rates, 1985-2018 (rolling 48-month windows).

The strongly negative correlations between changes in oil prices and exchange rates under floating exchange rates (Figure 1.9(b)) have increased the importance of the exchange

rate channel. This finding is also in line with recent empirical evidence reported in Akram and Mumtaz (2019), which supports that changes in effective exchange rates have become more strongly correlated with oil prices over the last decade.[22]

After the inflation target had been formally introduced in 2001, Norges Bank continued to develop the communication of its views on future interest rate developments. A stronger focus was put on the future inflation outlook and the bank's ability to deliver and actually achieve the inflation target.

1.6 From inflation targeting in its juvenile to coming of age (2001 - 2007)

The inflation targeting framework in Norway has been gradually changed and further developed from the early 2000s onwards and to the form it has today. There have been changes along several dimensions such as the frequency of interest rate meetings, in the communication of current and future policy decisions, on the policy horizon and on the criteria used for interest rate setting to mention a few. These will be presented in further detail in the following.

Although interest rates had been gradually brought down soon after the introduction of the new regime in 1999 it did not take long before the bank had to tighten its policy stance. During the first two years after having received the new mandate in 2001, the policy rate continued to be relatively high, with a substantial interest rate differential against the euro. Although Norges Bank responded to 11 September 2001 by reducing the bank rate, it did so in a less aggressive manner than the euro countries, which implied a widening of the interest rate differential to around 3 percent in mid-2002. On the background of rising oil prices and high and increasing interest rate differentials to Germany the currency appreciated strongly, by more than 10 percent during the course of 2001-2002 (cf. Figure 1.7 and 1.8 above).

The reaction pattern needed clarification

In July 2002, the central bank clarified its reaction pattern. In response to the outcome of the wage negotiations, and armed with the new *de jure* inflation targeting mandate, Norges Bank increased the bank rate. The background for the relatively tight policy of Norges Bank was to be found in the tight labour market. The wage settlements of 1998 and 2000 had been relatively costly. Ahead of the next biannual wage negotiations round in 2002, Governor Gjedrem warned that the consequence of yet another high outcome settlement would be higher bank rates. For Norges Bank it was a test of its resolve. The bank had

[22] The correlations between oil prices and effective exchange rates are derived from a time-varying parameter model in Akram and Mumtaz (2019). The results are reported to be in line with previous studies (Akram, 2004a). ter Ellen (2016) has studied potential nonlinearities in the relationship between oil price and effective exchange rate changes and finds some evidence which support that "large" oil price changes have a stronger effect on exchange rates than "small" changes.

repeatedly warned against the impact of too generous settlements. The decision to increase the interest rate as a response to the wage settlement has remained controversial, may be in part since the interest rate differential between Norwegian and international interest rates had grown larger. Despite this controversy, the Deputy Governor at the time, Jarle Bergo, has later referred to the episode as the bank's 'finest hour'.[23]

Changes in the communication of the policy horizon

When inflation targeting was introduced in Norway, it was explicitly stated by the bank that the targeted level of inflation, 2 1/2 percent, should be reached in two years. This two-year horizon was upheld quite strictly during the first years but was later relaxed. In the communication it was emphasised that although the evaluation of monetary policy normally would take into account developments over a two year horizon it was underlined that the bank would conduct flexible and not strict inflation targeting (Svensson, 1999). It was also underlined that the time horizon would vary with the actual economic disturbances and in Inflation Report 2/2004 the normal policy horizon was considered to be in the range 1-3 years. From 2007 onwards the bank started to use the expression "in the medium term perspective".

An important experience is that a flexible monetary policy regime has been essential for making appropriate trade-offs in response to the diversity of shocks hitting a small open economy like Norway's. The time horizon for achieving the target must therefore be sufficiently long as seen in light of the shocks in question. Internationally, inflation targeting central banks have moved in the direction of a more flexible approach, and the target horizon is typically longer today than in inflation targeting's early phase. This has certainly been the case in Norway as well (Norges Bank, 2017, p. 31). In a learning perspective, in a situation when the nominal anchor has been credibly established and the central bank's reaction pattern is well understood, the inflation targeting system allows for more flexibility and nuanced responses to news and disturbances.

This tendency towards increased flexibility in the policy horizon ("in the medium term perspective") certainly reflected the fact that the inflation targeting framework soon gained credibility. Orphanides (2010, p. 21) warns, however, that this tendency towards increased flexibility for inflation targeting central banks should not be confounded with "multiple goal targeting", and he warns about the risk of over-promising on what monetary policy can do.

Another potential form of overreach is the tendency to overstate the degree of exactness one can reasonably expect from the inflation targeting regime. Vredin (2017, p. 74) argues for example that "the high level of precision in the communication may also have contributed to an overly optimistic view - perhaps more outside than inside the central bank - of what the 'science of monetary policy' can achieve".[24] A metaphor sometimes

[23] Isachsen, Arne Jon (2008), "Jarle Bergo: En profesjonell pengepolitiker går fra borde", Penger og Kreditt, 1/2008, p. 8.

[24] https://www.regjeringen.no/contentassets/4555aa40fc5247de9473e99a5452fdfd/arbnotat_4_2017.pdf

used to characterize this overstated precision is to distinguish between two types of maps, those drawn with pencils with hard graphite versus those drawn with soft graphite pencils. Typically, hard 4H pencils would leave thin and distinct lines whereas soft 4B pencils would leave fuzzy lines, more like those from a broad tip Sharpie, which would downplay the degree of precision in the map.

Henry Ohlsson, a deputy governor at Sveriges Riksbank, offered some reflections along similar lines in his remarks in the bank's published Monetary policy minutes in December 2016.[25] He pointed to the fact that data uncertainty is often downplayed and that this may leave an overstated impression of exactness. It is easily forgot that many figures come from surveys based on small samples or that the underlying data sources may be inadequate and subject to both human errors and structural changes which may be difficult to detect in real-time. Statistical data used in policy discussions are also frequently of a preliminary nature and subject to revisions over a long period before the figures are considered final. In his opinion, policy should focus on general trends, not on the tenth of the decimals and he issued a general warning against 'the tyranny of the tenths', and Ohlsson stated that ".. everyone would benefit from, at least sometimes, looking up from the tenths - and the hundredths" (Sveriges Riksbank, 2016, p. 18(26)). At the same time, Ohlsson recognised that the tenths sometimes are not just white noise, but the first signs of a structural break in a trend.[26]

A calendar for interest rate meetings

Already during the fall of 1999 Norges Bank started to announce its calendar of Board meetings when the Board would evaluate the bank's key policy rate. These meetings were labelled as interest rate meetings, and it was typically nine such meetings every year. Three of these meetings, which coincided with the publication of a new and updated Inflation Report, discussed monetary policy strategy for the next four month period and were hence called "strategy meetings". The strategy which the board had decided, was then implemented through the next intervening interest rate meetings.

The normal way for Norges Bank to communicate changes in its view on the economic outlook would be in statements after interest rate meeting and most often in relation to presentations of its Inflation Reports/Monetary Policy Reports at the strategy meetings. The changes in the interest rate which were decided in the interest rate meetings on 12

[25] http://archive.riksbank.se/Documents/Protokoll/Penningpolitiskt/2016/pro_penningpolitiskt_161220_eng.pdf (Sveriges Riksbank, 2016, p. 18(26)).

[26] The switch from inflation forecasting to interest rate forecasting by the Riksbank in 2010 has been analysed by Andersson and Jonung (2018). They make the observation that "the combination of interest rate forecasting and the new inflation target without a band gave rise to the 'tyranny of the tenths', according to deputy governor Henry Ohlsson in Sveriges Riksbank (2016). Further more, that "rather than focusing on trends and a broad analysis of the economy, the Board, the media and the public began to treat monetary policy as an exact science in which inflation was perfectly measurable and controllable by the Riksbank." (Andersson and Jonung, 2018, p. 13)

December 2001 and 3 July 2002 respectively, were in both cases indicated in the previous strategy meeting.

On a few very exceptional occasions the governor of Norges Bank used his speeches to signal changes in Norges Bank's view on the economic outlook. Two such occasions were the speeches on 3 December 2002 and 3 June 2003. In both cases he stated explicitly in the introduction to the speech that he would offer his views on the latest developments in addition to repeating the views the bank had previously stated on the economic outlook. This was also stated in the invitation sent out to the media for these events. The experiences with announcing policy changes in speeches were mixed. The bank has later abandoned this. Today policy changes are communicated after the interest rate meetings, whereas speeches are used to further explain and underline the policy changes.

From exogenous assumptions about unchanged interest rates via assumptions based on market interest rates to endogenous interest rate path projections

Inflation Report 2/2001 discussed in detail how the bank considered the outlook of achieving the inflation target within a two-year horizon, conditional on keeping the key policy rate constant. If the inflation outlook, given unchanged interest rates, was below 2 1/2 percent, this would indicate that the interest rate over time would be reduced, whereas if the inflation outlook two year out, given constant interest rates, was above 2 1/2 percent, this would indicate that interest rates would be increased. Norges Bank did in this way express its evaluation of the economic development, with particular emphasis of the outlook for inflation. This would facilitate the predictability of the bank's reaction pattern by other economic agents and help inform expectations in financial markets.

On the basis of the large and predominantly negative shocks to the world economy in 2002-2003, the technical assumption typically made in macroeconomic projections and forecasting, that the nominal interest rates were held constant in the forecast period, became increasingly unrealistic in 2003. The reality was that the interest rate was reduced, in total no less than ten times, and with altogether 5.25 percentage points in the period from December 2002 until March 2004. From IR 3/2003 the bank decided that it would be more realistic to make projections based on market expectations in the short-term money markets, i.e. from the forward interest rate curve. Such conditioning on market prices is still the preferred practice followed by Bank of England when they make their projections.[27]

The gradual move towards more transparency and explicit forward guidance

Over time Norges Bank has become considerably more open in its comminication of monetary policy decisions and the decision making process. In the Inflation Report 1/2003 the interest

[27] See e.g. https://www.bankofengland.co.uk/monetary-policy-summary-and-minutes/2019/august-2019

rate strategy, which the Board had decided for the four-month period from November 2002 until March 2003 in its November meeting 2002, was published as an addendum. As of Inflation Report 2/2004 onwards the Board offered some forward guidance by announcing its future interest rate strategy for the period until the next Inflation Report, which was published in retrospect as an integrated part of this. The title was also changed to *Inflation report with monetary policy assessments*. More detailed information was also offered in the press conference after the Board's interest rate meetings.The press release following the interest rate meeting on 29 October 2003 presented for the first time a detailed account of elements of the economic development which had been particularly emphasized by the Board, and the main risk factors. The press release, typically two to three pages, would hereafter also contain a summary of the main judgements made by the Board in the meeting. From the interest meeting 12 December 2007 onwards a written document, *The Board's justification for the interest rate decision*, was distributed together with the press release.

Norges Bank's communication of monetary policy through press releases, reports and speeches aims at affecting expectations of economic agents. We have mentioned examples such as the bank's statement concerning its future interest rate setting in press releases and speeches. When the underlying rate of inflation declined in 2003 and 2004 it was important to ensure that inflation expectations remained well anchored around the target level of inflation at 2 1/2 percent. The press release following Inflation Report 1/2004 read *"When inflation increases from a very low level, this will provide a basis for gradually moving towards a more normal short-term interest rate level in Norway"*. And in the press release after the interest rate meeting on 26 May 2004 stated that *"The inflation outlook in Norway implies that Norway will not be the frontrunner when other countries increase interest rates"*. Norges Bank continued this line of communication throughout the fall 2004 and it was not until in his annual speech held 17 February 2005 that the governor stated *"With the prospect of low inflation, Norway has lagged behind other countries in adjusting interest rates to a more normal level"*. And he added *"After a period, the interest rate can then gradually be raised to a more normal level"*. From the press release after the interest rate meeting on 25 May 2005 and until the interest rate meeting on 24 January 2007 a statement was made using a phrase of the following type. *"Monetary policy is directed such that the interest rate rises gradually - in small, not too frequent steps - towards a more normal level"*. In 2007 the title of the report was changed again, this time to *Monetary Policy Report (MPR)*.

Publication of interest rate paths

Norges Bank started publishing its interest rate paths in Inflation Report 3/2005 in November 2005.[28] The precursor was rather traditional, like most central banks who produced inflation forecasts at the time Norges Bank based their forecast on an unchanged policy interest rate, the bank then moved on to make its forecast conditional on market interest

[28] See https://www.norges-bank.no/contentassets/a29c4583a0564142900cb50dd7b395a1/ir-2005-03-en.pdf.

rates, eventually with some judgement added to them before Norges Bank decided to go all in and publish its own projection of the interest rate path over a three-year horizon. We observe, however, that the move from one stage to the next did not necessarily occur because the next stage was considered as "the right solution". It was rather that the existing method had some inherent problems, which were hopefully resolved by changing the approach. It's more accurate to say, we will argue, that Norges Bank had a rather pragmatic approach to communicating its views on monetary policy going forward.

This was, however, a significant step towards increased transparency and openness about Norges Bank's views on future interest rate developments. The Board had previously only made public the interest rate strategy for the next four-month period. This was now extended with a complete forecast of the key policy rate path over the next three years. We may summarise this gradual development of forward guidance about the bank's monetary policy intentions in four steps. These steps correspond to changes in the assumptions underlying the macroeconomic projections which were published in the Inflation Reports/Monetary Policy Reports. Each step was considered as an improvement relative to the previous one.

1. Unchanged interest rate
2. Market rates
3. Market rates with added judgement
4. The bank's conditional projection of the interest rate path

In 2005 it was only the Reserve Bank of New Zealand who had previously published such interest rate projections. It was emphasised in the communication that the interest rate projection expressed a reasonable balance between the consideration to bring inflation back towards its target level and the consideration to stabilise output and employment, conditional on the information available for Norges Bank at the time. The uncertainty regarding the interest rate projection was underlined by the published uncertainty intervals surrounding the interest rate path. This fan of uncertainty reflect how unexpected disturbances may lead to alternative outcomes for future interest rate developments which are better aligned with the monetary policy targets. Figure 1.10 below shows an example taken from Inflation Report 3/2005, which illustrates how the bank communicated baseline scenarios with uncertainty fans for the key policy rate (upper left), the import-weighted exchange rate (upper right), underlying consumer price inflation (middle left) and the output gap (middle right) in the report's Chart 1.5a-d.[29]

[29] Output gap uncertainty in real-time was discussed in a separate box in Inflation Report 3/2005. From Inflation Report 3/2006 onwards the fan chart showing the output gap has been extended to also portray the uncertainty surrounding the current situation and the historic output gap. Qvigstad (2001) and Bernhardsen, Eitrheim, Jore and Røisland (2005) provide some empirical evidence on Norwegian real-time data and discuss challenges for monetary policy. A real-time database with the data series which were available for the production of Inflation Reports and Monetary Policy Reports (in real-time) is available for research purposes and contains vintages of real-time data from 1993 onwards, cf. also Jore (2017) who has analysed real-time properties of more recent vintages of quarterly national accounts data for Norway from 2004 to 2016.

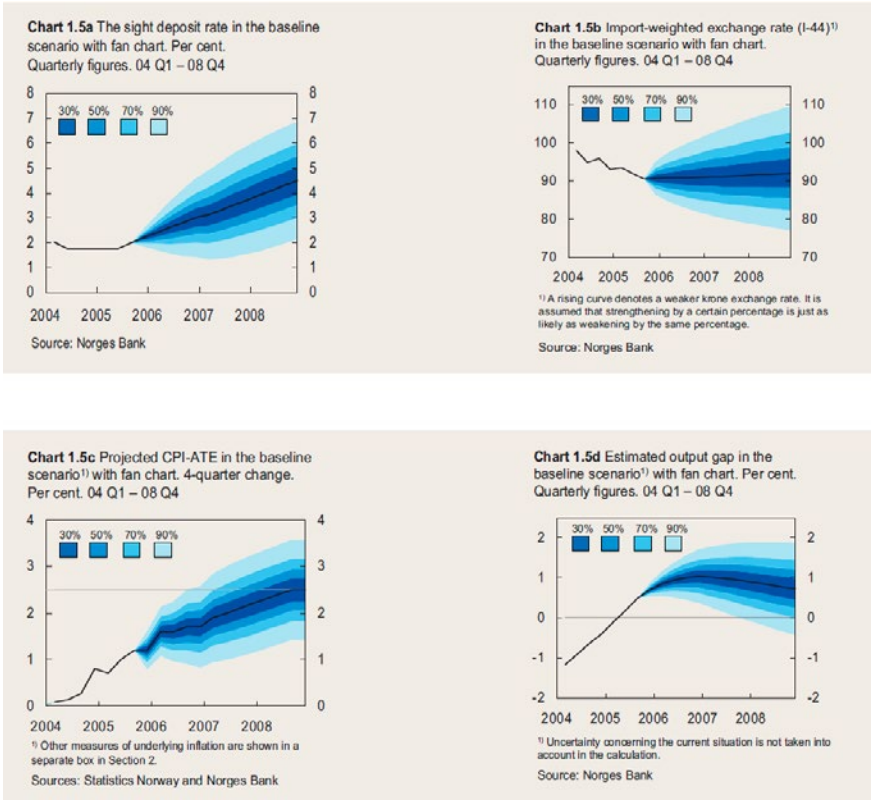


Figure 1.10 Projections of baseline scenarios with uncertainty bands, 2005Q4-2008Q4. Published as Chart 1.5a-1.5d in Norges Bank's Inflation Report 3/2005.

Criteria for good interest rate setting

In tandem with the publication of the interest rate path the bank also discussed their interest rate setting in light of a wider set of criteria of what constitutes *"a good interest rate path"*. These criteria had been published in the inflation report from Inflation Report 1/2005 onwards, but the criteria had already in 2004 been the subject of a detailed presentation, see Inflation Report 2004/3 for an example.[30]

[30] The criteria for good interest rate setting are discussed in further detail in Qvigstad (2005, 2006). The precise formulation of the criteria for good interest rate setting has varied in the bank's monetary policy reports since the criteria were first introduced in 2005. Although the words have changed over time, the criteria have always covered the following three dimensions: 1) that the inflation target is achieved, 2) that the inflation target is flexible and 3) that monetary policy is robust and takes due consideration to uncertainty. From Monetary Policy Report 1/2018 onwards the criteria are listed in a box on monetary policy objectives and trade-offs.

Box 1.1 Criteria for good interest rate setting (Inflation Report 3/2005)

Criterion 1: Anchoring inflation expectations
If monetary policy is to anchor inflation expectations around the target, the interest rate must be set so that inflation moves towards the target. Inflation should be stabilised near the target within a reasonable time horizon.[a]

Criterion 2: Getting the balance between inflation and output right
Assuming that inflation expectations are anchored around the target, the inflation gap and the output gap should be kept in reasonable proportion to each other until they close. The inflation gap and the output gap should normally not both be positive or negative simultaneously.[b] If both gaps are positive, for example, a path with a higher interest rate would be preferable, as it would bring inflation closer to the target and contribute to more stable output developments.

Criterion 3: Robustness
Interest rate developments, particularly in the next few months, should result in acceptable developments in inflation and output also under alternative, albeit not unrealistic assumptions concerning the economic situation and the functioning of the economy.

Criterion 4: Interest rate smoothing
Interest rate changes should normally be moderate unless the credibility of the nominal anchor is threatened.

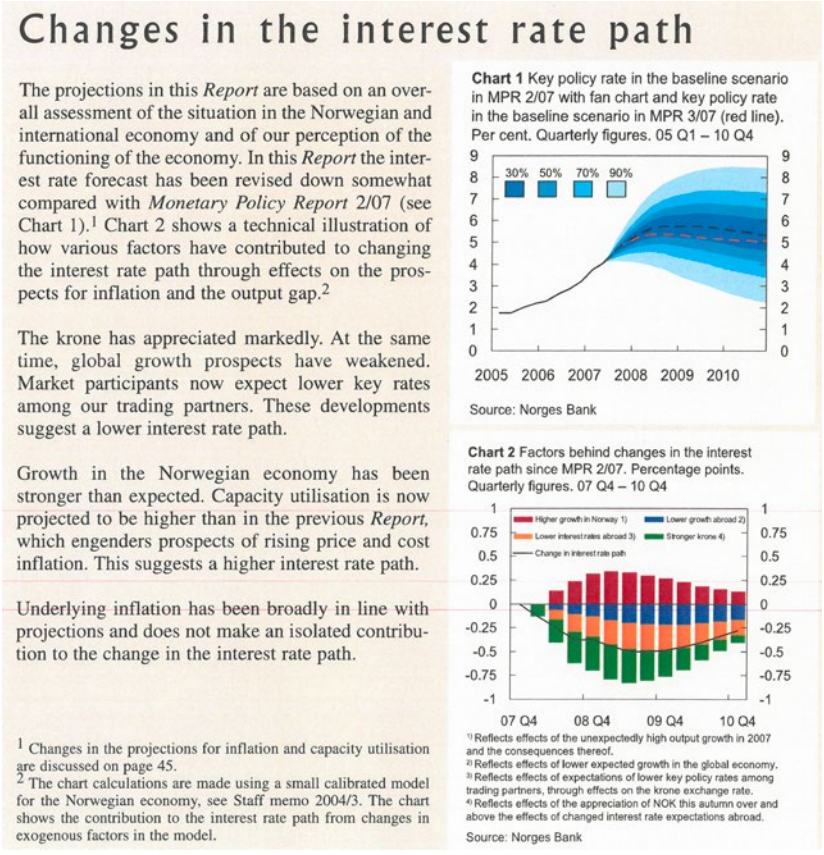
Criterion 5: Financial imbalances
Interest rate setting must also be assessed in the light of developments in property prices and credit. Wide fluctuations in these variables may constitute a source of instability in demand and output in the somewhat longer run.

Criterion 6: Cross-checks
It may be useful to cross-check by assessing interest rate setting in the light of some simple monetary policy rules without using the model framework of the first five criteria. If the interest rate deviates systematically and substantially from simple rules, it should be possible to explain the reasons for this.

[a] Norges Bank sets the interest rate with a view to stabilising inflation at the target within a reasonable time horizon, normally 1-3 years. The more precise horizon will depend on disturbances to which the economy is exposed and how they affect the path for inflation and the real economy ahead.

[b] However, economic theory indicates that under an optimal precommitment policy, it will under some circumstances (e.g. after a cost-push shock) be optimal to keep both the inflation gap and the output gap negative or positive for some time ahead, see, for example, Walsh (2003) pp. 527-529.

The two first criteria above can be read as verbal optimality criteria for good interest rate setting. The interest rate should be set in such a way that inflation gradually is brought back to its target level and there is a reasonable balance between this and the consideration to the capacity utilization in the real economy. The other criteria checks that the developments in interest rates should give acceptable outcomes for output and inflation also under alternative, not unrealistic assumptions for the workings of the economy, that interest rates normally should be changed gradually, and that large systematic deviations from simple stylized monetary policy rules, say, such as simple Taylor-rules, should be discussed. From 2007 onwards the inflation report changed its name to Monetary Policy Report. From Monetary Policy Report 3/2007 onwards the reports have also contained a detailed discussion of the changes in Norges Bank's interest rate projections since the previous report, including a simple decomposition of factors behind changes in the interest rate path. An example is shown in Figure 1.11.



Changes in the interest rate path

The projections in this *Report* are based on an overall assessment of the situation in the Norwegian and international economy and of our perception of the functioning of the economy. In this *Report* the interest rate forecast has been revised down somewhat compared with *Monetary Policy Report* 2/07 (see Chart 1).[1] Chart 2 shows a technical illustration of how various factors have contributed to changing the interest rate path through effects on the prospects for inflation and the output gap.[2]

The krone has appreciated markedly. At the same time, global growth prospects have weakened. Market participants now expect lower key rates among our trading partners. These developments suggest a lower interest rate path.

Growth in the Norwegian economy has been stronger than expected. Capacity utilisation is now projected to be higher than in the previous *Report*, which engenders prospects of rising price and cost inflation. This suggests a higher interest rate path.

Underlying inflation has been broadly in line with projections and does not make an isolated contribution to the change in the interest rate path.

[1] Changes in the projections for inflation and capacity utilisation are discussed on page 45.
[2] The chart calculations are made using a small calibrated model for the Norwegian economy, see Staff memo 2004/3. The chart shows the contribution to the interest rate path from changes in exogenous factors in the model.

Chart 1 Key policy rate in the baseline scenario in MPR 2/07 with fan chart and key policy rate in the baseline scenario in MPR 3/07 (red line). Per cent. Quarterly figures. 05 Q1 – 10 Q4

Source: Norges Bank

Chart 2 Factors behind changes in the interest rate path since MPR 2/07. Percentage points. Quarterly figures. 07 Q4 – 10 Q4

1) Reflects effects of the unexpectedly high output growth in 2007 and the consequences thereof.
2) Reflects effects of lower expected growth in the global economy.
3) Reflects effects of expectations of lower key policy rates among trading partners, through effects on the krone exchange rate.
4) Reflects effects of the appreciation of NOK this autumn over and above the effects of changed interest rate expectations abroad.

Source: Norges Bank

Figure 1.11 Box on "Changes in the interest rate path" published in Norges Bank's Monetary Policy Report 3/2007

The decision to publish the bank's projection of the interest rate path represented a major step forward in transparency and guidance on the future path of interest rates as the bank saw it at the time of publication, that is, conditional on the information available for Norges Bank at the time. Norges Bank's new communication strategy about its monetary policy intentions was also generally well received at the time, among both market participants and leading international academics in the field of monetary policy analysis.[31] Today, almost 15 years later, it is the authors' perception that the conditionality and uncertainty, with which the bank has communicated its views on the future path of interest rates, has been generally well understood by market participants over this period.

Criterion 2 (that the output gap and inflation gap normally should have opposite signs) has by professor Carl Walsh been dubbed a "Qvigstad rule" and a cross-plot of the two gaps a "Qvigstad plot" (Walsh, 2014).[32] In Walsh' interpretation: "If inflation is above target, the output gap should be negative and vice versa. If inflation is above target and the output gap is also positive, then policy is too loose; if inflation is below target and the output gap is negative, policy is too tight. If inflation relative to target is plotted against the output gap, observations should fall into quadrants II and IV. Points in quadrant I indicate policy that is too loose; points in quadrant III indicate policy is too tight."

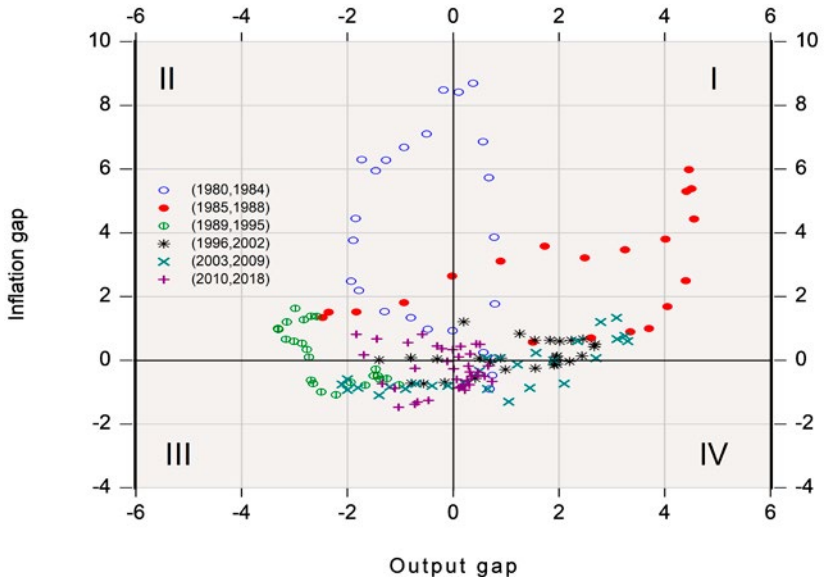


Figure 1.12 Qvigstad plot, output gaps and inflation gaps for Norway, 1980Q1-2018Q4.
Source: Norges Bank Historical Monetary Statistics.

[31] See e.g. Svensson (2006), Rudebusch and Williams (1997), Woodford (2007), Gosselin, Lotz and Wyplosz (2008), Blinder, Ehrmann, Fratzscher, De Haan and Jansen (2008).

[32] The term has also been used by others for example professor Charles Bean, see the Geneva Report 2017 *And Yet It Moves. Inflation and the Great Recession* (Miles et al., 2017, p. 102).

An example for Norway is shown in Figure 1.12. The chart provides a simple but rough assessment of monetary policy, similar to exercises that compare the actual policy interest rate to the predictions from, say, a Taylor rule. It has the advantage of focusing on the things we care about, inflation and real activity, rather than on the setting of the policy instrument in itself. It gives a general sense of the balancing act the central bank has had to make, but it doesn't tell us whether the outcomes are consistent with an optimal policy. Should the points in quadrants II and IV display a steep slope with the output kept close to zero while inflation fluctuates? Or should it have a flat slope, with inflation kept close to target while the output gap fluctuates?[33]

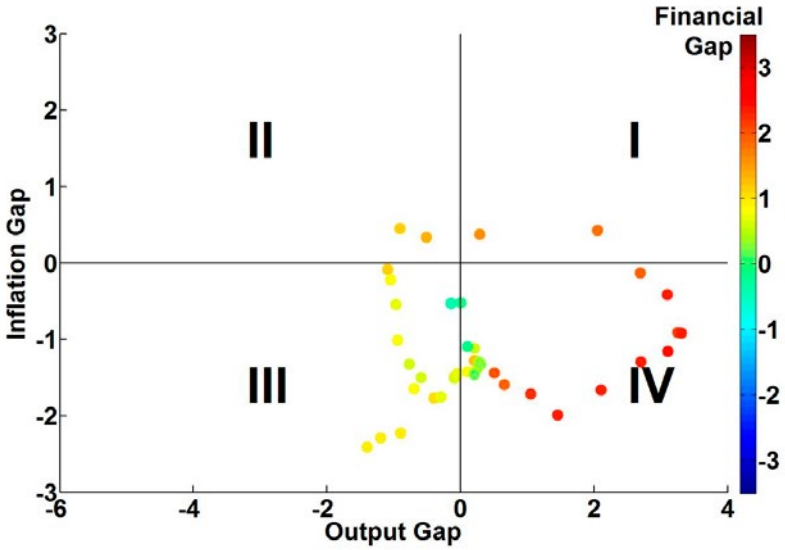


Figure 1.13 Extended Qvigstad plot, output gaps and inflation gaps for Norway, 2004Q1-2013Q4. The figure is extended with financial gaps (right axis)
Source: Norges Bank calculations. Note: The Financial gap is calculated as the first principal component of four financial stability indicators used by Norges Bank (credit to GDP gap, housing price to household income gap, real commercial property gap, wholesale funding gap), where the gaps and principal component are calculated recursively over the sample period.

Figure 1.13 shows a Qvigstad plot for Norway for the ten-year period 2004Q1-2013Q4, but with an additional twist. The plot have been augmented along a third dimension, with a measure of financial stability shown as a heat map using different colors on a blue to red scale, ranging from negative values in blue (no instability) to positive values in red indicating

[33] Charts showing the projected reference paths for inflation and the output gap were included already in the Inflation Report 2005/3. These charts were later amended to visualize the effects of new information and assessments of the inflation and output gap paths. From Monetary Policy Report 2/2019 onwards the charts on inflation and output gap projections are included in a box on model-based interpretation of new information.

increasing degree of financial imbalances.[34] A similar figure was presented in Haldane and Qvigstad (2016). The rationale for adding this third dimension to the plot is the point we have stressed earlier, that low and stable inflation is not by itself sufficient and that it is also necessary to monitor financial imbalances which may be building up and undermine financial stability. Even in cases where monetary policy can be said to be "appropriate" according to criterium 2 above, with dots placed in quadrants II and IV respectively indicating that output gaps and inflation gaps indeed have opposite signs, there is a risk that financial imbalances are building and require attention by policymakers for example by increasing the banks' countercyclical capital buffer.

1.7 Better late than never - reaping the benefits of flexible exchange rates

The inflation targeting regime was already well established in Norway when the financial crisis hit in 2008. Norges Bank was therefore able to benefit from a credible and transparent framework of communication of its policy intentions during the crisis. As we have commented above the monetary policy reports from Norges Bank have, since 2005, presented projections of future policy rates. Figure 1.14 shows all policy rate paths Norges Bank has published from November 2005 until June 2019.

Such projections represent a form of communication that enhances transparency, but more importantly, manages expectations in a manner which resemble monetary policy instruments. When circumstances changed because of the financial crisis, it was therefore relatively straightforward to account for the main factors behind the changes in the interest rate path to guide financial market participants' expectations. In this situation the bank cut interest rates substantially and made several downward revisions of its interest rate path projections (cf. Figure 1.14).

One immediate lesson from the financial crisis, however, was that monetary policy is more than setting the key policy rate. Appropriate and adequate liquidity measures were required to improve the functioning of the financial markets. Troubles started already in 2007. Spillover effects from liquidity problems in dollar markets affected Norwegian banks adversely already in August that year. And the dramatic escalation of the liquidity problems which took place after the Lehman bankruptcy in September 2008 required immediate intervention in the short-term money market by Norges Bank.

The collection of interest rate projections over the past 15 years also reveal the evolution over this period regarding the bank's view on the neutral real interest rate level. The neutral real interest rate is the rate that is neither expansionary nor contractionary, it cannot be observed and must be estimated. Typically, estimates of the neutral interest rate have trended downwards over the past two decades, and, notwithstanding the considerable

[34] Cf. criterion 5 above on financial imbalances. An early reference to this criterion was made already in Borio (2006).

uncertainty of such estimates, the neutral real interest rate in Norway is currently estimated to be close to 0 % (Monetary Policy Report 4/2019, p. 38).[35] Figure 1.14 shows that all projections published prior to around 2011 indicated that the nominal key policy rate was to be gradually brought back to a level around 5 percent. Thereafter the projected nominal interest rate level three years out has shifted significantly downwards, which also reflects the fact that Norway's inflation target was reduced from 2 1/2 to 2 percent in March 2018 (see Table 1.A).

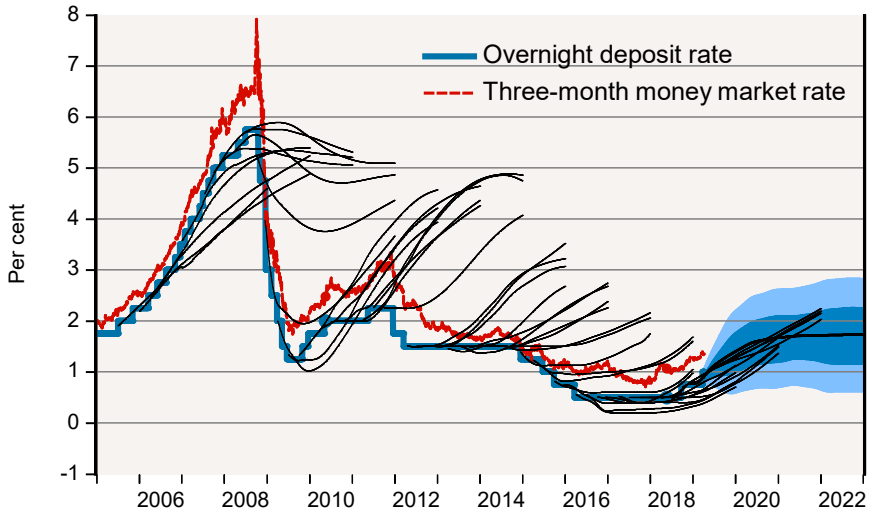


Figure 1.14 Norges Bank's projected interest rate paths 2005Q4-2019Q2.
Source: Norges Bank Monetary Policy Reports issued 2005Q4-2019Q2.

In an international perspective, however, the Norwegian economy and its financial institutions were less affected by the crisis than many other countries and their financial institutions. But Norway was of course indirectly affected, both from the repercussions of the global financial crisis on international trade and the 2008-2009 recession, and later by the European sovereign debt crisis which emerged in 2010 and the extraordinary monetary policy measures which followed.

However, despite the fallout from the global financial crisis, Norway continued to enjoy good export prices, in particular on its oil export, with the exception of a temporary fall in oil prices in 2008. To a large extent this was also the case for other important export

[35] The downward trend in estimates of the neutral real interest rate is a global phenomenon which has been subject to intense debate and analysis in many central banks in recent years, cf. e.g. Rachel and Smith (2015) and Holston, Laubach and Williams (2017), see also the paper by Jordà and Taylor (2019) presented at the recent Jackson Hole symposium, which was organized by the Federal Reserve Bank of Kansas in August 2019. Brubakk, Ellingsen and Robstad (2018) has reported estimates of the neutral real interest rate level in Norway.

products and Norway's terms of trade continued to be very beneficial. This was due to the major pre-crisis structural shifts in the global economy, and the fact that China for long remained an engine of growth in the world economy.

Inflation targeting stood the test of the global financial crisis. The regime provided a framework for a swift turnaround from the tightening monetary policy cycle and also contributed to a decisively more appropriate exchange rate response to the tsunami of uncertainty created by the 2008-2009 crisis than what a fixed exchange rate regime would have done. We have investigated this further in Section 3.5.1 in Chapter 3 using model simulations under alternative assumptions about the monetary policy response to the global financial crisis in 2008. We have compared the outcome for exchange rates under the prevailing inflation targeting regime with that under a counterfactual alternative where any depreciation pressure on the Norwegian currency following the global financial crisis would have been met with increases in the key policy rate in an attempt to stabilize exchange rates at their pre-crisis level. The results indicate that a small open economy like Norway clearly benefited from having a flexible exchange rate regime which allowed for a temporary depreciation of its currency. The counterfactual analysis in Section 3.5.1 shows that a return to the old fixed exchange rate regime would have caused a substantial tightening of monetary policy in order to maintain the exchange rate stable, and would have lowered economic growth and increased unemployment relative to the outcome under the prevailing inflation targeting regime with flexible exchange rates.

The fall in oil prices in 2008 turned out to be temporary. Norway was in this sense subject to good fortune, the domestic economy was soon back on a booming path and Norges Bank became only the second country (after Australia) to tighten monetary policy and increase interest rates again after the 2008 crisis. For a small open economy, however, the room for monetary policy manoeuvre soon proved to be limited by the extraordinary low interest rates which prevailed internationally, and interest rates were further reduced both internationally and in Norway after the European sovereign debt crisis in 2010.

This reminds us of a challenge for monetary policy in a small open economy, that it may turn out as quite procyclical, irrespective of the monetary policy regime in place. We have already seen how this was the case during the fixed exchange rate regime Norway from 1986 until the ERM collapsed in 1992, which led to too tight monetary policy in the early 1990s, and also during the following managed float regime 1994-1998 when interest rates were reduced in late 1996 in an attempt to avoid currency appreciation. In both cases illustrations of counterfactual policy alternatives indicate the potential for less procyclicality and a smoother trajectory for real macroeconomic variables when measured as deviations from their long run trends.

Some years after the global financial crisis the procyclical propensity showed itself again, this time under flexible inflation targeting and floating exchange rates. The combination of high oil prices and low interest rates has led to high trend growth in credit relative to nominal GDP. Notwithstanding the fact that Norges Bank used the freedom to maintain

somewhat higher interest rates than the eurozone, and entertained some currency appreciation, the overall monetary policy stance turned out to yield procyclical outcomes. But the developments since 2014 have also shown that the degree of procyclicality can change rapidly. The strong depreciation of the krone exchange rate that followed after the sharp drop in oil prices in 2014 soon helped monetary policy turn countercyclical, which provided important relief and smoothed the process of adjustments to what turned out to be a persistent fall in oil prices from their previously high levels.

This episode is further investigated in Section 3.5.2 in Chapter 3, again using model simulations under alternative assumptions about the monetary policy response to the drop in oil price level in 2014. The results indicate that a small open economy like Norway clearly benefited from depreciation of its currency following a persistent drop in oil prices. A counterfactual policy which tried to maintain a stable nominal exchange rate at its pre-crisis level would have led to substantially lower economic growth and increased unemployment, and also to significantly lower inflation. However, in contrast to the episode following the global financial crisis in 2008, which was rather temporary, the negative shock to oil prices in 2014 turned out to be persistent. Of course, this was not known at the time when the oil prices dropped in 2014.

So, whereas the contraction following the counterfactual temporary tightening of monetary policy in 2008 had only temporary negative effects on the real economy since the tightening was soon reversed, we found that a similar counterfactual response in 2014, aiming at keeping the exchange rate constant at the pre-crisis level, would turn out to be long-lasting and persistent. One could argue, however, that as the shock turned out to be persistent, this would likely have changed the policy response accordingly. It is therefore admittedly not a very realistic assumption that the policy scenario we have illustrated in Section 3.5.2 would have been maintained over a prolonged period. It is more likely that a permanent negative shock to oil prices instead would have entailed a real exchange rate depreciation. Under flexible exchange rates this could have been achieved through a nominal depreciation of the exchange rate and not only, such as in the counterfactual scenario we have illustrated in Section 3.5.2, through depressed consumer prices.

1.8 Concluding remarks

In a world of high capital mobility and extensive trade, there is certainly limited room for manouvre in monetary policy in a small open economy such as Norway. With floating exchange rates, the domestic interest rate may deviate from the interest rates abroad, but only within limits. An interest rate differential that becomes too wide can have such substantial effects on the exchange rate that gives rise to instability in inflation, output and employment. Thus, the domestic interest rate will also be influenced by external rates to a large extent under an inflation-targeting regime. But by adapting to persistent low interest rates internationally there is of course a potential danger that monetary policy may turn out as

procyclical also under inflation targeting and floating exchange rates, as we saw some years after the global financial crisis.

Even though the domestic interest rate cannot differ too widely from trading partners' rates, the exchange rate has an important role in cushioning the effect of shocks, in particular to the terms of trade. In periods when oil prices have fallen and the economy has entered a period of contraction, the krone exchange rate has depreciated, strengthening competitiveness and preventing inflation from becoming too low. We have illustrated this in this work drawing on two examples, both from recent crisis episodes, the 2008 global financial crisis and the 2014 drop in oil prices.

Despite its widespread adoption, inflation targeting has also been subject of intense debate. The global financial crisis in 2008 was a reminder that price stability is not sufficient to guarantee financial stability. This has raised the question of whether monetary policy, both in general, and within the framework of inflation targeting, should be utilised to a greater extent to counteract the build-up of financial imbalances that may pose a threat to long-run economic stability. The marked decline in global real interest rates in recent decades has reduced the room for manoeuvre in monetary policy and the ability to respond to major adverse shocks.

As long as confidence in the inflation target remain well established, there will be room for some constrained discretion where monetary policy can support changes in the krone exchange rate that have a stabilising effect on the business cycle. And we have presented evidence that the exchange rate channel has been effective in absorbing some of the macroeconomic disturbances in recent crisis episodes, both in the case of the 2008 global financial crisis and the 2014 drop in oil prices. At the same time, the Norwegian krone exchange rate have turned out as relatively stable when compared with those of other inflation-targeting countries that are heavily reliant on commodity-based exports.[36]

References

Akram, Q. F. (2004a). Oil Prices and Exchange Rates: Norwegian Evidence. *Econometrics Journal*, *7*, 476–504.

Akram, Q. F. (2004b). Oil wealth and real exchange rates: The FEER for Norway. Working paper 2004/16, Oslo: Norges Bank.

[36] Cf. Norges Bank (2017) for a discussion of the experiences with the monetary policy framework in Norway since 2001, and the review of flexible inflation targeting in Røisland (2017b). A box (by Drago Bergholt) on optimal inflation targeting in an open economy in Røisland (2017a, pp. 34-37) sheds light on welfare losses under different monetary policy regimes in a small open commodity-exporting country, and report, interestingly enough, the highest welfare losses in the case of a strict fixed exchange rate regime. Alstadheim (2017) discusses aspects of the interaction between monetary policy and financial stability and reminds us that the room for manouvre in monetary policy in small open economies in a crisis rests on having in place a well established reaction pattern for monetary policy before the crisis hits. This would also allow the exchange rate channel to effectively work as a shock absorber and help stabilize the economy, and make procyclical policy effects less likely.

Akram, Q. F. (2019). Oil price drivers, geopolitical uncertainty and oil exporters' currencies. Unpublished paper, Norges Bank (Central Bank of Norway).

Akram, Q. F. and H. Mumtaz (2019). Time-Varying Dynamics of the Norwegian Economy. *Scandinavian Journal of Economics*, *11*, 279–292.

Alstadheim, R. (2016). Exchange rate regimes in Norway 1816-2016. Staff Memo 15/2016, Norges Bank, Oslo.

Alstadheim, R. (2017). Hensynet til finansiell stabilitet i pengepolitikken. In Røisland, Ø. (ed.), *Review of Flexible Inflation Targeting [In Norwegian]*, Occasional Papers No. 51, Ch. 5, 135–146. Norges Bank, Oslo.

Andersson, J. and L. Jonung (2018). Lessons for Iceland from the Monetary Policy of Sweden. Working Paper 16, University of Lund.

Bårdsen, G., Ø. Eitrheim, E. S. Jansen and R. Nymoen (2005). *The econometrics of macroeconomic modelling*. Oxford University Press.

Bauer, M. D. and C. J. Neely (2014). International channels of the Fed's unconventional monetary policy. *Journal of International Money and Finance*, *44*, 24–46.

Berg, T. N. and C. Kleivset (2014). Inflasjonsstyring - et dokumentasjonsnotat om enkelte metodeendringer som har funnet sted i Norges Bank i perioden 2001-2013. Staff Memo 5/2014, Norges Bank.

Bernhardsen, T., Ø. Eitrheim, A. S. Jore and Ø. Røisland (2005). Real-time data for Norway: Challenges for monetary policy. *The North American Journal of Economics and Finance*, *16*, 333–349.

Bjørnstad, R. and E. S. Jansen (2007). The NOK/euro exchange rate after inflation targeting: The interest rate rules. Discussion Papers 501, Oslo: Statistics Norway.

Bjørnland, H. C. and H. Hungnes (2006). The importance of interest rates for forecasting the exchange rate. *Journal of Forecasting*, *25*, 209–221.

Blinder, A., M. Ehrmann, M. Fratzscher, J. De Haan and D.-J. Jansen (2008). Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence. *Journal of Economic Literature*, *46*, 910–945.

Borio, C. (2006). Monetary and prudential policies at a crossroads? New challenges in the new century. BIS Working Papers No. 216, Basle: BIS.

Brubakk, L., J. Ellingsen and Ø. Robstad (2018). Estimates of the neutral rate of interest in Norway. Staff Memo 8/2018, Norges Bank, Oslo.

Brubakk, L., T. A. Husebø, J. Maih, K. Olsen and M. Østnor (2006). Finding NEMO: Documentation of the Norwegian Economy MOdel. Staff Memo 2006/6, Norges Bank.

Christiansen, A. B. and J. F. Qvigstad (1997). *Choosing a monetary policy target*. Oslo: Scandinavian University Press.

Cobham, D., Ø. Eitrheim, S. Gerlach and J. F. Qvigstad (eds.) (2010). *Inflation Targeting. Lessons Learned and Future Prospects*. Cambridge: Cambridge University Press.

Corsetti, G., K. Kuester and G. J. Müller (2018). The Case for Flexible Exchange Rates after the Great Recession. *Sveriges Riksbank Economic Review*, (1), 38–47.

Ehrmann, M., M. Fratcher and R. Rigobon (2011). Stocks, bonds, money markets and exchange rates: measuring international financial transmission. *Journal of Applied Econometrics*, *55*, 275–298.

Eitrheim, Ø. and B. Gulbrandsen (2001). A model based approach to analysing financial stability. *BIS Paper No. 1*.

Eitrheim, Ø., T. A. Husebø and R. Nymoen (1999). Error-correction versus differencing in macroeconometric forecasting. *Economic Modelling*, *16*, 515–544.

Eitrheim, Ø., T. A. Husebø and R. Nymoen (2002). Empirical comparison of inflation models' forecast accuracy. In Clements, M. P. and D. F. Hendry (eds.), *A Companion to Economic Forecasting*. Oxford: Blackwell Publishers Ltd.

Eitrheim, Ø., J. T. Klovland and L. F. Øksendal (2016). *A Monetary History of Norway 1816-2016*. Cambridge University Press.

Eitrheim, Ø. and J. F. Qvigstad (1999). Monetary policy rules in Norway. A counterfactual experiment using the Norges Bank macroeconometric model RIMINI. Unpublished manuscript, Norges Bank.

ter Ellen, S. (2016). Nonlinearities in the relationship between oil price changes and movements in the Norwegian krone. Staff Memo 18/2016, Norges Bank, Oslo.

ter Ellen, S., E. Jansen and N. L. Midthjell (2018). ECB spillovers and domestic monetary policy effectiveness in small open economies. Working Paper 9/2018, Norges Bank.

Friedman, M. (1953). The Case for Flexible Exchange Rates. In *Essays of Positive Economics*.

Gopinath, G. (2017). Rethinking Macroeconomic Policy: International Economy Issues. Prepared for the conference on "Rethinking Macroeconomic Policy IV" organized by the Peterson Institute on International Economics.

Gosselin, P., A. Lotz and C. Wyplosz (2008). The Expected Interest Rate Path: Alignment of Expectations vs. Creative Opacity. *International Journal of Central Banking*, *4*(3), 145–185.

Haldane, A. and J. F. Qvigstad (2016). The Evolution of Central Banks - A Practitioner's Perspective. In Bordo, M. D., Ø. Eitrheim, M. Flandreau and J. F. Qvigstad (eds.), *Central Banks at a Crossroads: What Can We learn From History?*, chap. 15. Cambridge University Press.

Haldane, A. G. (1997). The monetary framework in Norway. In Christiansen, A. and J. Qvigstad (eds.), *Choosing a Monetary Policy Target*, 67–108. Oslo: Scandinavian University Press.

Hamilton, A. (2018). Understanding Exchange Rates and Why They Are Important. Bulletin, Reserve Bank of Australia.

Holston, K., T. Laubach and J. C. Williams (2017). Measuring the Natural Rate of Interest: International Trends and Determinants. *Journal of International Economics*, *108*(S1), S59–S75.

IMF (2019). Annual Report on Exchange Arrangements and Exchange Restrictions 2018. Tech. rep., International Monetary Fund.

Jordà, Ò. and A. M. Taylor (2019). Riders on the Storm. Presented at the Federal Reserve Bank of Kansas City Economic Policy Symposium "Challenges for Monetary Policy", Jackson Hole, Wyoming, August 2224, 2019.

Jore, A. S. (2017). Revisions of national accounts. Staff memo 6/2017, Norges Bank.

Kalemli-Özcan, Ş. (2019). U.S. Monetary Policy and International Risk Spillovers. Prepared for the Jackson Hole Economic Policy Symposium Federal Reserve Bank of Kansas City Augus 23-25, 2019.

Kleivset, C. (2012). Fra fast valutakurs til inflasjonsmål: Et dokumentasjonsnotat om Norges Bank og pengepolitikken 1992-2001. Staff Memo 30/2012, Norges Bank.

Klovland, J. T. (1995). Valutasystemer, pengepolitikk og konjunkturutvikling: De historiske bånd til Europa. In Norman, V. D. (ed.), *Europa: Forskning om økonomisk integrasjon (SNF årbok 1995)*, 133–168. Fagbokforlaget, Bergen.

Lie, E. (2020). *Norges Bank 1816-2016*. Oxford University Press (forthcoming).

Lie, E., J. T. Kobberrød, E. Thomassen and G. F. Rongved (2016). *Norges Bank 1816-2016*. Fagbokforlaget.

Lowe, P. (2019). Remarks at Jackson Hole Symposium, 25 August 2019. Panel participation by Philip Lowe, Governor, at the Jackson Hole Symposium, Wyoming, USA.

Miles, D., U. Panizza, R. Reis and A. Ubide (2017). And Yet It Moves. Inflation and the Great Recession. Geneva Reports on the World Economy 19, ICMB INternational Center for Monetary and Banking Studies.

Mimir, Y. and E. Sunel (2019). External Shocks, Banks, and Optimal Monetary Policy: A Recipe for Emerging Market Central Banks. *International Journal of Central Banking*, *15*(2), 235–239.

Mork, K. A. (1992). Valutapolitikk og ytringsfrihet [Foreign exchange policy and the freedom of speech]. Reply in the newspaper Dagbladet 1 December 1992.

Murray, J. (1997). Comments on "Monetary policy in Norway - experience since 1992". In *Monetary Policy in the Nordic Countries: Experiences since 1992*, 133–139. Bank for International Settlements.

Mussa, M. (1994). Some Reflections on Exchange Rate Policy for Smaller Countries. In Storvik, K., Berg, S. A. and J. F. Qvigstad (eds.), *With an Eye for Stability and the Long Run [Stabilitet og langsiktighet] - Festschrift for Hermod Skånland*, 394–413. Oslo: Aschehoug.

Nicolaisen, J. and J. F. Qvigstad (1997). Monetary policy in Norway - experience since 1992. In *Monetary Policy in the Nordic Countries: Experiences since 1992*, 101–132. Bank for International Settlements.

Norges Bank (2017). Experience with the monetary policy framework in Norway since 2001. Norges Bank Paper No. 1/2017, Norges Bank.

Olsen, K. and F. Wulfsberg (2001). The role of assessments and judgement in the macroeconomic model RIMINI. *Economic Bulletin [Norges Bank]*, *72*, 55–64.

Orphanides, A. (2010). Reflections on inflation targeting. In Cobham, D., Ø. Eitrheim, S. Gerlach and J. F. Qvigstad (eds.), *Inflation Targeting. Lessons Learned and Future Prospects*, chap. 3, 13–24. Cambridge: Cambridge University Press.

Qvigstad, J. F. (2001). Monetary policy in real time. Working Paper 2001/1, Norges Bank.

Qvigstad, J. F. (2005). When does an interest rate path "look good"? Criteria for an appropriate future interest rate path - A practitian's approach. Staff Memo 2005/6, Norges Bank.

Qvigstad, J. F. (2006). When does an interest rate path "look good"? Criteria for an appropriate future interest rate path. Working Paper 2006/5, Norges Bank.

Qvigstad, J. F. and A. Skjæveland (1994). Exchange rate regimes - Historical experience and future challenges [Valutakursregimer - Historiske erfaringer og fremtidige utfordringer] (in Norwegian). In Storvik, K., Berg, S. A. and J. F. Qvigstad (eds.), *With an Eye for Stability and the Long Run [Stabilitet og langsiktighet] - Festschrift for Hermod Skånland*, 235–271. Oslo: Aschehoug.

Rachel, L. and T. D. Smith (2015). Secular drivers of the global real interest rate. Staff Working Paper 571.

Rey, H. (2016). International Channels of Transmission of Monetary Policy and the Mundellian Trilemma. *IMF Economic Review*, *64*(1), 6–35.

Røisland, Ø. (2017a). Inflasjonsmål og alternative styringsmål. In Røisland, Ø. (ed.), *Review of Flexible Inflation Targeting [In Norwegian]*, Occasional Papers No. 51, Ch. 2, 13–46. Norges Bank, Oslo.

Røisland, Ø. (ed.) (2017b). *Review of Flexible Inflation Targeting [In Norwegian]*. Occasional Papers No. 51. Norges Bank, Oslo.

Rose, A. K. (2014). Surprising Similarities: Recent Monetary Regimes of Small Economies. *Journal of International Money and Finance*, *49*(Part A), 5–27.

Rudebusch, G. D. and J. C. Williams (1997). Revealing the Secrets of the Temple: The Value of Publishing Interest Rate Projections. Unpublished paper from the Federal Reserve Bank of San Fransisco.

Schembri, L. (2001). Conference Summary: Revisiting the Case for Flexible Exchange Rates. Bank of Canada Review Autumn 2001, Bank of Canada.

Schembri, L. (2019). Flexible Exchange Rates, Commodity Prices and Price Stability. Tech. rep., Bank of Canada. Towards 2021: Reviewing the Monetary Policy Framework. Remarks by Lawrence Schembri, Deputy Governor of the Bank of Canada, Economics Society of Northern Alberta, Edmonton, Alberta, June 17, 2019.

Schmidt-Hebbel, K. (2010). Inflation targeting twenty years on: where, when, why, with what effects and what lies ahead? In Cobham, D., Ø. Eitrheim, S. Gerlach and J. F. Qvigstad (eds.), *Inflation Targeting. Lessons Learned and Future Prospects*, chap. 5, 57–89. Cambridge: Cambridge University Press.

Skånland, H. (1999). Norway and the euro. Working Papers 8/1999, Norwegian School of Management, Centre of Monetary Economics.

Steigum, E. (1992). Wealth, structural adjustment and optimal recovery from the Dutch disease. *Journal of International Trade & Economic Development*, *1*, 27–40.

Straumann, T. (2010). *Fixed Ideas of Money: Small States and Exchange Rate Regimes in Twentieth-Century Europe*. Cambridge University Press, Cambridge.

Sullivan, R. (2013). Exchange rate fluctuations: How has the regime mattered? Bulletin Vol. 76 2, Reserve Bank of New Zealand.

Svensson, L. E. O. (1999). Inflation Targeting: Some Extensions. *Scandinavian Journal of Economics*, *101*(3), 337–361.

Svensson, L. E. O. (2006). The instrument-rate projection under inflation targeting: The Norwegian example. In Gran, G. (ed.), *Stability and Economic Growth: The Role of Central Banks*. Banca de Mexico.

Sveriges Riksbank (2016). Monetary policy minutes. December 2016. Tech. rep., Sveriges Riksbank.

Tillmann, P. (2016). Unconventional monetary policy and the spilllovers to emerging markets. *Journal of International Money and Finance*, *66*, 136–156.

Vårdal, E. (1998). Review of Christiansen, A. B. and J. F. Qvigstad (eds.): Choosing a monetary policy target. *Sosialøkonomen*, (4), 30–31.

Vredin, A. (2017). Norwegian monetary policy seen from abroad. In *Erfaringer med inflasjonsmål for pengepolitikken*, Working Paper 2017/10, 59–76. Ministry of Finance.

Walsh, C. E. (2014). Multiple Objectives and Central Bank Tradeoffs under Flexible Inflation Targeting. Working Papers 5097, CESifo.

Woodford, M. (2007). Forecast targeting as a monetary policy strategy: Policy rules in practice. NBER Working Paper No. 13716, NBER.

1.A Changes in Norway's exchange rate regime, 1986–2018

Table 1.A.1 provides an updated overview of changes in Norway's exchange rate regime since 1982. The table corresponds to the final part of Table 1.3 in Eitrheim, Klovland and Øksendal (2016, p. 44). The original version of this table is due to Ragna Alstadheim, a Senior Researcher in Norges Bank, and appeared in Qvigstad and Skjæveland (1994) (in Norwegian), in a Festschrift for previous Norges Bank Governor Hermod Skånland. A translated and slightly edited and extended version, is also available in Alstadheim (2016) at Norges Bank's web-site.

Table 1.A1 Changes in Norway's exchange rate regime, 1982–2018

Date	Adjustment	Commentary
	Changes in Norway's exchange rate regime since 1982	
2 Aug 1982	Weights in the krone exchange rate index changed while retaining base exchange rates. Results in a downward adjustment of the krone by about 3.5 per cent given the prevailing exchange rate relationships.	The new weights were based on IMF weights for export industry competitiveness. The US dollar weight was reduced from 25 to 11 per cent, counteracting the loss of competitiveness due to a rising dollar.
6 Sep 1982	Krone devalued by 3 per cent.	The krone was devalued by adjusting the base exchange rates, and the devaluation was part of economic policy for 1983. The primary aim was to improve business sector competitiveness.
2 July 1984	Transition from arithmetic to geometric average for calculation of krone exchange rate index. Base rates kept unchanged. Results in a downward adjustment of the krone by about 2 per cent given the prevailing exchange rate relationships.	The primary reason for the adjustment was that the rising US dollar had resulted in an unintentional increase in the dollar's effective basket weight. When a geometric average is used, nominal and effective rates coincide.

Table 1.A1 Changes in Norway's exchange rate regime, 1982–2018 (cont'd)

22 Sep 1984	Decision to keep the krone exchange rate index at a level about 2 percentage points higher than previously, for the time being. The target rate remains unchanged and the krone is kept within the current fluctuation margins. In practice, the fluctuation band narrows.	The change was introduced in an effort to counteract the effects of what was considered a temporary US dollar appreciation on competitiveness for Norwegian firms in non-dollar markets.
9 Aug 1985	Fluctuation margins at 2.25 per cent are publicly disclosed.	The krone exchange rate system was formalised in the regulation of 12 August 1985. The target value was set at 100, but with the aim of keeping the krone weak and within the band, the exchange rate was normally between 101.13 and 102.25.
11 May 1986	The target value of the exchange rate index is changed from 100 to 112, resulting in a depreciation of the krone by 9.2 per cent from the 1985 level.	The adjustment was made because of a sharp reversal from a current account surplus to a deficit, partly as a result of lower oil prices and partly due to strong growth in domestic demand and lost cost competitiveness. The adjustment followed a period of substantial interventions by Norges Bank to counteract a depreciation of the krone.
2 Dec 1986	Norges Bank decided to raise its key policy interest rate from 14 to 16 percent to stabilise the krone exchange rate.	The authority over the key policy interest rate had been returned to the central bank.
22 Oct 1990	Krone pegged to the European currency unit (ecu).	The government aimed to link the krone more closely to the European Monetary System (EMS). Norges Bank established swap agreements that gave access to short-term credit for intervention purposes up to a total of ecu 2 billion from European Community (EC) central banks.

Table 1.A1 Changes in Norway's exchange rate regime, 1982–2018 (cont'd)

Date	Adjustment	Commentary
10 Dec 1992	Norwegian krone allowed to float. A royal decree of 8 January 1993 confirmed the floating exchange rate regime.	Earlier in the autumn, the British pound, Italian lira, Finnish markka and Swedish krona were allowed to float after persistent and substantial pressure. The Norwegian krone eventually came under such intense pressure that the fixed exchange rate could no longer be maintained. The government's objective was to return to a fixed exchange rate when international conditions permitted.
6 May 1994	A new exchange rate regulation was given in a royal decree. In practice a managed float regime.	Norges Bank's conduct of monetary policy was to be aimed at maintaining a stable krone exchange rate against European currencies, based on the range of the exchange rate maintained since the krone was floated on 10 December 1992.
10 Jan 1997	Norges Bank discontinued interventions temporarily.	Following a considerable appreciation pressure against the krone, Norges Bank intervened massively in the first days of January 1997. Interventions to stabilise the exchange rate were resumed in June 1997.
24 Aug 1998	Norges Bank discontinued interventions temporarily.	Norges Bank increased the interest rate to 8 percent and announced that there would be no further changes in monetary policy instruments for the time being. Interventions to stabilise the exchange rate were resumed in October 1998.
1 Jan 1999	Norges Bank started to use the euro as indicator of the krone's value against "European currencies".	The euro was introduced as a common currency in 11 EU countries.
4 Jan 1999	De facto inflation targeting.	The de facto introduction of inflation targeting in Norway is usually associated with Svein Gjedrem taking over the helm as governor of Norges Bank in January 1999.

Table 1.A1 Changes in Norway's exchange rate regime, 1982–2018 (cont'd)

29 Mar 2001	De jure inflation targeting, with a target of 2 1/2 percent over time, was introduced. A floating exchange rate regime replaced the managed float regime of the 1990s.	In addition to this codification of the inflation targeting regime, an operational fiscal policy rule was also introduced: all oil revenues should be channelled to the sovereign wealth fund, to be invested abroad. As a benchmark rule, only the real return of the fund (estimated at 4 percent) should be used annually, as an average over time.
2 Mar 2018	A revised inflation target, with a target of 2 percent over time, was introduced.	In their press release the Ministry of Finance stated that "Inflation targeting shall be forward-looking and flexible so that it can contribute to high and stable output and employment and to counteracting the build-up of financial imbalances".

1.B Counterfactual monetary policy - analytical framework

1.B.1 Norges Bank's macromodel in the 1990s - RIMINI

Norges Bank's macromodel RIMINI was used as a tool for making medium term projections from 1992 until 2003. The main channels of monetary transmission in RIMINI, i.e. its numerous and often rather complex interest rate and exchange rate channels, are briefly illustrated in Figure 2.13 and Figure 2.14 in Section 2.B in Chapter 2,[37] together with a brief overview over the empirical price and wage model in RIMINI. A summary of the empirical model of household behaviour in RIMINI is available in Eitrheim and Gulbrandsen (2001), which illustrates the simultaneous determination of real house prices and household debt. A conditional submodel of recorded bank losses is also presented together with an overview over indicators of financial fragility in RIMINI. A more comprehensive presentation of the empirical research program underlying the RIMINI model is available in Bårdsen, Eitrheim, Jansen and Nymoen (2005). The forecasting properties of this class of models is discussed, *inter alia* in Eitrheim et al. (1999), Eitrheim et al. (2002) and Bårdsen et al. (2005). The RIMINI model was primarily used as a tool to help produce conditional projections of a fairly comprehensive set of macroeconomic variables for given paths of the key policy rate and the exchange rate. In the baseline version of the model the two main monetary policy variables, i.e. the key policy interest rate and the effective exchange rate were given exogenous values. In the counterfactual simulations which were discussed in (Eitrheim and Qvigstad, 1999) both these policy variables were endogenised. More specifically, we let monetary policy be represented with a Taylor rule for the key policy rate and we added a simple type of response mechanism for the nominal exchange rate assuming a simple Uncovered Interest Parity (UIP) condition. Expected exchange rate changes were thus driven by the interest rate differential between Norway and the euro-area average, adjusted for a risk premium.

In the counterfactual exercise in chapter 2 we also considered alternative exchange rate scenarios, for different assumptions regarding the risk premium, taking into consideration the possibility that the new monetary policy regime would not have been regarded as credible as early as in 1990. These scenarios were formulated such that the transition to inflation targeting, as represented with a simple Taylor rule for the key policy rate, would have led to capital outflow and currency depreciation. Under the most optimistic reference scenario without any extraordinary currency depreciation, the two main drivers of the key policy rate, the inflation gap and the output gap would, on average, have given rise to immediate and significant reductions of the interest rate, yielding around 300 basis point lower interest rates during the four years 1990-1993. Although the currency depreciation under the alternative scenarios would have rendered alternative paths for the inflation gap, pointing in the direction of higher interest rates, the scenarios we considered would all have rendered substantially lower interest rates compared with the interest rates under the prevailing fixed exchange rate regime.

[37] Eitrheim and Qvigstad (1999)

1.B.2 Norges Bank's macromodel in the 2000s - NEMO

The introduction of inflation targeting (1999-2001) paved the ground for a change in Norges Bank's macroeconomic toolkit. The RIMINI model which had been used to make medium term projections since 1992 was replaced with other models in 2003 and a project was initiated in the Monetary Policy Wing of the bank to develop a new macroeconomic core model, see Berg and Kleivset (2014) for details. A small scale model dubbed Model-1A was soon developed and used for monetary policy analysis, basically a prototype version of the textbook new-Keynesian model which determined four key macroeconomic variables, the rate of inflation, the output gap, the nominal exchange rate and the nominal short term interest rate. The dynamics in Model 1A was calibrated to match the prevailing views in the bank on the dynamic transmission from interest rate changes to the real economy and consumer prices. Model 1A was useful as a first step but also proved insufficient to cover many types of model applications due to its overly simplistic structure. The next step was to develop a more complete new-Keynesian DSGE model. This work benefitted from close cooperation with experts from IMF, using the IMF Global Economy Model (GEM) as a template for model development. However, model development takes time, so also in this case, and the first version of NEMO was first launched in 2006, see Brubakk, Husebø, Maih, Olsen and Østnor (2006) for details. Since 2008 NEMO has been the bank's core macroeconomic model (Berg and Kleivset, 2014).

2

Monetary policy in Norway - A counterfactual view on the 1990s

Øyvind Eitrheim and Jan Fredrik Qvigstad

Monetary policy rules in Norway - A counterfactual experiment using the Norges Bank macroeconometric model RIMINI

by Øyvind Eitrheim and Jan F. Qvigstad[1]
Original text as of June 28th, 1999

Abstract

The paper reports on counterfactual model simulations used to analyse the potential effects of alternative monetary policy rules, such as standard Taylor rule reaction functions for the short-run interest rate. When applied to the period 1990-1996, this creates a temporary downward shift in nominal interest rates when compared to the historical path. Given the considerable uncertainty about the effects on exchange rates of such a counterfactual policy, we have considered four sets of different assumptions, ranging from no effect at all to a strong immediate currency depreciation followed by a gradual strengthening of the currency back to its reference level. The analysis has been made within the framework of Norges Bank's macroeconometric model RIMINI. For the purpose of the paper, the model has been extended to include a submodel for financial sector losses assumed to be explained by key macroeconomic indicators of financial fragility, such as the debt service to income ratio, real housing prices and the level of unemployment.

Keywords and phrases: Econometric models, macroeconomics, monetary policy rules, financial sector losses.

[1] When this paper was written two decades ago in 1999 the first author was head of research in the Research Department, Norges Bank (the Central Bank of Norway) and the second author was chief economist and executive director in Norges Bank and industrial professor at the Center for Monetary Economics (CME), the Norwegian School of Management (BI), Oslo.
The paper was widely circulated and presented at seminars in central banks including Norges Bank, Sveriges Riksbank, Finland's Bank, Danmark's Nationalbank, Bank of England, Swiss Nationalbank, the Bundesbank and at the Center for Monetary Economics (CME), the Norwegian School of Management (BI). The authors received comments from many colleagues including Arne Jon Isachsen, Hermod Skånland, Fredrik Wulfsberg and numerous seminar participants. Students and colleagues in Norges Bank, Jan S. Helgesen, Tore A. Husebø, Inger Anne Nordal and Elin Vandevjen helped with collecting data on financial sector losses.

2.1 Introduction

The increased attention in recent years among policymakers and academics on the formulation and evaluation of monetary policy rules has resulted in a mushrooming literature on these issues. In the first half of 1998 alone there have been three international conferences on monetary policy rules organised by NBER in Florida (January 1998), BIS/CEPR in Basle (January 1998), and IIES/Sveriges Riksbank in Stockholm (June 1998). In Norway, the proceedings of a related seminar in June 1997, on the choice of a monetary policy target, were recently published in Christiansen and Qvigstad (1997).

In this paper we have used the Norges Bank quarterly macroeconometric model RIMINI as a vehicle to illustrate how alternative monetary rules, like the interest rate rules suggested in Taylor (1993), perform when applied to counterfactual model simulations in the period from 1990 Q1 to 1996 Q4. In addition, we have extended the model to include a simple submodel for financial sector losses which provides a link between monetary policy and macroeconomic behaviour on the one hand, and indicators of financial fragility and loan losses on the other.

The paper is organised as follows. In Section 2 we provide a historical perspective on macroeconomic development in Norway from the mid-1980s to the mid-1990s. In Section 3 we provide an outline of the macroeconometric model RIMINI, in particular the important elements of the monetary transmission mechanism. Section 4 contains a brief documentation of the empirical results for financial sector losses. The counterfactual model simulations are discussed in Section 5. Finally, Section 6 contains a short summary and we point out some directions for future work.

2.2 Historical perspective on the decade from the mid-1980s to the mid-1990s

In the mid-1980s, the Norwegian economy experienced a very strong domestic-led expansion similar to developments in many other countries, *inter alia* Sweden and Finland. Expansionary monetary policy, notably in the form of very low interest rates, contributed to this expansion, as did the deregulation of the credit markets in the early 1980s. The bubble had to burst sooner or later, but in Norway it was punctured rather early by the fall in oil prices at the end of 1985, which led to adverse terms of trade effects between 1985 and 1986 in the range of -17.5%. At the same time, the growth rate of Norway's real GDP was sharply reduced, from 6.5 to 3 per cent. As a consequence, fiscal policy was tightened in order to adjust domestic absorption to the new income level, and the Norwegian krone was devalued by 9.2 per cent in May 1986. The tightening in the structural fiscal deficit amounted to 4 1/2 percent of GDP accumulated over the years 1986, 1987 and 1988.

From 1978 to 1986 monetary policy had been accommodating. Even though the formal

exchange rate system was based on a fixed exchange rate, the currency had been adjusted 9 times. So in 1986, when the authorities declared that this was the last time the krone was to be devalued - that a fixed exchange rate really meant fixed - the markets took some time to acknowledge it. Credibility is easily lost and hard to gain. The risk premium in short-term interest rates was high in 1986 (7 percentage points), but was steadily reduced to roughly zero in 1990. The long-term exchange rate risk premium did not vanish until 1993. The inflation rate in Norway was much higher than that of Norway's main trading partners after the devaluation in 1986, but Norway's subsequent tight economic policy stance and anti-inflation policy brought inflation down and into line with the "outside" world in 1989. The current account deficit, which rose to 7 percent of GDP in 1986, was reversed to a surplus in 1989.

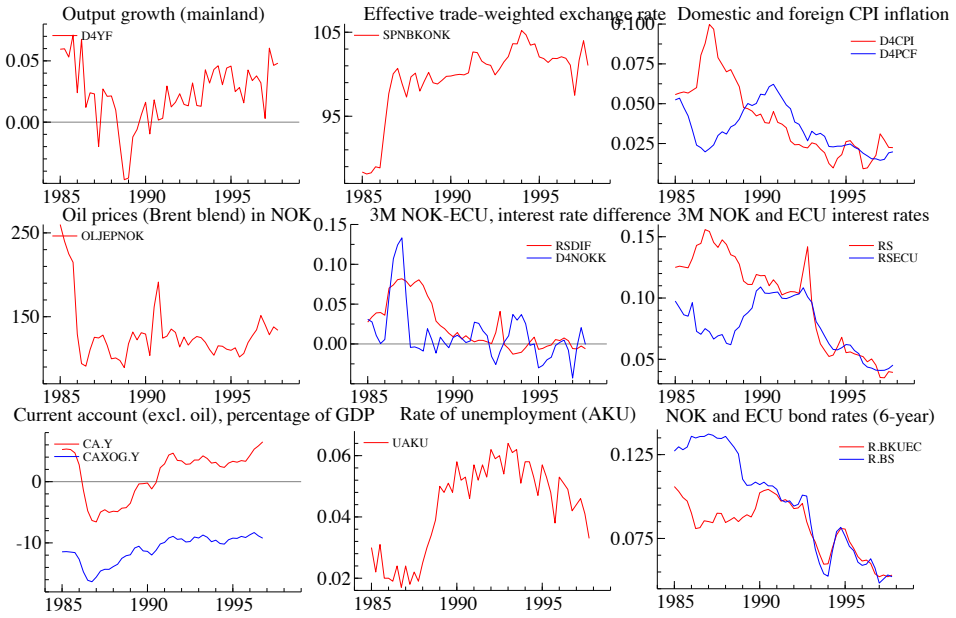


Figure 2.1 Macroeconomic variables for Norway from 1985 Q1 to 1997 Q4.

Several financial sectors, but the banking sector in particular, experienced severe problems in the early 1990s, following the rapid credit expansion in the mid-1980s. The deep economic recession from 1987 to 1990 (mainland GDP was reduced by 1.5 percent during the period) contributed to an increasing stock of non-performing loans, and ultimately to a dramatic buildup in recorded financial sector losses. The operating results for both commercial banks and savings banks were negative in these years, and the guarantee funds of the two bank groups, as well as the government were subsequently led to organise rescue operations for several small and large banks.

In 1990 the macroeconomic balance was more or less back in place. Most observers felt that the Norwegian economy was set for an upturn. The general feeling was that the fight against high inflation had been won and that it was time to increase the level of ambition. Instead of the currency being pegged to that of Norway's main trading partners, it was linked to the ECU, a currency area which was considered to have a more credible track record of lower inflation than that of Norway's trading partners.

The upturn did not materialise, however. One reason may have been that the domestic economy was in deeper trouble than was generally realised. Another contributing factor was German unification, and the tighter monetary policy that followed. Through the ECU link, the Norwegian economy imported this tighter monetary policy.

The Norwegian domestic economy did not start its real cyclical upturn until 1993, fuelled by the expansionary monetary policy imported from continental Europe. After the speculative attacks on the Scandinavian currencies through 1992, first Finland, then Sweden, and finally Norway had to give up their fixed exchange rates. Norway abandoned its fixed exchange rate on 10 December 1992, and has since then pursued a dirty float, stabilising the krone in relation to the ECU as formalised in a Royal Decree of May 1994. Immediately after the decoupling of the NOK, the currency depreciated by some 5 percent. Krone short-term interest rates shadowed European interest rate reductions through 1993. Since 1993, the Norwegian economy has been growing at a rate of close to 4 percent, with low inflation and current account surpluses.

The upturn in the Norwegian economy, was thus delayed for three crucial years, and did not materialise until 1993. In the meantime, the Norwegian economy experienced a severe banking crisis. Three of the largest banks (all commercial banks) lost all their capital and could only continue to operate with the aid of new capital injected by the government.

Norway has traditionally had a monetary policy regime geared towards exchange rate stability (see Qvigstad and Skjæveland (1994) for an overview). That has been the ideology ever since the founding of the central bank in 1816. There have been shorter periods with a floating exchange rate, but only because it was impossible to maintain stable exchange rates, and these periods were used to reestablish fixed rates. In Norway, as well as in the other Scandinavian countries, the discussion of an alternative monetary policy regime, such as inflation targeting, did not arise until the collapse of the fixed exchange rate regimes in 1992. See for example Qvigstad and Skjæveland (1994) and an article in Norges Bank's Economic Bulletin no. 2/1994 on international experience of inflation targeting. Even Professor Lars Svensson, who now advocates inflation targeting, was a strong defender of fixed exchange rates in this period.

Clearly then, asking how economic developments in the first half of the 1990s would have been under alternative monetary policy regimes has an aspect of hindsight to it. In 1990 the exchange rate regime had been successful in winning back the credibility of monetary policy - an anchor had been established. But the question is still an interesting one: What would have been the outcome for the Norwegian economy in general and the banking sector

in particular if the Norwegian authorities had adopted the idea of inflation targeting in 1990, which, although still in its embryonic state, had been implemented in countries like New Zealand, Canada and considered with greater interest by others?

One important caveat with such a monetary policy shift relates to the credibility of the new regime. Despite the relative success of maintaining stable exchange rates during the four preceding years, a regime of inflation targeting could have been interpreted as a return to the accommodating monetary policy of 1978-86. We do not question the exchange rate regime of 1986-1990, but rather ask what was the optimal regime of the 1990s. A related question is whether a new institutional framework for the central bank, designed to underpin its credibility, would have been called for - even though the existing Norges Bank Act can also serve as a basis for inflation targeting, see Skånland (1998) for a discussion.

To perform this counterfactual experiment, we use the Norges Bank macroeconometric model RIMINI. This model is used operationally in Norges Bank to forecast macroeconomic developments, and is used, *inter alia*, in conjunction with the projections published in the official Inflation Report.

The implementation of an alternative monetary policy regime in this counterfactual framework obviously calls for many additional assumptions, and also raises a number of very important questions related to the robustness of the model to such a shift. In the following we have abstracted from the fact that changes in the monetary policy regime can affect the

- formulation of fiscal policy. Some authors have argued that inflation targeting provides less disciplinary incentives on fiscal policy compared with an exchange rate regime.
- incomes policy. Norway has a strong tradition of centralised wage formation, and it is frequently argued that incomes policies like the "solidarity alternative" are deeply rooted in the prevailing exchange rate regime.

Some of these hypotheses may have testable implications, in the sense that a change in monetary policy regime may lead to fundamental changes in e.g. the system for wage formation. In the language of econometricians, a shift in the monetary policy regime could potentially be at odds with the super exogeneity assumptions needed for valid policy analysis (Ericsson (1994)), and provide us with a case for testing the empirical relevance of the Lucas critique (Ericsson and Irons, 1995).

We also use the model to analyse the consequences for the banking sector of alternative monetary regimes. We start the counterfactual analysis in 1990 and end it in 1996 - a year in which all the different monetary policy regimes would probably have generated a fairly similar short-term interest rate, i.e. close to the same value for the central bank's operating instrument.

2.3 The macroeconometric model RIMINI

The macroeconometric model RIMINI[2] is used by forecasters in Norges Bank in their preparation of the quarterly inflation reports and the medium-term (5-year) projections for the Norwegian economy. Although the model is mainly used as a projection tool, it has become increasingly used by policymakers to analyse the effects of alternative scenarios for key exogenous variables, such as the growth in international markets and world market prices, in particular the price (in USD) of crude oil. It is also frequently used to assess the effects of changes in key monetary policy variables like short-term interest rates and exchange rates, which are exogenous variables in the baseline version of the model.

RIMINI can be regarded as a fairly aggregated macroeconometric model. As the model stands today it has 357 endogenous variables, although a large fraction of these are accounting identities or technical relationships creating links between variables. The core model comprises about 30 stochastic equations, and there are about 100 non-trivial exogenous variables which must be projected by the forecaster. The oil and shipping sectors are treated exogenously in the model, as are agriculture, forestry and fisheries. The rest of the private non-financial sector is divided between the manufacturing and construction sectors (producers of traded goods) and services and retail trade (producers of non-traded goods).

The main links between short-term interest rates and exchange rates and aggregated variables like output, employment and CPI inflation in RIMINI, can be denoted the "interest rate channel" and the "exchange rate channel" respectively. Appendix 2.B outlines the submodel for wage and price formation in RIMINI, as well as figures illustrating the "interest rate" and "exchange rate" channels.

The main mechanisms of the interest rate channel are: A partial rise in the short-term money market interest rate (typically 3-month NOK rates) assuming fixed exchange rates, leads to an increase in banks' borrowing and lending interest rates with a lag. Aggregate demand is influenced by the interest rate shift through several mechanisms, such as a negative effect on housing prices which (for a given stock of housing capital) causes real household wealth to decline and suppresses total consumer expenditure. Likewise, there are negative direct and indirect effects due to an increase in interest rates on real investments in traded and non-traded sectors and on housing investments. CPI inflation is reduced after a lag, mainly as a result of the effects of changes in aggregate demand on aggregate output and employment (productivity), but also as a result of changes in unit labour costs.

An appreciation of the local currency (NOK) has a more direct effect on CPI inflation than the interest rate channel. It works mainly through reduced import prices with a lagged response, but such that there is complete pass-through in import and export prices after about

[2] RIMINI is an acronym for a model for the Real economy and Income accounts - a MINI-version, see Eitrheim and Nymoen (1991) for a brief documentation (in english) of a predecessor of the model.

two years. The model specification allows for a non-constant mark-up factor on unit labour costs in import and export prices in the short run. Furthermore, a currency appreciation has a weak negative effect on demand for traded goods. In addition to small relative price elasticities in the export equations, export prices (in local currency) adjust with a lag and tend to restore relative prices.

A different subsection in the model concerns indicators of financial fragility (see Davis (1995) for a discussion). The baseline version of RIMINI contains indicators of financial fragility for the household sector, such as e.g. debt service to income and capital gearing ratios. The increased attention to these issues has arisen from the Norwegian experiences with the banking crisis in 1991-1992, and we plan to extend the set of indicators of financial fragility to cover those of financial sectors and private non-financial corporate sectors in a future model version. In section 2.4 below we present some preliminary results of an attempt to link recorded losses in financial sectors to a set of macroeconomic indicators of financial fragility.

2.4 Links between recorded losses in financial sectors and macroeconomic indicators of financial fragility

In the aftermath of the Norwegian banking crisis, Norges Bank and the Banking, Insurance and Securities Commission (Kredittilsynet) monitor financial stability in financial and non-financial private sectors more systematically, and Norges Bank now publishes a biannual financial stability report, Financial Sector Outlook. A wide range of different indicators of financial fragility are considered in this connection, such as debt service to income ratios and capital gearing ratios (cf. Davis (1995) for an analysis).

The RIMINI model has been used to help project and evaluate the development of a set of indicators of financial fragility, at first for the household sector and more recently for the non-financial private sector as well. The banking sector has so far, however, been given only rudimentary treatment in the RIMINI model, and the link to the banking sector consists of dynamic equations for average interest rates on bank loans and bank deposits respectively, each of which is formulated as a mark-up relationship driven by the money market interest rate.

One of the purposes of this paper is to try and link the development in indicators of financial indicators to the trend in financial sector losses. The data for recorded financial sector losses are shown in figure 2.2, and we refer to Appendix 2.C for a more detailed discussion of their decomposition.

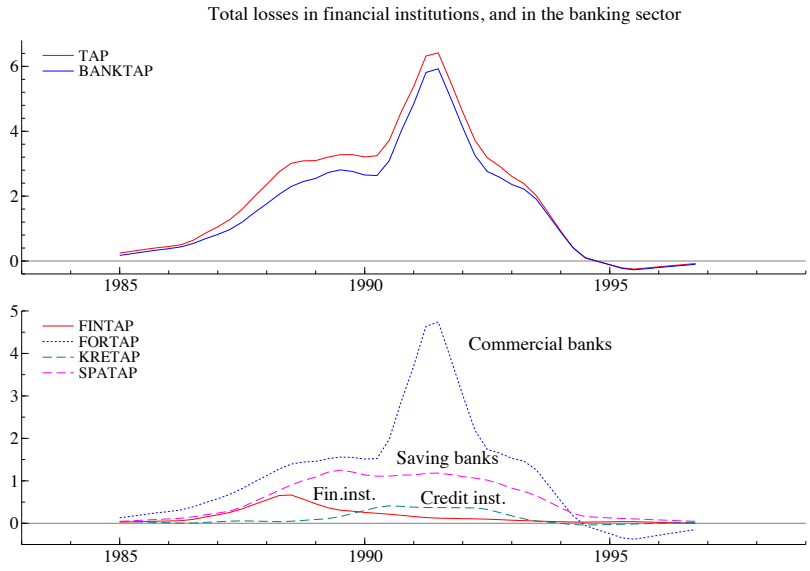


Figure 2.2 Recorded losses in banks and other financial institutions and their decomposition, annual data from the SAFT database, 1990 to 1997 (NOK billions).

2.4.1 Equation for losses as a ratio of private sector debt

Losses are assumed to depend on the debtor's ability to service the debt as well as on the value of the collateral in loan contracts and the level of unemployment. Recorded financial sector losses have been scaled by the level of private sector debt, and we have modelled this ratio, TAN_t (per cent), as a function of the debt service to income ratio of households, $FFRU50_t$ (debt service ability), the real price of housing capital, $ph_t - cpi_t$, (value of the collateral in loan contracts) and the unemployment rate, $UAKU_t$ (uncertainty about future income and debt servicing ability).

The explanatory variables relate to the household sector for the simple reason that we lack relevant information for the business sector in RIMINI. By far the largest proportion of the losses was incurred in the non-financial corporate sector (85%) whereas only a minor part (15%) was due to the household sector. However, we will make the assumption that these variables can act as useful proxy variables for losses incurred in the business sector. In this context it should be noted, of course, that the real price of housing capital is only an imperfect measure of the market value of real estate and capital in the corporate sector.

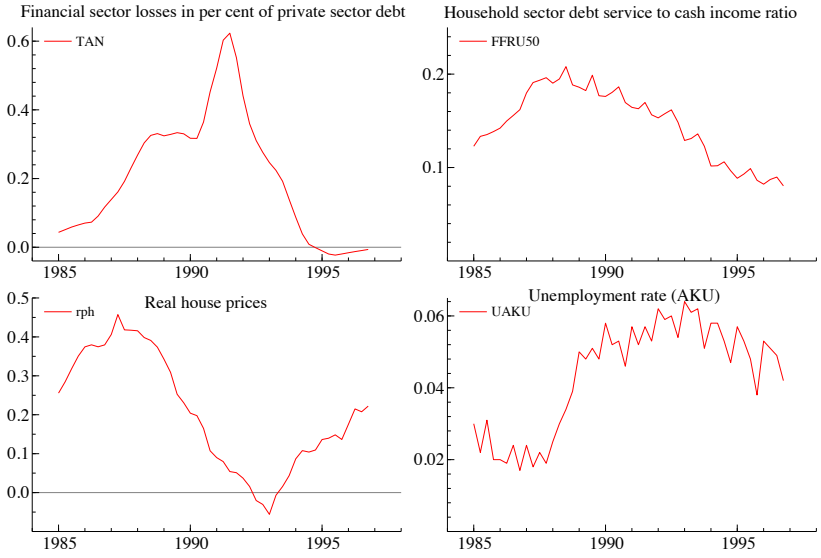


Figure 2.3 Quarterly data used in the model for financial sector losses, 1985 Q1 to 1996 Q4.

$$TAN_t = \underset{(0.0479)}{-0.44025} + \underset{(0.1762)}{3.7192}\,FFRU50_t \underset{(0.0859)}{-0.2404}\,(ph_t - cpi_t) \qquad (2.1)$$
$$\underset{(0.7552)}{+2.7031}\,UAKU_t + \underset{(0.0202)}{0.25144}\,CRISIS91_t + \underset{(0.0395)}{0.1634}\,IDUM90Q4_t + \hat{\varepsilon}_t$$

Estimation period 1985(1)-1996(4)

$k = 6,\ R^2 = 0.9614,\ \hat{\sigma} = 0.0376,\ \text{DW} = 1.81,\ \text{AR1-3F}(3,39) = \underset{(0.8264)}{0.2983},$
$\text{ARCH1-3F}(3,36) = \underset{(0.7227)}{0.4444},\ \chi^2_{JB}(2) = \underset{(0.5608)}{1.1568},\ \text{F}_{RESET}(1\ ,41\ ) = \underset{(0.0472)}{4.1855}^{*}$

The selected macroeconomic indicators have the expected sign in equation (2.1). The real price of housing capital has a negative effect on losses, reflecting the importance of the market value of the collateral, on which loan contracts are written, on the probability that banks will carry losses in the event of loan defaults.

The level of unemployment and the debt service to income ratio both have a positive effect on the loss ratio. Both indicators are expected to affect the level of bankruptcies in the corporate sector, and hence they act like proxies for the increased vulnerability to default on loans in the corporate sector in the period we consider.

The dummy variable $CRISIS91_t$ captures the bulk of recorded losses which were reported of 1991 and the first quarter in 1992, primarily in commercial banks. The estimated

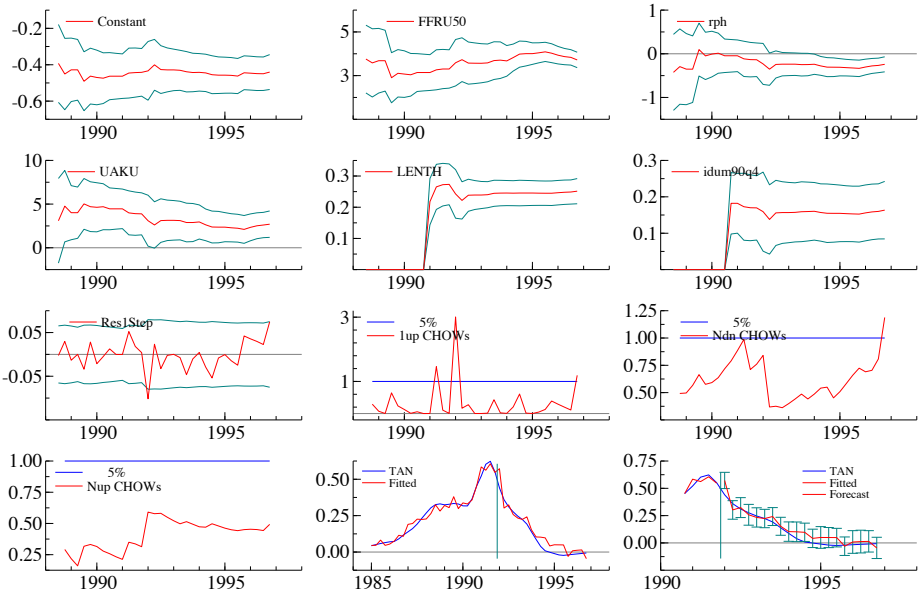


Figure 2.4 Model for bank losses as a proportion of private sector debt. Recursive coefficient estimates, 1-step residuals, Chow tests, fitted and actual observations, forecasting properties over the last 20 quarters.

coefficient indicates that losses equivalent to 0.25 pp (relative to the scaling of TAN_t) are captured by this dummy variable. One interpretation of this is that it captures a *timing effect* of the banking crisis, and also coincides with the timing of management changes in the largest banks and the injection of new capital by the Government. It is impossible to distinguish, at least at this level of aggregation, between losses on loans granted during the rapid expansion of credit in the mid-1980s and losses which are more closely related to the severe downturn of the economy in the late 1980s and early 1990s. Both may be part of the fraction of losses picked up by the dummy variable $CRISIS91_t$. Another problem with this dummy variable is that it decouples the large amount of recorded losses during the peak of the banking crisis from the subsequent decline in the stock of loss provisions which was recorded in the mid-1990s. This decline in recorded losses has been successfully accounted for in the model by the included indicators of financial fragility. We have studied the empirical effects of this dummy variable in more detail in one of the following simulation experiments.

2.5 Simulations of a counterfactual monetary policy regime

This section contains some preliminary results from counterfactual RIMINI simulations of an alternative monetary policy regime, implemented in the period from 1990 Q1 to 1996 Q4. The experiment was inspired by the considerable attention among both policymakers and academics in recent years devoted to a closer evaluation of alternative monetary policy rules, such as simple interest rate reaction functions (Taylor, 1993), and more sophisticated monetary rules rules which have been developed in the context of inflation targeting (Rudebusch and Svensson, 1997).

Another aspect of this exercise, which makes it distinct from some of the recent contributions to the academic debate, is that it allows a closer evaluation of this type of policy rules in the context of a macroeconometric model which is actually used by forecasters in Norges Bank to produce the Inflation Report. This is also relevant in the context of the Central Bank's accountability. Norges Bank's Inflation Report is not produced by means of a "black box" model. The structure and coefficients of RIMINI are in the public domain. The Bank is also open on the values assigned to the exogenous variables, as well as on the use of "add factors" (intercept correction). A lot of judgement is of course put into the add factors, more in the short run (the first 4-6 quarters) than in the long run, so it is perhaps more accurate to say that the "black box" is narrowed down to the values of the add factors. However, in the text of the Inflation Report, the reasoning underlying the values assigned to the add factors is normally explained.

Finally, the inclusion of a submodel of aggregate financial losses in RIMINI, allows us to assess empirically the relationship between monetary policy instruments and the real economy on the one hand (the transmission mechanism) and through the indicators of financial fragility we create a link to the development in financial sector losses. It should be stressed however, that the work on financial sector losses is in a rather embryonic state, and that further empirical work is called for.

2.5.1 Interest rate rules

We focus on simple linear interest rate rules of the general form (assuming quarterly data)

$$i_t = \gamma_i i_{t-1} + (1-\gamma_i)(r^* + \Delta_4 p_{t-1}) + \gamma_y (y - y^*)_t + \gamma_\pi (\Delta_4 p - \pi^*)_t \tag{2.2}$$

where i_t is the short-term interest rate, r^* is the equilibrium real interest rate, $(y-y^*)_t$ is the output gap and $(\Delta_4 p - \pi^*)_t$ is the price gap.

Different combinations of $(\gamma_i, \gamma_y, \gamma_\pi)$ can be associated with different interest rate rules. The simple Taylor (1993) rule is characterized by the triplet $(\gamma_i = 0, \gamma_y = 0.5, \gamma_\pi = 0.5)$. In this case there is no weight on the lagged interest rate level $(\gamma_i = 0)$, and the interest rate is given by

$$i_t = r^* + \Delta_4 p_{t-1} + \gamma_y (y - y^*)_t + \gamma_\pi (\Delta_4 p - \pi^*)_t \qquad (\gamma_i = 0) \tag{2.3}$$

This is the form which was considered in Frøyland and Leitemo (1997), where they set $r^* = 3.5\%$ and $\pi^* = 2.5\%$. We have used the same assumptions in the simulations discussed this paper.

If $\gamma_i = 1$, the interest rate rule can be rewritten as

$$\begin{aligned} i_t &= i_{t-1} + \gamma_y (y - y^*)_t + \gamma_\pi (\Delta_4 p - \pi^*)_t \qquad (\gamma_i = 1) \\ &\Downarrow \\ \Delta i_t &= \gamma_y (y - y^*)_t + \gamma_\pi (\Delta_4 p - \pi^*)_t \end{aligned} \tag{2.4}$$

cf. the interest rate rules III and IV in Taylor (1998).

It is instructive to rewrite the general interest rate rule in (2.2) above in difference form as an equilibrium correcting model.

$$\Delta i_t = (\gamma_i - 1)(i_{t-1} - r^* - \Delta_4 p_{t-1}) + \gamma_y (y - y^*)_t + \gamma_\pi (\Delta_4 p - \pi^*)_t \tag{2.5}$$

From this representation it is easily recognised that the steady state solution for the interest rate, i.e. when $\Delta i_t = 0$, $\Delta_4 p_t = \Delta_4 p_{t-1} = \pi^*$, is given by $i_t = r^* + \pi^*$.

2.5.2 Exchange rate assumptions

The model simulations have been carried out under alternative assumptions with respect to how the exchange rate will react to a counterfactual interest rate scenario. A useful reference to these alternative exchange rate scenarios is the type of forward looking uncovered interest parity models for exchange rate behaviour considered in Fischer et al. (1990).

We start by defining a reference scenario RT where the short interest rate is determined by a standard backward-looking Taylor rule with $(\gamma_y = 0.5, \gamma_\pi = 0.5, \gamma_i = 0)$.

Under the uncovered interest parity assumption, the expected change in the exchange rate is given by the interest rate differential adjusted for a risk premium.

$$E[\Delta s_{t+1})] = i_t - i_t^f - \rho_t \tag{2.6}$$

where $i_t - i_t^f$ is the interest rate differential and ρ_t denotes a risk premium (in percent), known in period t. In 1990 the interest rate differential between Norway and the ECU rate had been eliminated, and with the exception of the periods in the autumn of 1992 (the turmoil in the Nordic foreign exchange markets) and in 1994 (the referendum on the issue of Norway joining the EU), the interest rate differential remained small over the entire period from 1990 to 1996.

An attempt to further reduce the interest rate in 1990 would possibly have caused an

outflow of capital (the remaining capital controls in Norway were removed in 1990), and a weakening of the exchange rate. To account for this possibility in the experiments with a counterfactual interest rate policy starting in 1990, we have considered four alternative exchange rate scenarios. In the reference Taylor rate scenario RT we assume that the exchange rate is unaffected by the change in monetary policy regime.

If, however, a new regime is not regarded as a credible one, it is possible that an immediate pressure to weaken the currency would occur through a shift in the depreciation expectations. After an initial currency depreciation, we have assumed that the krone gradually appreciates again until it attains the same level as in the historical path in 1995, as in a traditional Dornbusch (1976) model. It should be noted however, that this is a rather ad hoc way of incorporating a temporary exchange rate effect following a monetary policy shock, and that further work is required. The size of the currency depreciation is scaled as suggested in Eika and Moum (1998), and with reference Taylor rates which are 3 percentage points lower on average than in the historical path, over a period of five years, we have assumed that the immediate depreciation is 15% (RTE1), followed by a gradual appreciation back to the historical path.

Given the ad hoc nature of this exchange rate effect, we have also simulated the model under two alternative set of assumptions for the timing and the size of this effect (cf. e.g. Eichenbaum and Evans (1995) and Gourinchas and Tornell (1996) for an analysis of exchange rate dynamics following a monetary policy shock). Table 2.1 summarises these assumptions.

Table 2.1 *RIMINI simulations*

SimExp	**Description**
	Baseline, historical path
RT	Taylor interest rate, with $(\gamma_y = 0.5, \gamma_\pi = 0.5, \gamma_i = 0)$
RT5L	Same as RT, but with only 50% of the *CRISIS91* effect on bank losses
RTE1	Same as RT, but with immediate 15% currency depreciation, followed by gradual currency appreciation
RTE2	Same as RT, but with gradual 15% currency depreciation over 2.5 years, followed by gradual currency appreciation
RTE3	Same as RT, but with gradual 7.5% currency depreciation over 2.5 years , followed by gradual currency appreciation

2.5.3 Simulations with backward-looking Taylor interest rates

Figure 2.5 shows the simulated Taylor interest rates under the alternative exchange rate assumptions. The most expansive interest rate effect is obtained in the case in which exchange rates are unaffected (RT). In the polar case, which could represent a situation in which little credibility is associated with the new regime (RTE1), the exchange rate response is passed through to domestic inflation, which rises in little over a year, and since the Taylor rule

reflects actual inflation with a lag, interest rates increase accordingly and counteract the expansive effect of the currency depreciation in the short run. Since the exchange rate shock is temporary, so is this contractive effect, and after a while inflation and interest rates come down with the gradual currency appreciation.

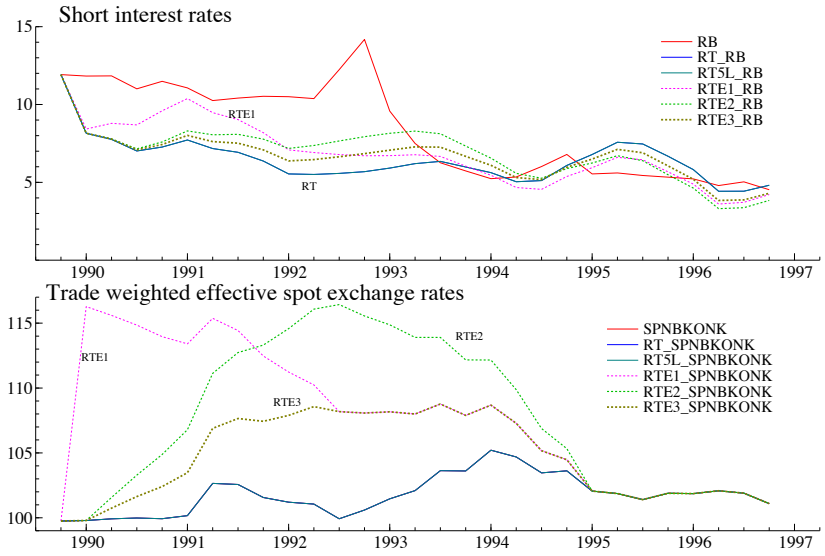


Figure 2.5 Counterfactual interest rate and exchange rate scenarios from 1990 Q1 to 1996 Q4.

Some of the determining factors in the Taylor rule are shown in figure 2.6. The interest rate reduction in the reference scenario RT fuels aggregate demand, and gives rise to a less negative output gap without noticeable effects on domestic inflation in the short run. As we move towards the end of the simulation period, however, we see that domestic inflation picks up relative to the historical path. This is also reflected in the short-term interest rates at the end of the simulation period, when the highest interest rates observed apply to the RT case. More generally, the Taylor rule generates a feedback effect from actual and lagged inflation to the interest rate.

This feedback effect becomes even more pronounced in case TRE1, where the strongly adverse exchange rate response to the announcement of a new monetary policy regime feeds into domestic CPI inflation (with a lag) through increasing prices (in local currency) on imported final and intermediate goods. This adverse response is furthermore reflected in the interest rates through a temporary increase in interest rates back to the historical path, which effectively postpones the expansive stimulus due to a further interest rate decrease by more than a year.

The two alternative exchange rate scenarios, RTE2 and RTE3, reflect the uncertainty in the timing and size of the credibility effect, and give rise to similar responses in domestic CPI inflation and interest rates.

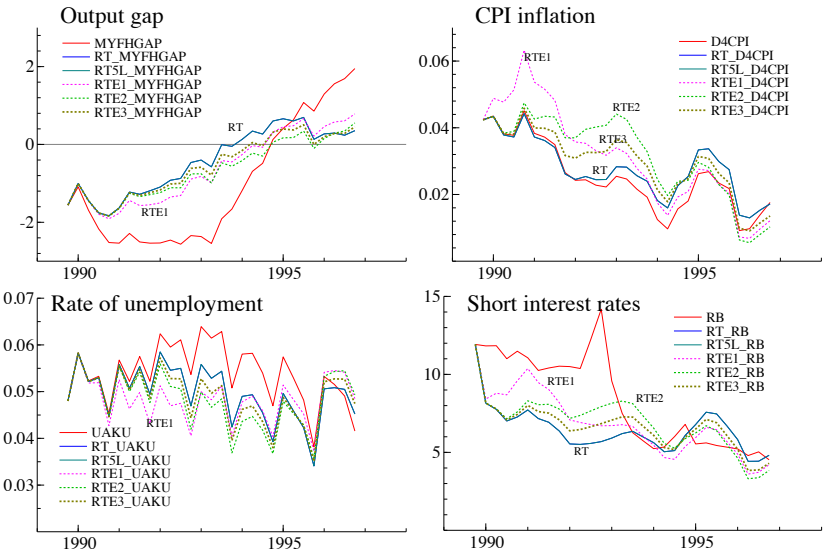


Figure 2.6 Taylor interest rates - explanatory factors, 1990 Q1 to 1996 Q4.

In figure 2.7 we have presented the effects on the aggregate rate of growth over 4 quarters in mainland output, CPI and wage cost inflation and the unemployment rate (absolute deviations from the historical path). The RT scenario with no adverse exchange rate effect is associated with the largest aggregate output effect, as we have also seen from the effect on the output gap. The effects on CPI inflation in the short run reflect the different exchange rate assumptions, but we see how the reference scenario TR gives rise to the strongest effect on inflation after 5 years. The effects on the unemployment rate need some further explanation. The reduction in the rate of unemployment seems to be closely linked to the (exogenous) exchange rate assumption. The explanation for this effect is that interest rate and exchange rate shocks have different effects across sectors producing traded and non-traded goods. A currency depreciation improves competitiveness in the exposed sector, at least in the short run, and contributes to an increase in the demand for labour and output in sectors producing traded goods.

At the bottom of figure 2.7, we see how the bank loan rate is affected by the different Taylor rate scenarios with a lag. The figure shows the difference in percentage points between the historical path and the Taylor rate scenarios. The shifts in the loan rate affects the market

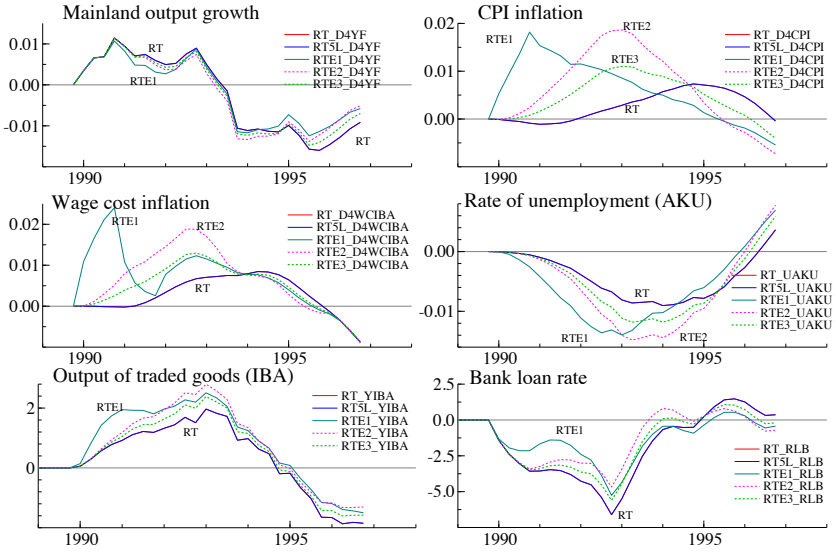


Figure 2.7 Effects on output growth, price and wage inflation and unemployment, 1990 Q1 to 1996 Q4. Absolute deviations (in percentage points) from the historical path (except for output of traded goods where we report the relative deviation in percent).

for housing capital and household demand for loans, as we see in figure 2.8. After 2 1/2 years, house prices are about 10% above the historical path. An interesting empirical property in the present version of the RIMINI model is that it allows for dynamic spill-over effects between the housing and credit markets. This contributes to some degree of persistence in the responses to interest rate shocks in macroeconomic variables like housing prices and household loans. The net effect on the household sector balance sheet can be seen at the bottom of figure 2.8, where we show the effects on total household wealth and real consumer expenditure. The nominal variables are of course influenced by the CPI trajectory (cf. the large relative deviations from the historical path in the RTE1 case). The real effects on private consumption seems to map fairly closely the effects commented upon above on mainland GDP. The largest effect on real consumer expenditure is associated with the (credible) case RT with no adverse exchange rate effects.

Finally, we turn to the simulated effects on losses in financial sectors. While keeping in mind that the main indicators of financial fragility in the present version of RIMINI relate to the household sector, and only act as proxy indicators for the situation in the corporate sector, some conditional results can be noted[3].

[3] Conditional results refers in this context to the assumed invariance of the reported links between macroeconomic indicators of financial fragility for the household sector to total financial sector losses to a further disaggregation of the model for financial sector losses to separate submodels for losses in the

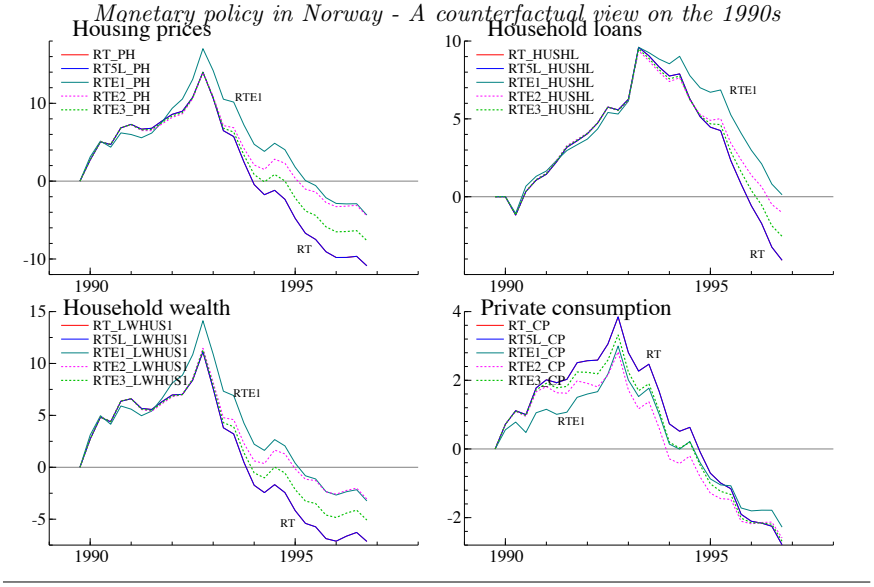


Figure 2.8 Effects on house prices, loans, household real wealth and private consumption, 1990 Q1 to 1996 Q4. Relative deviations from the historical path (as percentages).

The main results can be seen in figure 2.9 and figure 2.10 (absolute deviations from the historical path). The simulated smoothing of the business cycle contributes to higher real housing prices, lower unemployment rates and lower debt service to income ratios than in the historical path. Hence, all the major determinants of recorded losses indicate a lower level of losses, and this result is also clear from the reported figures.

personal and corporate sectors, and perhaps, within the corporate sector, between losses in sectors producing traded and non-traded goods.

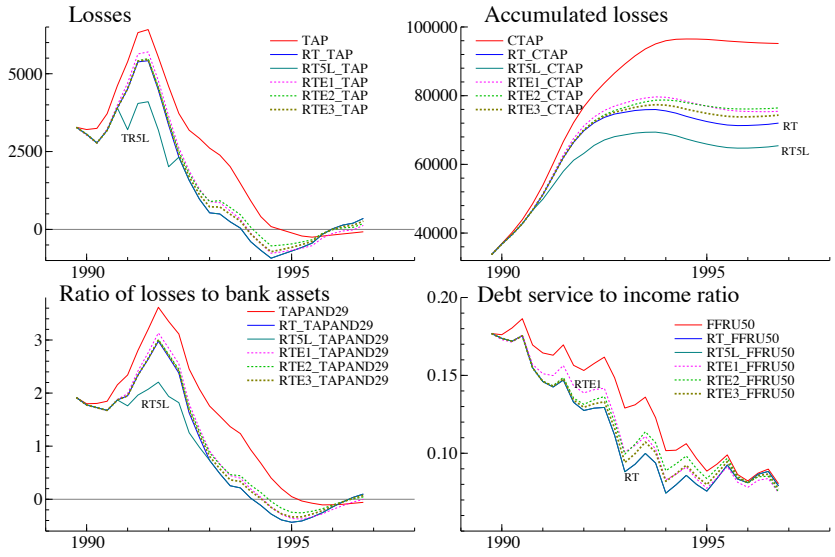


Figure 2.9 Effects on the financial sector's losses, accumulated losses and the losses to banking sector asset ratio, 1990 Q1 to 1996 Q4.

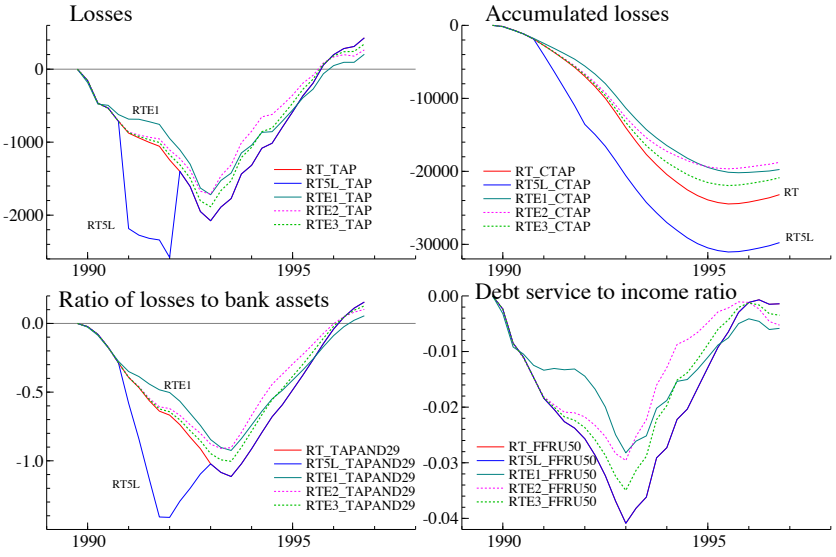


Figure 2.10 Effects on the financial sector's losses, accumulated losses and the losses to banking sector asset ratio, 1990 Q1 to 1996 Q4. Absolute deviations from the historical path.

2.5.4 Forward-looking inflation forecast targeting

In this section we consider a forward-looking variant of the interest rate rule (2.5) we have applied in the previous subsection. A rule which could be considered e.g. in the context of an inflation forecast targeting regime is obtained by replacing $\Delta_4 p_t$ with $E[\Delta_4 p_{t+h}|\mathcal{I}_t]$ and we obtain the following expression:

$$\Delta i_t = (\gamma_i - 1)(i_{t-1} - r^* - \Delta_4 p_{t-1}) + \gamma_y (y - y^*)_t + \gamma_\pi (E[\Delta_4 p_{t+h}|\mathcal{I}_t] - \pi^*) \tag{2.7}$$

See Batini and Haldane (1997) for a general analysis of forward looking interest rate rules, and Svensson (1998) for a discussion of forward looking interest rate rules in the context of inflation forecast targeting. In the following we compare RIMINI simulations with backward- and forward-looking interest rate rules respectively[4]. We assume that the interest rate set by policymakers partly reflects an inflation forecast target looking eight quarters ahead, i.e. we set $h = 8$ in (2.7), and instead of the conditional expectation of the annual rate of inflation eight quarters ahead, we plug in the model's "most likely" annual rate of inflation forecast obtained by forward-looking deterministic simulation[5], i.e. we let

$$Est[\mathsf{Mode}\,[\Delta_4 p_{t+8}|\mathcal{I}_t]] = ForwDetSim[\Delta_4 p_{t+8}] \tag{2.8}$$

The effects on the interest rates are shown in figure 2.11. With a forward-looking interest rate rule, the policy response seems to come earlier than in the backward-looking case. In the case with no exchange rate effect, RTF, there seems to be a faster and somewhat stronger reduction in the interest rate in 1990, which gives rise to a slightly more expansive demand impulse which, helps further reduce the output gap. It is also interesting to note that the forward- and backward-looking rules seems to behave very differently towards the end of the simulation period. While the backward-looking interest rate rules seems to be heavily influenced by the temporary upswing in (headline) inflation in 1994/1995, this is a less pronounced effect in the forward-looking interest rate rules, since these (rightly) take into account that the upswing was temporary and was in fact driven by a positive shift in indirect taxes in 1994 Q3 which affected the growth rate in the following four quarters.

The effects on housing prices and private consumption are shown in figure 2.12. Since the larger negative shift in the forward-looking interest rates contributes to a faster pick-up in housing prices relative to the reference scenario.

[4] The simulations with forward-looking interest rate rules are handled technically by the stacked-time option in Portable TROLL's SIMULATE task, which has been especially designed to solve forward-looking models, cf. Hollinger (1996) for further details on the algorithm.

[5] If the model is sufficiently non-linear in the range of values considered by the solution algorithm, the mean and the mode of the distribution of the eight quarters ahead inflation forecast need not coincide, and hence this would introduce a potential (downward) bias in this estimate of the mean of the inflation forecast distribution.

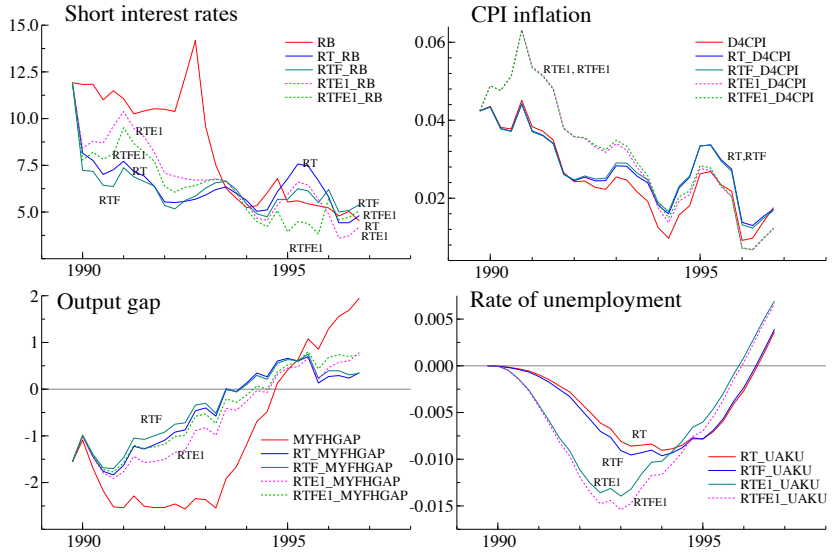


Figure 2.11 Comparing backward- and forward-looking interest rules. Effects on short interest rates, CPI inflation, output gap and the rate of unemployment, 1990 Q1 to 1996 Q4.

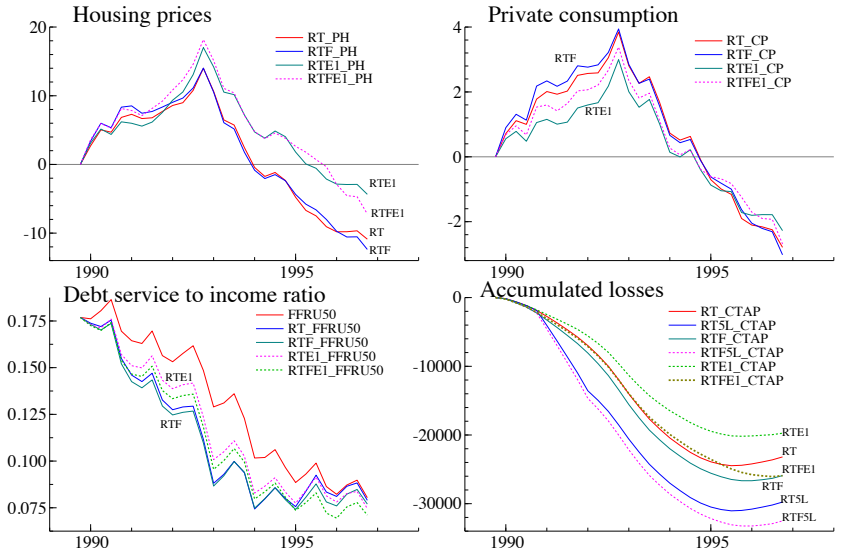


Figure 2.12 Comparing backward- and forward-looking interest rules. Effects on housing prices and private consumption (relative deviation from the historical path as a percentage), and the debt service to income ratio and accumulated loans (absolute deviation from the historical path in percentage points), 1990 Q1 to 1996 Q4.

2.6 Concluding remarks

When Taylor rule reaction functions for the short-run interest rate are applied to the period 1990-1996, this creates a temporary downward shift in nominal interest rates compared to the historical path. Given the considerable uncertainty about the effects on exchange rates of such a counterfactual policy, we have considered four sets of different assumptions, ranging from no effect at all to a strong immediate currency depreciation followed by a gradual strengthening of the currency back to its reference level. A temporary currency depreciation delays the downward shift in interest rates, through the effect on current (or expected) inflation reflected by the Taylor rule. It also alters the policy mix between interest rate and exchange rate changes, and this affects the output and employment responses across sectors producing traded and non-traded goods.

As we would expect, the counterfactual policy simulations indicate that many macroeconomic variables which exhibited strong cyclical swings in the period 1990-1996, such as output growth and unemployment, are smoothed out by the policy mix we have analysed. This result is of course a partial one, since we have conditioned on unchanged fiscal policies and income policies across the period. The smoothing of the business cycle also seems to yield a considerable effect on the accumulated losses in the financial sectors. Some caution is in order here, however, first of all because of the partial nature of this simulation exercise and secondly since the results rely on the critical assumption that macroeconomic indicators of financial fragility derived for the household sector are sufficiently correlated with those for the private non-financial corporate sector. The robustness of our results to changes in these assumptions is on the research agenda for future work.

References

Bårdsen, G., P. G. Fisher and R. Nymoen (1995). Business cycles: Real facts or fallacies. Working paper 1995/1, Oslo: Norges Bank.

Batini, N. and A. Haldane (1997). Forward-looking rules for monetary policy. Prepared for the NBER Conference on Monetary Policy Rules, Islamorada, Florida, January 15-17, 1998.

Christiansen, A. B. and J. F. Qvigstad (1997). *Choosing a monetary policy target*. Oslo: Scandinavian University Press.

Davis, E. P. (1995). *Debt, financial fragility and systemic risk*. Oxford: Clarendon Press.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of Political Economy*, *84*, 1161–1176.

Eichenbaum, M. and C. Evans (1995). Some empirical evidence on the effects of monetary policy shocks on exchange rates. *Quarterly Journal of Economics*, *110*, 975–1009.

Eika, T. and K. Moum (1998). Pengepolitikk som virkemiddel i dagens konjunktursituasjon. *Økonomiske Analyser 2/1998*, *17*, 3–15.

Eitrheim, Ø. and R. Nymoen (1991). Real wages in a multisectoral model of the Norwegian economy. *Economic Modelling*, *8*(1), 63–82.

Ericsson, N. R. (1994). Testing exogeneity: An introduction. In Ericsson, N. R. and J. S. Irons (eds.), *Testing Exogeneity*. Oxford: Oxford University Press.

Ericsson, N. R. and J. S. Irons (1995). The Critique in practics: Theory without measurement. In Hoover, K. D. (ed.), *Macroeconometrics. Developments, Tensions and Prospects*. Boston/Dordrecht/London: Kluwer Academic Publishers.

Fischer, P. G., S. K. Tanna, D. S. Turner, K. F. Wallis and J. D. Whitley (1990). Econometric evaluation of the exchange rate in models of the UK economy. *The Economic Journal*, *100*, 1230–1244.

Frøyland, E. and K. Leitemo (1997). Pengepolitisk stabilisering ved hjelp av Taylor's regel (in Norwegian). *Sosialøkonomen*, *51*(8), 10–15.

Gourinchas, P.-O. and A. Tornell (1996). Exchange rate dynamics and learning. Working Paper 5530, NBER.

Hollinger, P. (1996). The stacked-time simulator in TROLL: A robust algorithm for solving forward-looking models. Paper presented at the Second International Conference on Computing in Economics and Finance, Geneva, Switzerland, June 20-23, 1996.

Qvigstad, J. F. and A. Skjæveland (1994). Valutakursregimer - Historiske erfaringer og fremtidige utfordringer (in Norwegian). In Storvik, K., Berg, S. A. and J. F. Qvigstad (eds.), *Stabilitet og langsiktighet - Festskrift til Hermod Skånland*, 235–271. Oslo: Aschehoug.

Rudebusch, G. D. and L. E. O. Svensson (1997). Policy rules for inflation targeting. Prepared for the NBER conference on monetary policy rules, January 16-17, 1998.

Skånland, H. (1998). En pengepolitikk for Norge - etter solidaritetsalternativet (in Norwegian). *Sosialøkonomen*, *52*(7), 2–11.

Svensson, L. (1998). Inflation targeting as a monetary policy rule. Prepared for the Monetary Policy Rules Conference sponsored by Sveriges Riksbank and IIES, Stockholm, June 12-13, 1998.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester conference series on public policy*, *39*, 195–214.

Taylor, J. B. (1998). The robustness and efficiency of monetary policy rules as guidelines for interest rate setting by the European Central Bank. Prepared for the Monetary Policy Rules Conference sponsored by Sveriges Riksbank and IIES, Stockholm, June 12-13, 1998.

2.A Variable symbols and definitions

Symbol	Definition
$BGRG60Z_t$	Interest-bearing debt for non-financial corporations, NOKm.
$BGRG56Z_t$	Private sector interest-bearing debt, $= HUSHL_t + BGRG60Z_t$, Mill NOK.
CPI_t	Consumer price index. 1993 = 1.
$CRISIS91_t$	Dummy variable for the timing of losses reported during 1991 and 1992 = 1 from 1991 Q1 to 1992 Q1
$D4CPI_t$	Annual inflation rate (CPI based).
$D4YF_t$	Annual growth rate for mainland GDP.
$FFRU50_t$	Ratio of debt service (interests paid) to income.
$HUSHL_t$	Total loans by households. NOKm.
PH_t	Housing price index, 1993 = 1.
TAN_t	Sum financial sector losses as fraction of private non-financial sector debt $= 100 * TAP_t/BGRG56Z_t$
$TAPAND29_t$	Financial sector losses (sum over four quarters) as a proportion of private non-financial sector debt $= 100 * \sum_{i=0}^{3} TAP_{t-i}/BGRG56Z_t$
$TAPAND56_t$	Financial sector losses (sum over four quarters) as a proportion of total assets in the banking sector, $= 100 * \sum_{i=0}^{3} TAP_{t-i}/BF29Z_t$
$UAKU_t$	AKU unemployment as a proportion of labour force (excluding self employed).
TAP_t	Sum financial sector losses, converted annual series (spline function). NOKm. $= = FORTAP_t + SPATAP_t + FINTAP_t + KRETAP_t$
$CTAP_t$	Accumulated losses in financial sectors. NOKm.
$FORTAP_t$	Losses in commercial banks, converted annual series (spline function). NOKm.
$SPATAP_t$	Losses in saving banks, converted annual series (spline function). NOKm.
$FINTAP_t$	Losses in financing institutions, converted annual series (spline function). NOKm.
$KRETAP_t$	Losses in credit institutions, converted annual series (spline function). NOKm.

Table 2.2 *Variable symbols and definitions*

2.B Price and wage determination

As background for the discussion of the empirical price and wage model in the Norges Bank macroeconometric model RIMINI, we will present a simple aggregated model of wage and price formation (cf. Bårdsen et al. (1995)). Bargained nominal wages depend on a combination of firm-side variables (e.g. productivity, producer prices and the payroll tax rate) and variables which affect take-home pay (e.g. consumer prices and the income tax rate) as well as variables which capture the effect on wage and price formation of labour market pressure (unemployment). We follow Bårdsen et al. (1995) and postulate the following equations for the equilibrium wage level, w_t^{**}, and the producer price level, pp_t^{**}.

$$w_t^{**} = \alpha_1 pp_t + (1-\alpha_1)p_t + \theta zy_t - \beta_1 t1_t + \beta_2 t2_t - \kappa_1 u_t$$

$$pp_t^{**} = m_{pp} + w_t - zy_t + t1_t$$

where pp_t and zy_t denote producer prices and productivity respectively, p_t the consumer price level, u_t unemployment, $t1_t$ the payroll tax rate and $t2_t$ the income tax rate. To simplify the exposition we follow Bårdsen et al. (1995) and let $\theta = 1$ and $\beta_2 = 0$. The equilibrium producer price level is a constant mark-up, m_{pp}, on normal unit labour costs and the equilibrium wage share depends negatively on the payroll tax rate and the rate of unemployment, i.e.

$$w_t^{**} - zy_t - \alpha_1 pp_t - (1-\alpha_1)p_t = -\beta_1 t1_t - \kappa_1 u_t$$

The consumer price level, p_t, is homogeneous of degree one in domestic producer prices, pp_t, and import prices in domestic currency, pb_t and also includes net indirect taxes $t3_t$. The equilibrium consumer price level can be written as follows:

$$p_t^* = \eta(w_t^* - zy_t + t1_t) + (1-\eta)pb_t + t3_t$$

where η is the share of domestically produced goods in the consumer price index. The dynamic structure of the model is set out as follows:

$$\Delta w_t = c_1 + \gamma_{11}\Delta p_{t+1}^e + \gamma_{12}\Delta pp_{t+1}^e - \delta_1[w - w^{**}]_{t-1} + \varepsilon_{1t}$$

$$\Delta pp_t = c_2 + \gamma_2\Delta(w - zy)_{t+1}^e - \delta_2[pp - pp^{**}]_{t-1} + \kappa_2[y - y^{**}]_{t-1} + \varepsilon_{2t}$$

The model is closed by introducing the following assumption about the expectation mechanisms for producer prices, consumer prices and unit labour costs

$$\Delta pp_{t+1}^e = \Delta pp_t$$

$$\Delta p_{t+1}^e = \Delta p_t$$

$$\Delta(w - zy)_{t+1}^e = \Delta(w - zy)_t$$

We derive the following simultaneous system for wage and price inflation $(\Delta w_t, \Delta p_t)'$

$$\begin{aligned}
\Delta w_t &= c_1 + (\gamma_{1,1} + g_{1,2})\Delta p_t - (g_{1,2} - \gamma_{1,2})\Delta pb_t - g_{1,2}\Delta t3_t \\
&\quad -\delta_1[w - \underbrace{(p + zy + (1-\eta_w)(pb-p) + \beta_1 t1 - a_1 t3 - \kappa_1 u)}_{w^*}]_{t-1} \\
\Delta p_t &= \eta(c_2 + \delta_2 m_{pp}) + g_2\Delta(w - zy)_t + (1-\eta)\Delta pb_t + \Delta t3_t \\
&\quad -d_2[p - \underbrace{(\eta(w - zy + t1) + (1-\eta)pb + t3)}_{p^*}]_{t-1} \\
&\quad +\kappa_2[y - y^*]_{t-1} + u_{pt}
\end{aligned}$$

where $g_{1,2} = \gamma_{1,2}/\eta,\ a_1 = \alpha_1/\eta,\ g_2 = \gamma_2\eta,\ d_2 = \delta_2/\eta,\ u_t = \eta\varepsilon_{2t},\ \eta_w = 1-(\alpha_1 - a_1)$

Estimated equation for consumer prices, Δp_t

$$\begin{aligned}
\Delta p_t = {} & \underset{(0.0145)}{0.0373}\Delta pb_t \ \underset{(0.0183)}{-0.0609}\,\Delta_4 zy_t \ \underset{(0.1114)}{-0.2067}\,\Delta t1_{t-2} + \underset{(0.0170)}{0.0410}\,\Delta\Delta w_{t-3} \\
& \underset{(0.0449)}{-0.0889}\Delta hh_{t-4} + \underset{(0.1371)}{0.5365}\,\Delta t1_{t-4} + \underset{(0.0273)}{0.1627}\,(\Delta p_{t-2} + \Delta p_{t-4}) + \underset{(0.0117)}{0.0644}\,(yf - yf^*)_{t-1} \\
& \underset{(0.0074)}{-0.0808}(p_{t-1} - t3_{t-1} - 0.45pb_{t-1} - 0.55(w_{t-1} + t1_{t-1} - zy_{t-1})) \\
& + \underset{(0.0037)}{0.0491}\,D701_t \ \underset{(0.0019)}{-0.0053}\,WDUM_t \ \underset{(0.0014)}{-0.0133}\,PDUM_t \\
& \underset{(0.0009)}{-0.0042}(S1_t + S3_t) + \underset{(0.0010)}{0.0091} + \hat{\varepsilon}_t
\end{aligned}$$

	{0.0832}	{0.0848}	{0.4655}	{0.0901}
	{0.2066}	{0.1032}	{0.0554}	{0.6169*}
	{0.0956}			
	{0.0950}	{0.2739}	{0.0971}	
	{0.1290}	{0.0513}		

Equilibrium price relationship:

$$p_t = \underset{(0.06)}{0.45}\,pb_t + \underset{(0.09)}{0.55}\,(w_t + t1_t - zy_t) + t3_t + constant$$

Equation diagnostics:

	T = 100 [1969(1) - 1993(4)]	R^2 = 0.90	$\hat{\sigma}$= 0.0035	DW = 1.84
	k = 14	AIC =-11.1708	SC =-10.8061	HQ = -11.0232
$F_{AR,1-4}$(4, 82) = 1.3295 (0.2660)	$F_{ARCH,1-4}$(4, 82) = 0.2335 (0.9187)		$\chi^2_N(2)$ = 0.4028 (0.6871)	
F_{ENC}(43 ,43)= 1.1026 (0.3751)	F_{RESET}(2 ,84)= 0.7320 (0.4840)			
Stability:	$S_{BH,SIG}$(1)= 0.1429		$S_{BH,JNT}$(15)= 2.9587	
Non-linearity:	$F_{STRNL,L,d=1}$(30, 56)= 0.9649 (0.5313)		$F_{STRNL,4,d=1}$(10, 56) = 0.5755 (0.8269)	
	$F_{STRNL,3\|4,d=1}$(10, 66) = 1.3818 (0.2083)		$F_{STRNL,2\|34,d=1}$(10, 76) = 1.0443 (0.4156)	
	$F_{STRNL,3\|24,d=1}$(10, 76) = 1.2403 (0.2798)			
STR Structural break	$F_{STRSB,3}$(33, 53)= 1.0153 (0.4711)		$F_{STRSB,2}$(22, 64)= 1.2522 (0.2395)	
	$F_{STRSB,1}$(11, 75)= 0.9807 (0.4714)			

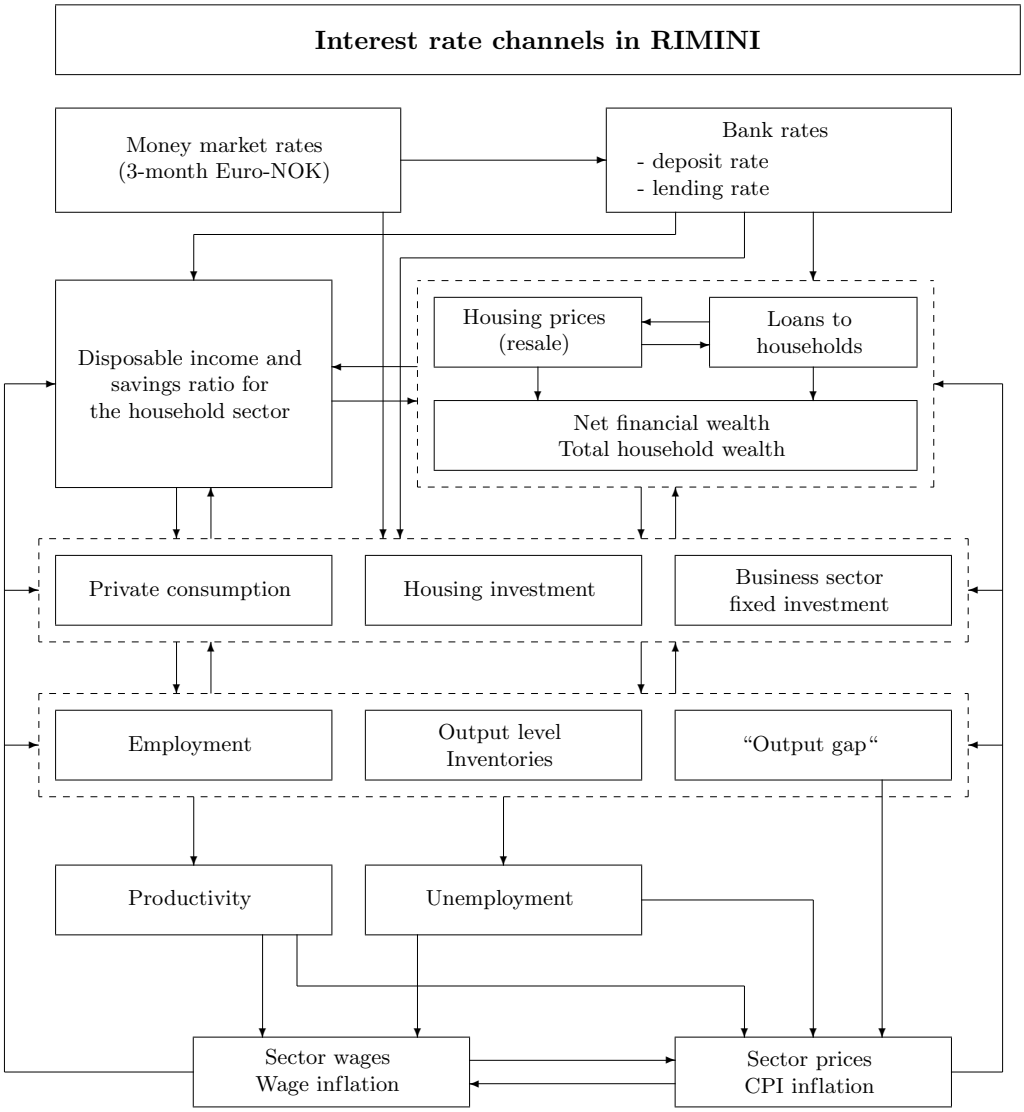


Figure 2.13 Interest rate channels in RIMINI. Effects on CPI inflation assuming constant exchange rates

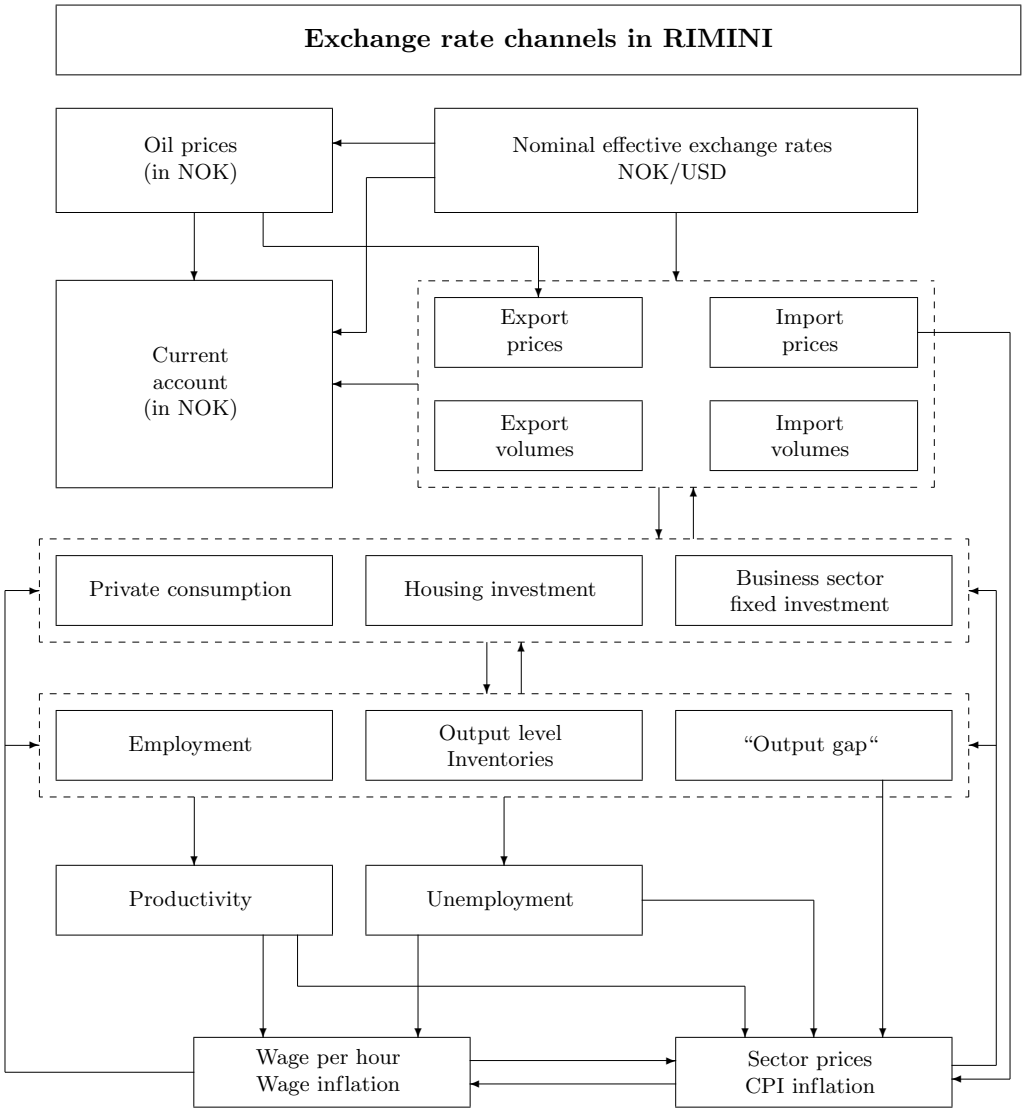


Figure 2.14 Exchange rate channels in RIMINI. Effects on CPI inflation assuming constant interest rates

2.C A decomposition of the data for recorded losses in commercial and savings banks

Estimated recorded losses are defined as the sum of changes in the stock of loss provisions, plus established losses (with and without previous loss provisions), minus reversed previously established losses (see figure 2.15).

$$EBTAP_t = \Delta TAVS_t + KTAP_t - TTAP_t \tag{2.9}$$

$EBTAP_t$ denote estimated losses, $TAVS_t$ is the stock of loss provisions, $KTAP_t$ are established losses (with and without previous loss provisions) and $TTAP_t$ denote reversed previously established losses. We can compare the estimated recorded losses, $EBTAP$, with the recorded losses, $BTAP$, reported by the banks. Discrepancies between the two series may occur e.g. because of interest rate changes or exchange rate fluctuations.

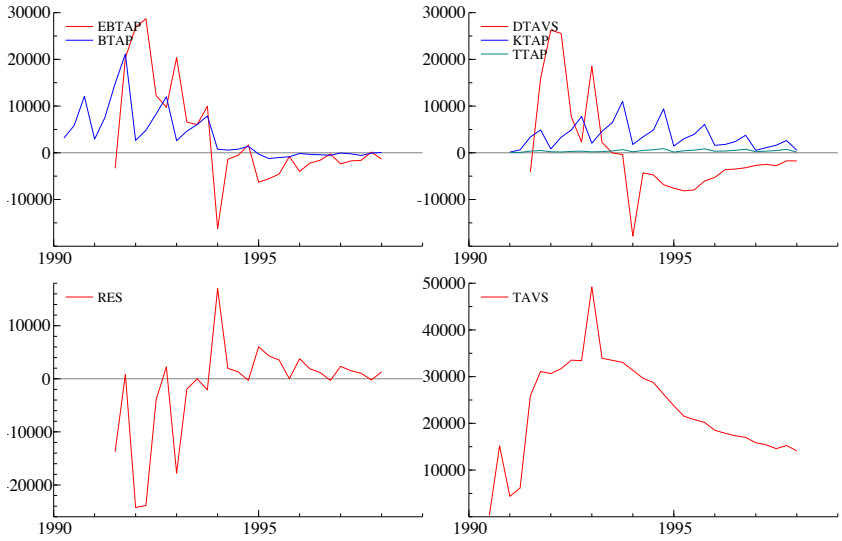


Figure 2.15 Estimated recorded bank losses and their decomposition, annual data from the SAFT database, 1990 to 1997.

2.D Scaling financial sector losses to the level of total bank assets

The level of total bank assets is not determined in the present version of RIMINI. To scale the level of losses, determined as a ratio of private sector interest bearing debt, to the level of assets in the banking sector we have estimated a simple relationship between the ratio of accumulated losses over four quarters to private sector debt, $TAPAND56_t$, to the ratio of accumulated losses over four quarters to total bank assets, $TAPAND29_t$.

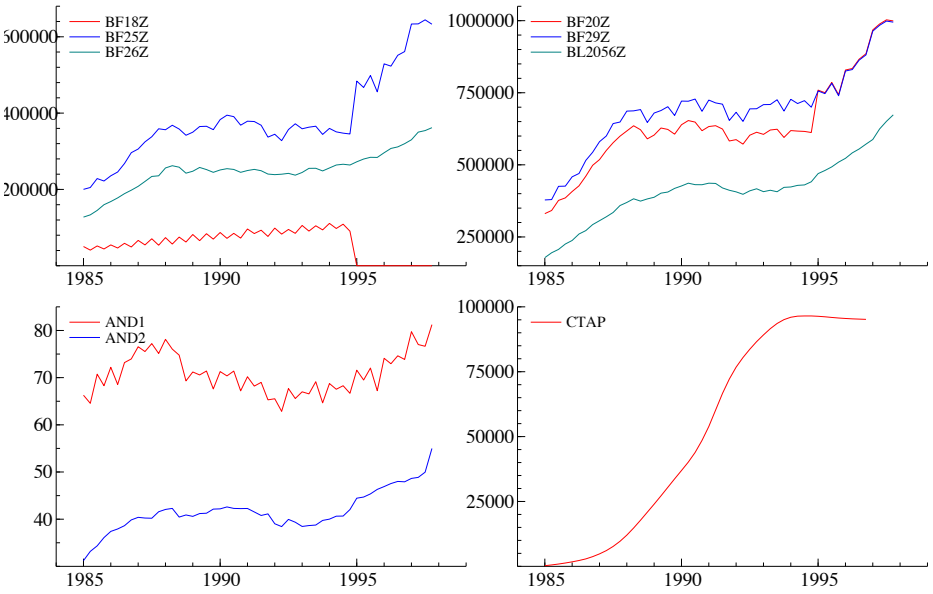


Figure 2.16 Gross financial assets in banks (20/29), 1985 Q1 to 1996 Q4. Postbanken (18), saving banks (25) and commercial banks (26).

$$TAPAND29_t = \underset{(0.0767)}{-0.3454} + \underset{(0.0007)}{0.0030}t + \underset{(0.0139)}{1.5099}TAPAND56_t + \hat{\varepsilon}_t$$

Estimation period 1986(1)-1996(4)

$k = 3,\ R^2 = 0.9967,\ \hat{\sigma} = 0.0610,\ \text{DW} = 1.27,\ \text{AR1-3F}(3, 38) = \underset{(0.0008)}{6.9533}^{**},$
$\text{ARCH1-3F}(3, 35) = \underset{(0.6712)}{0.5202},\ \chi^2_{JB}(2) = \underset{(0.0372)}{6.583}\ ^{*},\ \text{F}_{RESET}(1\ ,40) = \underset{(0.0005)}{14.183}^{**}$

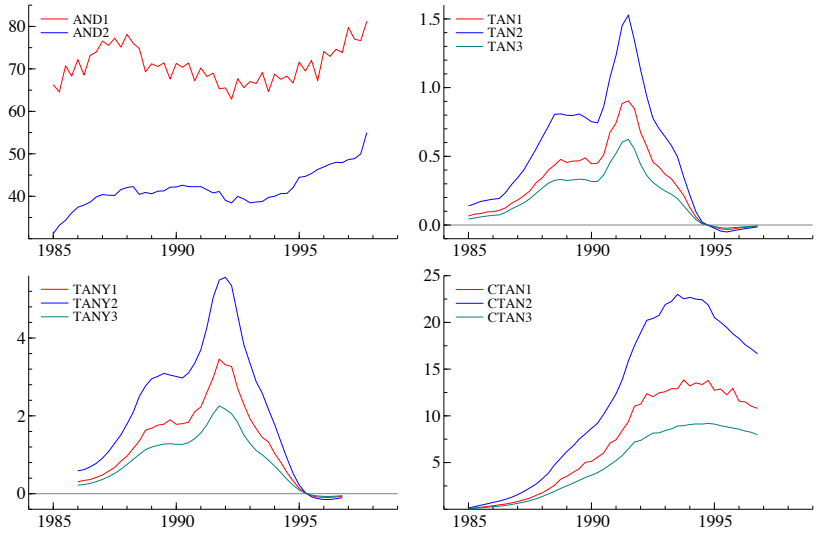


Figure 2.17 Quarterly data for bank losses, scaled as a ratio of bank assets and private debt, 1985 Q1 to 1996 Q4.

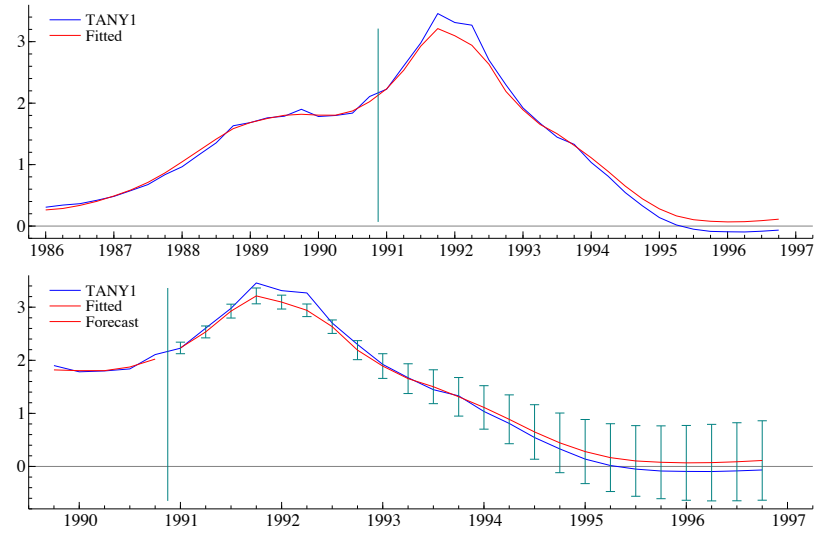


Figure 2.18 Technical relationship between annual bank losses, scaled as a ratio of bank assets and private debt respectively, 1985 Q1 to 1996 Q4.

2.E Two alternative ways to measure the output gap

Calculations of the output gap have become a widely used (shorthand) method of summarising the current state of macroeconomic development, whether the economy grows at a slower or faster rate than its long run (steady state) trend component.

In many applications, the output gap is calculated by a simple two-sided (centred) moving average of the output observations, such as the Hodrick/Prescott filter. The trend component τ_t is the solution of

$$\min_{\tau_t}\{\sum_{t=1}^{T}(y_t-\tau_t)^2+\lambda\sum_{t=2}^{T-1}[\Delta\tau_{t+1}-\Delta\tau_t]^2\}$$

for $t=1,\ldots,T$. y_t is the series to be filtered, τ_t is the trend and λ is the smoothing parameter. The output gap is estimated by $(y-y^*)_t$ where $y^*=(\tau_1,\ldots,\tau_T)$. The λ-parameter punishes changes in the trend component, and hence contributes to smoothing trend behaviour. If $\lambda=0$ (no punishment of non-smoothness), the optimal trend is the series y_t itself.

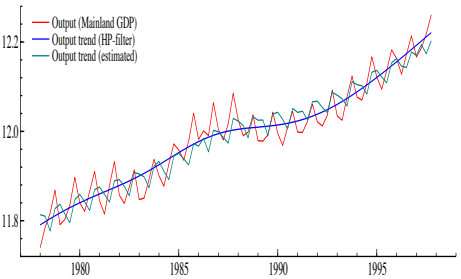
An alternative approach is to estimate the output gap from a simple linear regression model using a production function approach. Although we also considered a constant return to scale production function, linking potential output to capital and labour input, we ended up with the following simple specification whereby potential output is determined from a linear deterministic trend and labour input which captures the potential influence from a stochastic trend.

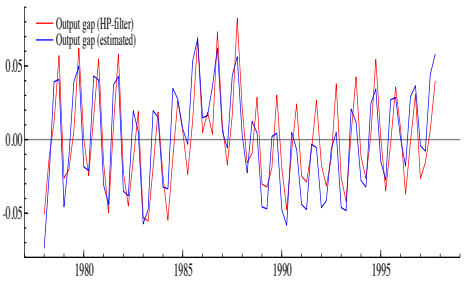
$$\widehat{yf}_t = \underset{(0.6513)}{8.3472} + \underset{(0.00017)}{0.00478}t + \underset{(0.0501)}{0.2482}twf_t + \hat{\varepsilon}_t$$

Estimation period 1978(1)-1997(4)

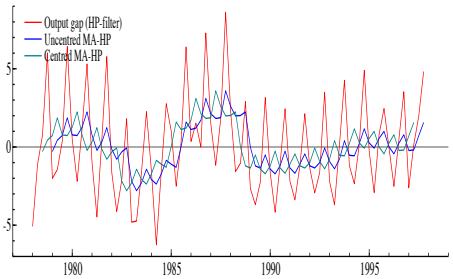
$k=3,\ R^2=0.9120,\ \hat{\sigma}=0.0353,\ \mathrm{DW}=1.32,\ \mathrm{AR1\text{-}4F}(4,73)=\underset{(0.0000)}{62.526^{**}},$
$\mathrm{ARCH1\text{-}4F}(4,69)=\underset{(0.0000)}{12.445^{**}},\ \chi^2_{JB}(2)=\underset{(0.0897)}{4.8231},\ \mathrm{F}_{RESET}(1\ ,76)=\underset{(0.1414)}{2.2087}$

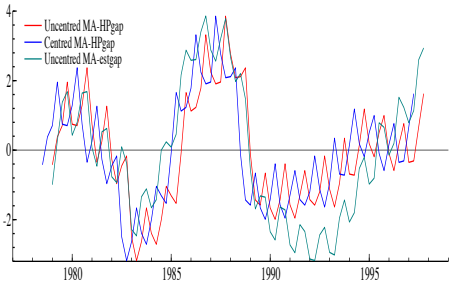
The output gap is estimated by $(y-\widehat{yf})_t$.



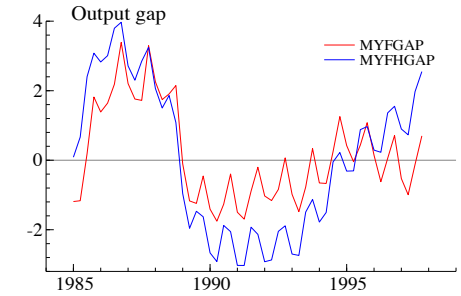


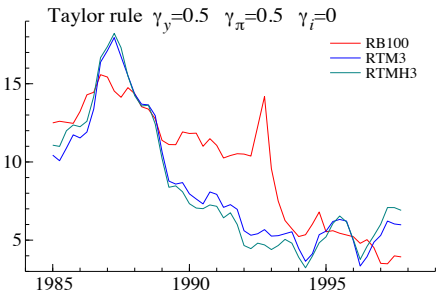
(a) Output gap - comparison of filtered and estimated version

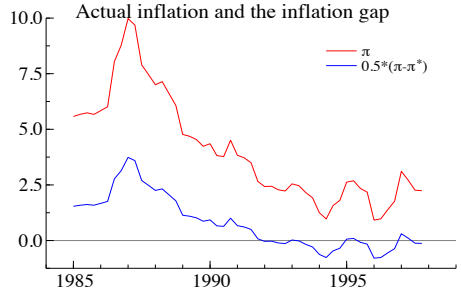


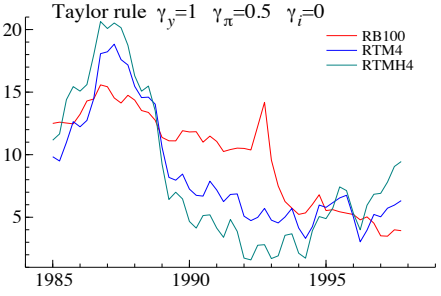


(b) Output gap - comparison of centred and uncentred moving averages









(c) Taylor interest rates - with different parameters

Figure 2.19 Output gap and Taylor interest rates

3

Monetary policy in Norway - A counterfactual view on the 2000s

Øyvind Eitrheim, Erling Motzfeldt Kravik and Yasin Mimir

3.1 Introduction

In Chapter 2 we presented a study of counterfactual monetary policy in the early 1990s, which was written in the late 1990s. The analysis was motivated by the views, which were widely held in Norges Bank at the time, that the monetary policy regime needed to be overhauled in light of previous experiences with an overly procyclical monetary policy stance under the prevailing fixed exchange rate regime.

In this chapter, which is written two decades later, we present a new study of counterfactual monetary policy, this time using Norges Bank's current main macroeconomic model NEMO (the Norwegian Economy MOdel).[1] We use different variants of NEMO to illustrate, in hindsight, how developments in the 2000s might have been different under counterfactual assumptions regarding monetary policy during two more recent episodes of disturbances in the 2000s, firstly when the global financial crisis hit in the fall of 2008 and secondly when oil prices fell significantly in 2014.[2]

In fact, Schembri (2019) reports a similar thought experiment as we have conducted in the case of Norway, assuming that the Bank of Canada had attempted to hold the Canadian dollar steady in 2014-2015, when key export commodity prices dropped significantly. Canada's experiences are obviously of relevance for Norway too. Commodity prices are typically hit first as they are traded in global markets where new information is rapidly embedded in prices. The Canadian dollar tends to move largely in tandem with the index of commodity prices. A recent study by Akram (2019) has compared co-movements between oil prices and the Canadian and Norwegian nominal effective exchange rates, respectively, and reports similar results, noting that exchange rates of major oil exporters tend to appreciate when oil prices increase and depreciate when they fall.[3]

This points to a feature Norway shares with other small open economies with a dominating oil-producing sector, namely that they are exposed to potentially large real shocks, which are related to the world market for oil. These shocks have asymmetric effects on small open economies relative to their core neighbouring central economies like Continental Europe in the case of Norway and the US in the case of Canada. In the early 1990's Norway's business cycle was in fact quite strongly negatively correlated with that of the countries in the European Monetary Union, far from what is prescribed for an optimum currency area.[4]

In both episodes of 2008 and 2014, respectively, the actual policy response to the

[1] NEMO is a modern type new-Keynesian DSGE-model (Dynamic Stochastic General Equilibrium) which was introduced in Norges Bank in 2006. The model is primarily used for monetary policy analysis and forecasting, cf. Brubakk, Husebø, Maih, Olsen and Østnor (2006) and Brubakk and Sveen (2009) for an overview and documentation of the first version of NEMO, and Gerdrup, Kravik, Paulsen and Robstad (2017) and Kravik and Mimir (2019) for subsequent model developments.

[2] Thanks to Karsten Gerdrup for many useful suggestions and comments to the analysis presented in this chapter.

[3] See also Akram (2004).

[4] See Eitrheim, Klovland and Øksendal (2016, p. 562) for some empirical evidence. Arguments along similar lines were presented by Andrew Haldane in Haldane (1997, p. 87), who argued that Norway needed nominal exchange rate flexibility in order to cushion against large and asymmetric shocks and structural dissimilarities relative to other European economies.

disturbances was to make monetary policy more expansionary. The key policy rate was in both cases reduced and we saw a rapid depreciation of the exchange rate. The counterfactual alternatives we analyse in theses two episodes of the 2000s, however, work in the opposite direction compared with those we analysed in Chapter 2. More precisely, in both episodes we analyse the effects of a counterfactual policy where Norges Bank, has to tighten monetary policy significantly in order to defend the prevailing exchange rate level, at least for some time, following a negative shock which threatens to depreciate the currency.

We will argue that this approach to the analysis of the two episodes of the 2000s, using NEMO, is quite analogous, at least in spirit, to the way the RIMINI model was applied in the late 1990s to analyse potential effects of alternative monetary policy rules had they been implemented in the early 1990s. In both cases we apply the modelling tools from the macroeconomic toolbox which are available to the central bank in real-time. One difference, however, is that in the 2000s we implement the counterfactual monetary policy by making changes in the monetary policy rule as will be explained later in this chapter.

In the final part of this chapter we have also used the NEMO to illustrate a possible counterfactual development in the late 1990s, which highlights some potential effects had inflation targeting and floating exchange rates been introduced some years earlier than what actually took place. As we have seen in Section 1.5 the transition to floating exchange rates took place around the turn of the century (1999-2001). In 1996 the economic growth in Norway had picked up again and had been on a steady rise since the slump ended in 1993. The oil prices had also grown to a level high enough to support the first surplus to be channelled into the sovereign wealth fund in 1996. In a period when rising petroleum revenues were being phased into the economy, it was a challenge for fiscal policy to stabilise the economy. The result was a rising appreciation pressure against the krone. During the prevailing fixed exchange rate regime the key policy rate was lowered to avoid a stronger krone. The effect was clearly pro-cyclical.[5]

3.2 Historical perspective on the two first decades with inflation targeting

Inflation targeting as a policy framework has proved to be resilient to major shocks such as the global financial crisis. Inflation targeting was no constraint with respect to a decisive monetary policy response when the financial crisis hit in 2008. Inflation expectations had been well-anchored and enabled central banks to implement extensive measures to put economies back on their feet. Monetary policy had a more pronounced stabilising effect in countries with an inflation target combined with floating exchange rates than in countries where the exchange rate was maintained at a fixed level.

In practice, inflation targeting internationally has moved in the direction of a more

[5] See Christiansen and Qvigstad (1997) for a comprehensive survey which analysed the existing monetary policy framework and assessed possible future alternative monetary policy regimes for Norway.

flexible approach, where the horizon for achieving the target is longer than in inflation targeting's early phase. Also for Norway, the main conclusion is that inflation targeting has worked well. It has helped to anchor inflation expectations, enabling monetary policy to stabilise output and employment. The Norwegian economy has been subject to major shocks since 2001. An important lesson is that a flexible monetary policy regime has been essential for the ability to make appropriate trade-offs in response to these shocks. The time horizon for achieving the target must be sufficiently long. Another lesson is that the exchange rate has played an important role as a shock absorber, especially during the financial crisis and in periods when oil prices have fallen. At the same time, the prevailing low interest rate regime internationally has restricted the room for manoeuvre in monetary policy in a small open economy like Norway.[6]

3.3 The new-Keynesian DSGE model NEMO

Norges Bank's main model for monetary policy analysis since 2006 is called NEMO (the Norwegian Economy MOdel). NEMO is a new-Keynesian dynamic stochastic general equilibrium model (DSGE) which has become a standard component in many central banks' macroeconomic toolkit since the early 2000s. NEMO has undergone continuous development since it was first introduced in 2006.[7]

The model features several real and nominal rigidities, which are standard in medium to large-scale New Keynesian DSGE models. These features are habit persistence, investment adjustment costs, variable capacity utilization as well as price and wage stickiness. The model also includes collateral constraints based on loan-to-value ratios, long-term mortgage debt contracts, incomplete interest rate pass-through and capital requirements in the banking sector.

The economy consists of several types of agents: households, entrepreneurs, financial intermediaries, capital and housing producers, intermediate goods and final goods producers, oil supply and oil extraction sectors. Figure 3.1 provides a schematic illustration of the model and displays how the different sectors and agents are linked to each other.

The numeraire good of the model, the *final good*, is shown near the top of the figure. This is produced by combining inputs from the domestic firms (Q), labeled intermediate goods producers in the figure, and imports (M). The final goods are converted into household consumption (C), corporate investment (I_C), housing investment (I_H), government expenditures (G) and used as inputs in the oil sector (Q_O). The intermediate goods producers employ labor supplied by households (L_I), rent capital from entrepreneurs (K_I) and sell their goods to the final goods producers (Q) and as export (M^*). The oil sector uses labor

[6] Cf. Røisland (2017) and the articles therein for a review of flexible inflation targeting and Norges Bank (2017) for an overview over experiences with the monetary policy framework in Norway since 2001.

[7] See Brubakk et al. (2006) and Brubakk and Sveen (2009) for an overview and documentation of the first version of NEMO, and Gerdrup et al. (2017) and Kravik and Mimir (2019) for subsequent model developments.

(L_O), capital (K_O) and final goods (Q_O) to produce oil supply goods which are exported (M_O^*) or sold to the domestic rig producers (I_{OF}). The rig producers invest in oil rigs (F_O) in order to extract oil (Y_O) that in turn is exported in full. The revenues are invested in the Government Pension Fund Global (GPFG), named "Oil fund" in the figure. Households consume (C), work in the intermediate goods sector (L_I) and in the oil sector (L_O), buy housing services (H), and interact with banks through borrowing (B_h) and savings through deposits (D). The banking sector lends to households (B_h) and entrepreneurs (B_e), and is funded through deposits (D), foreign borrowing (B^*), and equity (K_B). An uncovered interest parity relationship (UIP) together with the country's net foreign debt position (private borrowing, B^*, minus government claims on foreigners, B_F) tie down the debt-elastic risk premium to ensure stationarity.

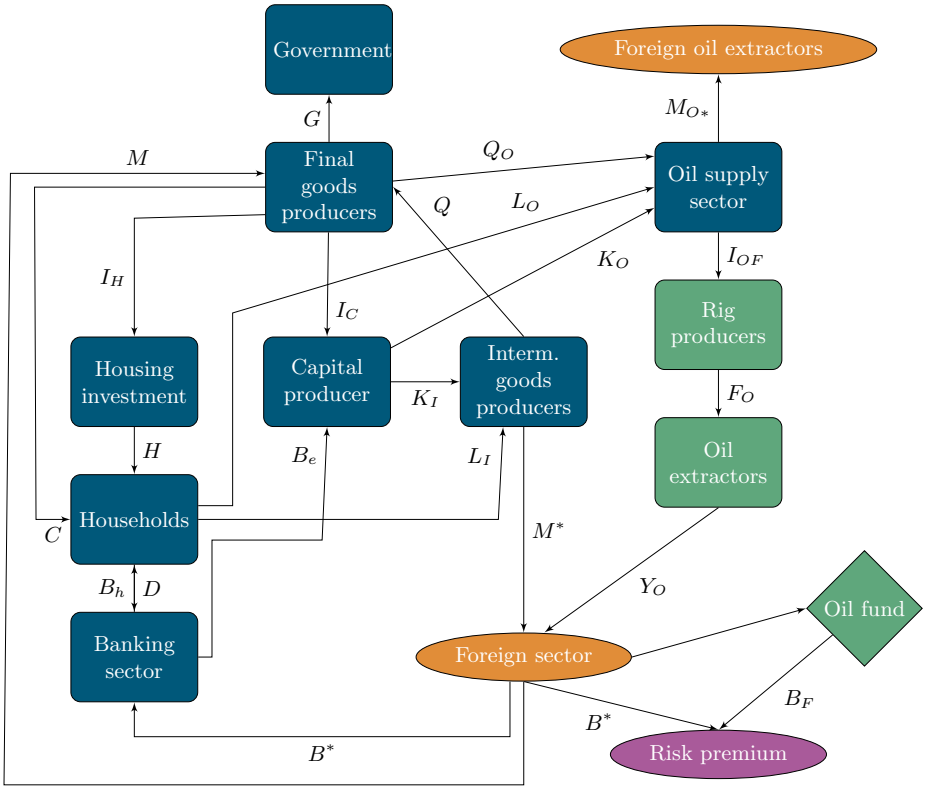


Figure 3.1 A schematic illustration of NEMO.

3.4 Simulations of a counterfactual monetary policy regime

When NEMO is used for monetary policy analyses and forecasting in the Monetary Policy Reports, the model is solved under optimal, discretionary, monetary policy. The weights in the operational loss function are model-dependent and have been calibrated to achieve reasonable responses and trade-offs between, e.g., output and inflation stabilization, when the economy is hit by different shocks. However, for the experiments in this paper we have instead utilized two alternative versions of augmented Taylor-type policy rules. The first is a benchmark monetary policy rule which is used in the simulations under the maintained assumption of floating exchange rates, whereas we have applied an alternative augmented Taylor-type policy rule in the counterfactual simulations where we want to stabilize the exchange rate at its initial level at the time of the shock. This alternative augmented Taylor-type policy rule will be explained in more details later.

The central bank conducts monetary policy (of type P) by setting its policy rate $R_{P,t}$. The money market rate R_t is equal to the policy rate $R_{P,t}$ multiplied by the money market premium $Z_{prem,t}$.

$$R_t = R_{P,t} Z_{prem,t}.$$

The benchmark policy rule can be thought of as a "mimicking policy rule" originally developed for model estimation purposes. This is a simple augmented Taylor-type policy rule that is estimated to match impulse responses under optimal policy in response to shocks to a selected set of variables.

The benchmark augmented Taylor-type policy rule is displayed in equation (3.1) below. The variables in the benchmark (mimicking) policy rule include (in gap terms) annual inflation ($\widehat{\pi}_t$), expected annual inflation one quarter ahead ($\widehat{\pi}_{t+1}$), wage inflation ($\widehat{\pi}_t^W$), output ($\widehat{Y}_{NAT,t}$), the real exchange rate ($\widehat{S}_t$), the money market premium ($\widehat{Z}_{prem,t}$), the foreign monetary policy rate ($\widehat{R}_t^*$), a monetary policy shock ($Z_{RN3M,t}$) and a lagged term $R_{P,t-1}$.

$$\begin{aligned}\widehat{R}_{P,t} = \omega_R \widehat{R}_{P,t-1} + (1-\omega_R)\left(\omega_P \widehat{\pi}_t + \omega_{P1}\widehat{\pi}_{t+1} + \omega_W \widehat{\pi}_t^W + \omega_Y \widehat{Y}_{NAT,t}\right. \\ \left. +\omega_S \widehat{S}_t + \omega_{PREM}\widehat{Z}_{prem,t} + \omega_{RF}\widehat{R}_t^*\right) + Z_{RN3M,t}.\end{aligned} \tag{3.1}$$

where $Z_{RN3M,t}$ represents a monetary policy shock which is assumed to follow an AR(1) process. The domestic and foreign money markets are linked together by the Uncovered Interest rate Parity condition (UIP),

$$E_t\{[1-\gamma_t^{B^*}]R_t^* \frac{S_{t+1}}{S_t}\} = R_t$$

Here R_t^* is the foreign money market interest rate, S_t is the nominal exchange rate (NOK per foreign currency unit) and $1-\gamma_t^{B^*}$ is a debt-elastic risk premium. It is assumed that the risk premium depends positively on the country's net foreign debt position. The

assumption of a financial friction is necessary to ensure stationarity in small open economy models like NEMO.

3.5 Three episodes with counterfactual analyses

3.5.1 Fixing nominal exchange rates during the financial crisis in 2008

In the exercises we use the standard model (with the benchmark monetary policy rule) to filter out all exogenous shocks that have hit the Norwegian economy in the period 1994Q1 to 2017Q4. These shocks are treated as structural and independent of the monetary policy regime. In the counterfactual simulations with the alternative monetary policy rule we have amended the benchmark policy rule with a term which puts a sufficiently large weight on the nominal exchange rate such that this variable is kept within a band of $\pm$ 0.5 percentage points measured from its starting value when we begin the counterfactual simulation.

All exogenous shocks (except the monetary policy shocks) are fed into this alternative model, starting in 2008Q4 and we run the model through 2010Q4, using data in 2008Q3 as starting values. The results indicate what would have happened if Norges Bank in 2008Q4 (*cet. par.*) had switched to a fixed nominal exchange rate regime, conditional on keeping all other impulses (shocks) unchanged.

Figure 3.2 shows the results from the counterfactual simulations and the benchmark simulations, respectively, plotted against the historical data. The *blue lines* show the historical data observed by the model whereas the *purple lines* indicate how the variables would have evolved if Norges Bank had followed the benchmark monetary policy rule exactly, i.e. feeding all filtered shocks except for the monetary policy shocks through the standard model. The *yellow lines* denote the counterfactual scenario. The purple and blue lines follow each other quite closely for most variables in Figure 3.2, indicating that the benchmark policy rule generates trajectories for the real economy which are broadly consistent with the historical data. Two exceptions concern, respectively, the policy rate and the exchange rate, where we observe larger differences, in particular towards the end of the simulation period.[8]

Figure 3.3(a) and Figure 3.3(b) focus on the results for the policy rate and the exchange rate, respectively. The blue lines show the observed historical data and the yellow lines denote how the variables evolve in the counterfactual scenario. Both the policy rate and the exchange rate are denoted in levels. We see that instead of the observed reduction in the policy rate we would have seen a tightening of monetary policy in the counterfactual scenario in order to counteract currency depreciation and preserve a stable exchange rate around its pre-crisis level. Figure 3.3(a) shows that the interest rate would have been increased to around 6.75 percent in 2008Q4 (annualized quarterly rate).

Additionally, the policy rate exhibits a more volatile pattern as small changes in the exchange rate has a large impact on the policy rate. Many of the negative shocks turned

[8] This stems in part from the fact that we do not feed the monetary policy shock into the model during the simulations with the benchmark policy rule.

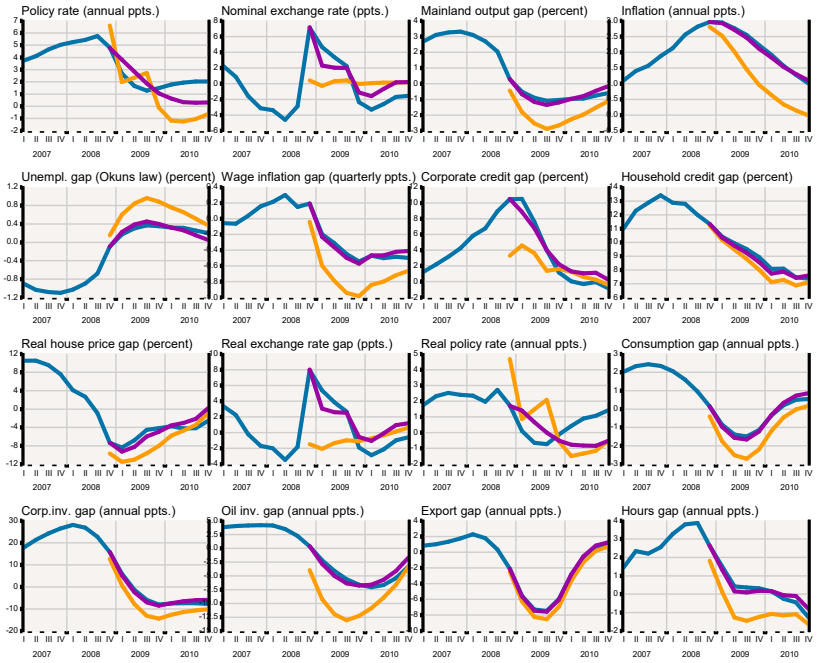
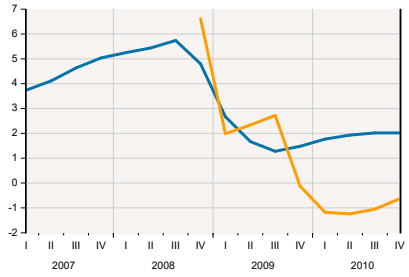
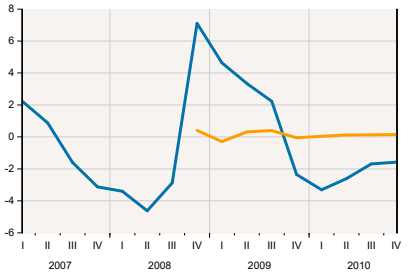


Figure 3.2 Counterfactual simulations, benchmark simulations and historical data. The global financial crisis, 2008Q4 - 2010Q4. The *blue lines* show the historical data whereas the *purple lines* indicate how the variables would have evolved if Norges Bank had followed the benchmark "mimicking" monetary policy rule exactly. The *yellow lines* denote the counterfactual scenario.

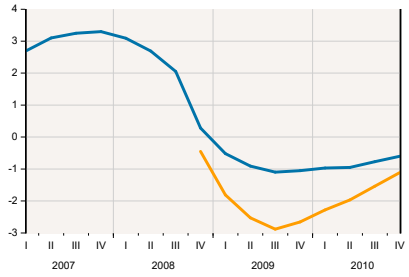
also out to be of a temporary nature and this would have called for a swift reversal of the interest rate to maintain exchange rate stability at its pre-crisis level. The monetary policy tightening would have led to reduced inflation, consumption, exports, and investments. In addition, hours worked and wage inflation would have been reduced and unemployment rates would have increased. In 2009Q4, a year into the alternative scenario, (annualized) inflation would have been around 1.25 percentage points lower than in the benchmark case and the mainland output gap would have been around 1.8 percentage points lower (in 2009Q3) (see Figure 3.3(c) and Figure 3.3(d)).



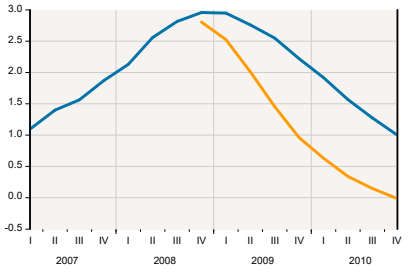
(a) Policy rate (annual ppts).



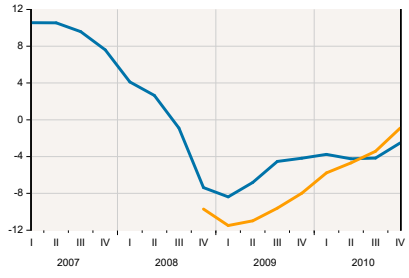
(b) Exchange rate (ppts).



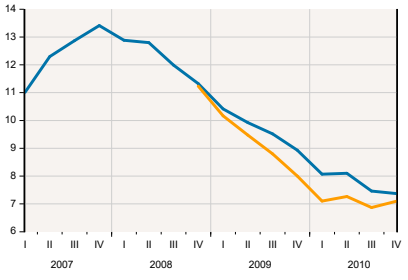
(c) Output gap for mainland Norway (percent).



(d) Inflation (annual ppts).

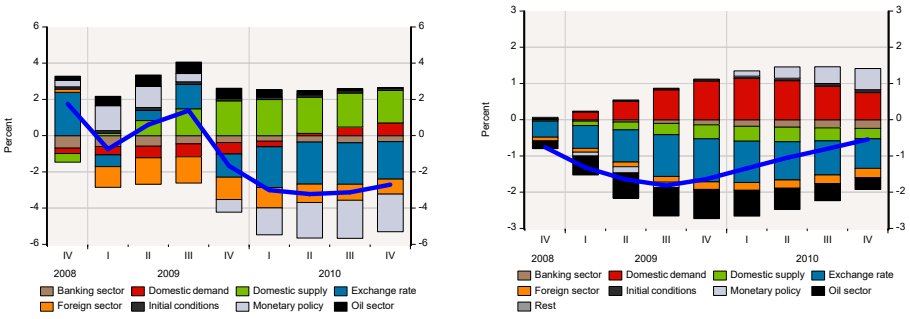


(e) Real housing price gap (percent).



(f) Credit gap (percent).

Figure 3.3 Counterfactual monetary policy during the global financial crisis, 2008Q4 - 2010Q4. The *blue lines* show the observed historical data and the *yellow lines* denote how the variables evolve in the counterfactual scenario.



(a) Policy rate gap (percent). *(b) Output gap for mainland Norway (percent).*

Figure 3.4 Counterfactual monetary policy during the global financial crisis, shock decomposition relative to observed data, 2008:4 - 2010:4.

Figure 3.4(a) and Figure 3.4(b) show how the differences in nominal interest rates and the output gap, respectively, can be decomposed in contributions from seven different types of shocks which are specified in NEMO, see Kravik and Mimir (2019, Section 4.3, p. 50) for details. More specifically, the figures show how the (same) filtered shocks have a different impact on the economy in the counterfactual case compared to historical data. This shock decomposition accounts for the main drivers behind the counterfactual changes and help guide our intuition regarding how the model works in this experiment. Figure 3.4(a) shows that the shock to the exchange rate risk premium is the main positive contribution to increase the policy rate in order to stabilize the exchange rate at the pre-crisis level. The other positive contributions during the initial quarters are shocks from the oil sector, domestic supply and monetary policy. The negative effects on the output gap are primarily driven by the oil sector and the exchange rate risk premium. Interestingly, in the counterfactual case, monetary policy is more accommodative towards positive demand shocks, leading to a stronger positive effect on the output gap in the counterfactual case. The temporary nature of the counterfactual tightening of monetary policy is illustrated by the rapid reverting of the policy rate already from 2009Q4 relative to what was observed in the data. After two years the output gap is almost back to its pre-crisis level.

3.5.2 Fixing nominal exchange rates during the 2014 drop in oil prices

The second experiment is conducted in a similar fashion as the one above: The exogenous shocks (except the monetary policy shocks) are fed through the alternative model, starting in 2014Q3 and we run the model through 2016Q3, using data in 2014Q2 as starting values. The results should be interpreted as what would have happened if Norges Bank switched to a fixed nominal exchange rate regime starting in 2014Q3, keeping all impulses (shocks) unchanged.

Figure 3.5 shows results from the counterfactual simulations and the benchmark simulations, respectively, plotted against the historical data. The blue lines show the data, the purple lines indicate how the variables would have evolved if Norges Bank had followed the benchmark "mimicking" monetary policy rule exactly, i.e. removing all monetary policy shocks from 2014Q3. The counterfactual scenario is denoted with yellow lines. In this case the benchmark policy rule generates trajectories for the real economy which are very close to the historical data, i.e. the purple and blue lines follow each other very closely for all variables reported in Figure 3.2, in this case the deviations are notably smaller also for the policy rate and the exchange rate.

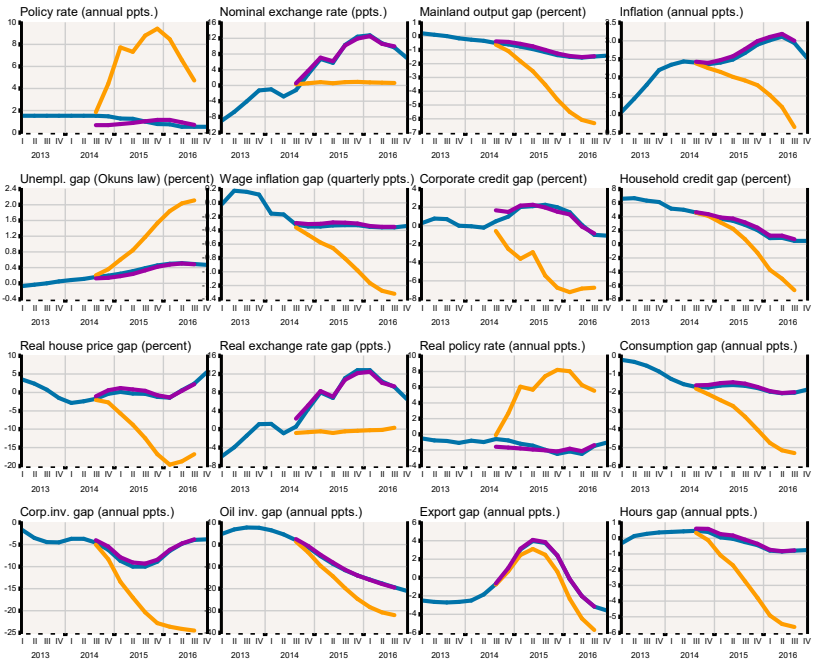
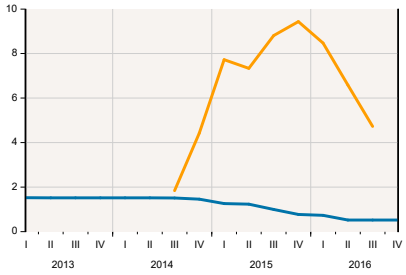
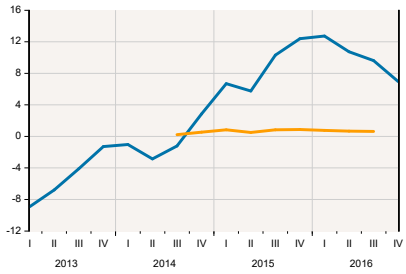


Figure 3.5 Counterfactual simulations, benchmark simulations and historical data. The global financial crisis, 2014Q3 - 2016Q3. The *blue lines* show the historical data whereas the *purple lines* indicate how the variables would have evolved if Norges Bank had followed the benchmark "mimicking" monetary policy rule exactly. The *yellow lines* denote the counterfactual scenario.

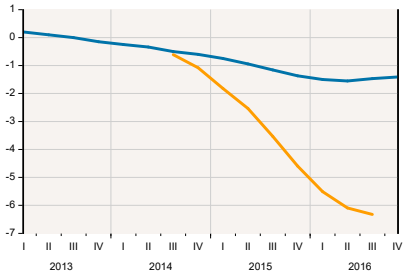
Figure 3.6(a) and Figure 3.6(b) focus on the policy rate and the exchange rate. We disregard the benchmark simulations explained above and focus only on the counterfactual scenario (yellow lines) and the historical data (blue lines).



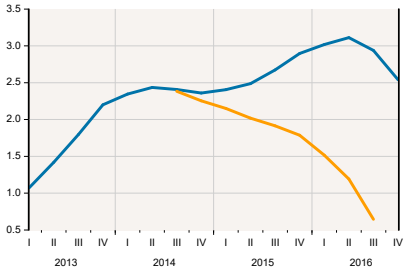
(a) Policy rate (annual ppts).



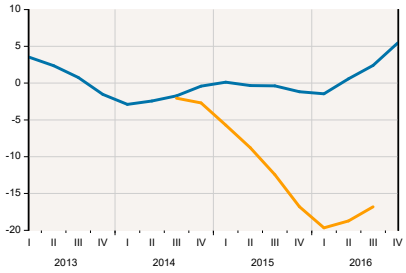
(b) Exchange rate (ppts).



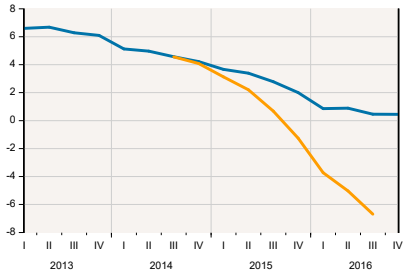
(c) Output gap for mainland Norway (percent).



(d) Inflation (annual ppts).



(e) Real housing price gap (percent).



(f) Credit gap (percent).

Figure 3.6 Counterfactual monetary policy after the oil price drop, 2014Q3 - 2016Q3. The *blue lines* show the observed historical data and the *yellow lines* denote how the variables evolve in the counterfactual scenario.

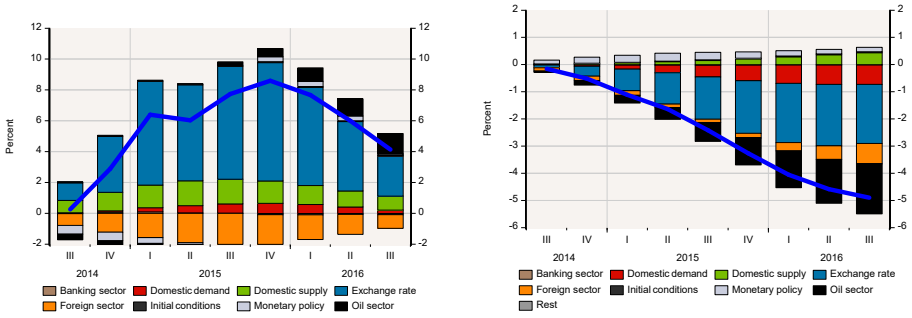
In the counterfactual scenario the policy rate is increased immediately to prevent the nominal exchange rate from depreciating. Note however that in this counterfactual scenario (from 2014 onwards), which distinguishes it from the scenario we discussed above following

the global financial crisis in 2008, is that the negative disturbances turn out to be considerably more persistent.

Consequently, the increase in the policy rate turns out to be more persistent too, and the policy rate is kept at a higher level for a considerably longer time and reaches levels we have not experienced in Norway since August 1998. The effects on the real economy are also of a more persistent nature in this case. The counterfactual monetary policy depresses consumption, investments, output and inflation, as well as real housing prices and credit considerably. This is shown in Figure 3.6(c) and Figure 3.6(d) for the output gap for the mainland economy and inflation, respectively, whereas Figure 3.6(e) and Figure 3.6(f) shows similar results for the real housing price gap and the credit gap.

Under the counterfactual scenario we observe eventually a negative output gap and annual inflation rates show a rapid decline ending around 200 basis points below the inflation target towards the end of 2016. Similarly, the real housing price gaps and the credit gaps also show a rapid decline into negative territories. This calls of course into question the realism of this counterfactual scenario and we will return to this later on.

Figure 3.7(a) and Figure 3.7(b) show the main drivers, according to the model, behind the policy changes under this counterfactual monetary policy aimed at stabilizing the exchange rate in 2014. Following such a persistent decline in oil prices the decomposition of the counterfactual response confirm that shocks related to the oil sector would have affected the real economy negatively in absence of flexible exchange rates. Note however, that the most important shocks are the risk premium shocks (real exchange rate shocks).



(a) Policy rate gap (percent). *(b) Output gap for mainland Norway (percent).*

Figure 3.7 Counterfactual monetary policy during the global financial crisis, shock decomposition relative to observed data, 2014Q3 - 2016Q3.

A couple of comments on the realism of such counterfactual scenarios are in order. We observe that in both counterfactual episodes we have discussed, in 2008 and 2014, respectively, the immediate response to hinder currency depreciation would have been a significant tightening of monetary policy, similar to what we have seen during previous episodes of currency depreciation in Norway in the 1980s and 1990s. In both episodes the depreciation

threat is met with a significant increase in the policy rate, which, in turn, results in a reduction in aggregate demand, prices and wage inflation, real house prices and credit, and an increase in unemployment.

The main difference between the two counterfactual scenarios, however, is that whereas the first episode during the global financial crisis was rather temporary, and the policy measures were quickly reversed, the negative shock to oil prices in 2014 turned out to be persistent. This difference is clearly reflected in the two counterfactual scenarios.

Due to the temporary nature of the disturbances in 2008 we reported in the previous subsection that the contraction following a counterfactual temporary tightening of monetary policy at that time would have entailed only temporary negative effects on the real economy. In contrast, we find in this case that a monetary policy tightening in response to the negative shocks to oil prices in 2014, aiming at keeping the exchange rates constant at the pre-crisis level, would have turned out to be more long-lasting due to the greater persistence of the negative oil price shock in 2014.

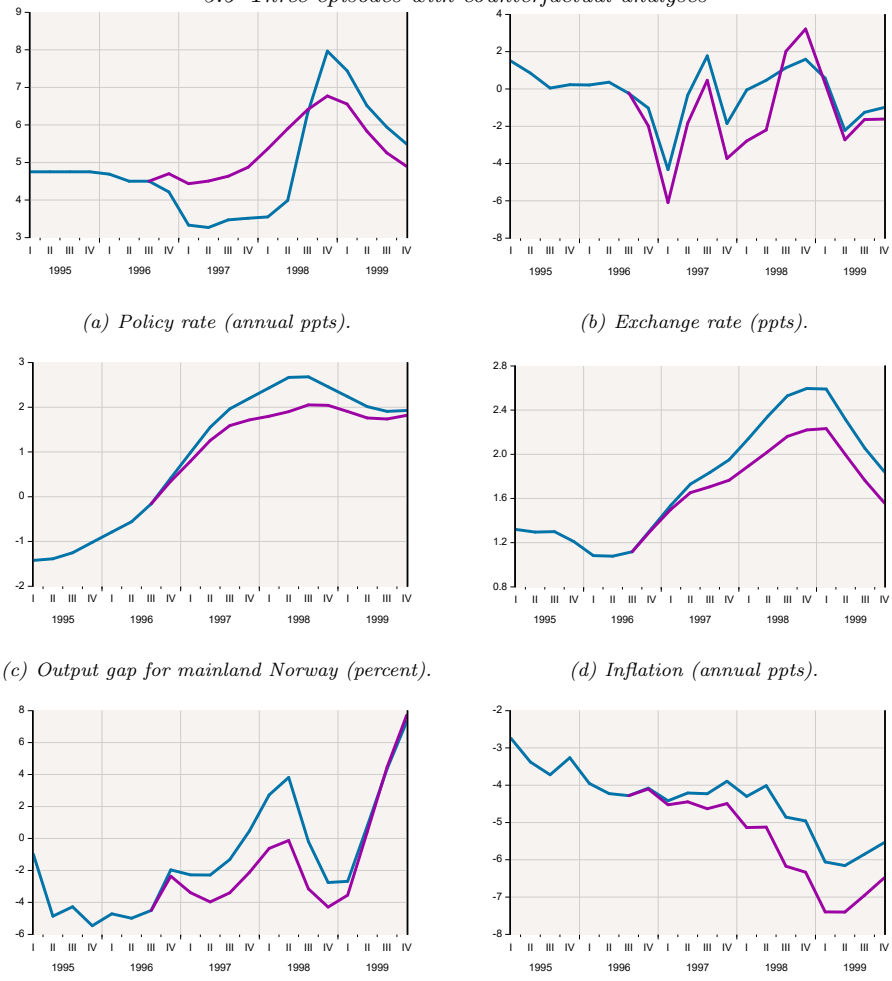
But this was not known when the oil prices dropped in 2014. It is therefore likely that as policymakers learned about the considerable persistence in the oil price shock this would have entailed changes the policy response accordingly. Admittedly, it may not be a very realistic assumption in this scenario that the policy response we have illustrated here would have been maintained over such a prolonged period. A permanent negative shock to oil prices would have entailed a depreciation of the equilibrium real exchange rate. Under flexible exchange rates we could achieve this through a nominal depreciation of the exchange rate and not only, such as in the case illustrated, through depressed consumer prices.

3.5.3 Floating exchange rates and a Taylor rule for policy rates during 1996-1999

In this section we present a counterfactual exercise of a different kind using the NEMO, but this time more like the counterfactual simulations for which we applied the RIMINI model in Chapter 2. We have conducted the following exercise: First, we have applied the standard version of NEMO (using the benchmark (mimicking) rule explained above) to filter out all exogenous shocks hitting the Norwegian economy from 1995Q1 to 2017Q4. We then feed the exogenous shocks (except the monetary policy shocks), through the same model, starting in 1996Q4 and run the model through 1999Q4, using data in 1996Q3 as starting values.[9] The results indicate what would have happened, counterfactually, had Norges Bank switched to a fully floating exchange rate regime starting in 1996Q4, keeping all impulses (shocks) unchanged but reacting to them according to the benchmark (mimicking) rule. Thus, we interpret the monetary policy shocks we have filtered out as representing the "managed float" aspect of monetary policy during this period.

Figures 3.8(a) and 3.8(b) shows the results for the policy rate and exchange rate. The

[9] This is similar to the purple lines in the experiments above.



(a) Policy rate (annual ppts).

(b) Exchange rate (ppts).

(c) Output gap for mainland Norway (percent).

(d) Inflation (annual ppts).

(e) Real housing price gap (percent).

(f) Credit gap (percent).

Figure 3.8 Counterfactual monetary policy during the latter half of the 1990s, 1996Q4 - 1999Q4.

counterfactual simulation indicate that monetary policy would have left the key policy rate considerably more stable in 1997 and 1998 compared with what actually happened in the data. Instead of first reducing the policy rate in 1997 before reversing it and engaging in a sequence of tightening changes in 1998, the counterfactual exercise would have implied a relatively constant interest rate in 1997 and a more gradual tightening during 1998. Monetary policy would have been considerably less procyclical and showed less tendency of a go-stop policy during these years. The net effect would have been a moderate tightening of aggregated demand, somewhat lower inflation, and a smaller, yet still positive output gap and a corresponding, yet less negative unemployment gap.

References

Akram, Q. F. (2004). Oil Prices and Exchange Rates: Norwegian Evidence. *Econometrics Journal*, *7*, 476–504.

Akram, Q. F. (2019). Oil price drivers, geopolitical uncertainty and oil exporters' currencies. Unpublished paper, Norges Bank (Central Bank of Norway).

Brubakk, L., T. A. Husebø, J. Maih, K. Olsen and M. Østnor (2006). Finding NEMO: Documentation of the Norwegian Economy MOdel. Staff Memo 2006/6, Norges Bank.

Brubakk, L. and T. Sveen (2009). NEMO - a new macro model for forecasting and monetary policy analysis. *Economic Bulletin 2009/1*, *80*, 39–47.

Christiansen, A. B. and J. F. Qvigstad (1997). *Choosing a monetary policy target*. Oslo: Scandinavian University Press.

Eitrheim, Ø., J. T. Klovland and L. F. Øksendal (2016). *A Monetary History of Norway 1816-2016*. Cambridge University Press.

Gerdrup, K., E. M. Kravik, K. S. Paulsen and Ø. Robstad (2017). Documentation of NEMO - Norges Bank's core model for monetary policy analysis and forecasting. Staff Memo 2017/8, Norges Bank.

Haldane, A. G. (1997). The monetary framework in Norway. In Christiansen, A. and J. Qvigstad (eds.), *Choosing a Monetary Policy Target*, 67–108. Oslo: Scandinavian University Press.

Kravik, E. M. and Y. Mimir (2019). Navigating with NEMO. Staff Memo 2019/5, Norges Bank.

Norges Bank (2017). Experience with the monetary policy framework in Norway since 2001. Norges Bank Paper No. 1/2017, Norges Bank.

Røisland, Ø. (ed.) (2017). *Review of Flexible Inflation Targeting [In Norwegian]*. Occasional Papers No. 51. Norges Bank, Oslo.

Schembri, L. (2019). Flexible Exchange Rates, Commodity Prices and Price Stability. Tech. rep., Bank of Canada. Towards 2021: Reviewing the Monetary Policy Framework. Remarks by Lawrence Schembri, Deputy Governor of the Bank of Canada, Economics Society of Northern Alberta, Edmonton, Alberta, June 17, 2019.

Tidligere utgivelser i Norges Bank skriftserie

Previously issued in this series:
(Prior to 2002 this series also included doctoral dissertations written by staff members of Norges Bank. These works are now published in a separate series: «Doctoral Dissertations in Economics».)

Nr. 1 Leif Eide: Det norske penge- og kredittsystem, Oslo 1973, utgått, erstattet med nr. 23
No. 1 Leif Eide: The Norwegian Monetary and Credit System, Oslo 1973, replaced by No. 23/24
Nr. 2 En vurdering av renteutviklingen og rentestrukturen i Norge, Oslo 1974
No. 3 Arne Jon Isachsen: The Demand for Money in Norway, Oslo 1976
No. 4 Peter Karl Kresl: The Concession Process and Foreign Capital in Norway, Oslo 1976
Nr. 5 Leif Eide og Einar Forsbak: Norsk rentepolitikk, Oslo 1977
No. 6 A credit model in Norway, Oslo 1978
Nr. 7 Struktur- og styringsproblemer på kredittmarkedet, Oslo 1979
Nr. 8 Per Christiansen: Om valutalovens formål, Oslo 1980
Nr. 9 Leif Eide og Knut Holli: Det norske penge- og kredittsystem, Oslo 1980, utgått, erstattet med nr. 23
No. 9 The Norwegian Monetary and Credit System, Oslo 1980, replaced by No. 23/24
Nr. 10 J. Mønnesland og G. Grønvik: Trekk ved kinesisk økonomi, Oslo 1982
No. 11 Arne Jon Isachsen: A Wage and Price Model, Oslo 1983
Nr. 12 Erling Børresen: Norges gullpolitikk etter 1945, Oslo 1983
No. 13 Hermod Skånland: The Central Bank and Political Authorities in Some Industrial Countries, Oslo 1984
Nr. 14 Norges Banks uttalelse NOU 1983:39 «Lov om Norges Bank og Pengevesenet», Oslo 1984, med vedlegg
Nr. 15 Det norske penge- og kredittsystem, Oslo 1985, utgått, erstattet med nr. 23
No. 15 The Norwegian Monetary and Credit System, Oslo 1985, replaced by No. 23/24
Nr. 16 Norsk valutapolitikk, Oslo 1986, utgått, erstattet med nr. 23
No. 16 Norwegian Foreign Exchange Policy, Oslo 1987, replaced by No. 23/24
Nr. 17 Norske kredittmarkeder. Norsk penge- og kredittpolitikk, Oslo 1989, utgått, erstattet med nr. 23
No. 17 Norwegian Credit Markets. Norwegian Monetary and Credit Policy, Oslo 1989, replaced by No. 23/24
No. 18 Ragnar Nymoen: Empirical Modelling of Wage-Price Inflation and Employment using Norwegian Quarterly Data, Oslo 1991 (Doct.d.)
Nr. 19 Hermod Skånland, Karl Otto Pöhl og Preben Munthe: Norges Bank 175 år. Tre foredrag om sentralbankens plass og oppgaver, Oslo 1991
No. 20 Bent Vale: Four Essays on Asymmetric Information in Credit Markets, Oslo 1992 (Doct.d.)
No. 21 Birger Vikøren: Interest Rate Differential, Exchange Rate Expectations and Capital Mobility: Norwegian Evidence, Oslo 1994 (Doct.d.)
Nr. 22 Gunnvald Grønvik: Bankregulering og bankatferd 1975–1991, Oslo 1994 (Doct.d.)
Nr. 23 Norske finansmarkeder, norsk penge- og valutapolitikk, Oslo 1995. Erstattet av nr. 34
No. 24 Norwegian Monetary Policy and Financial Markets, Oslo 1995. Replaced by no. 34
No. 25 Ingunn M. Lønning: Controlling Inflation by use of the Interest Rate: The Critical Roles of Fiscal Policy and Government Debt, Oslo 1997 (Doct.d.)
No. 26 ØMU og pengepolitikken i Norden, Oslo 1998
No. 27 Tom Bernhardsen: Interest Rate Differentials, Capital Mobility and Devaluation Expectations: Evidence from European Countries, Oslo 1998 (Doct.d.)
No. 28 Sentralbanken i forandringens tegn. Festskrift til Kjell Storvik, Oslo 1999
No. 29 Øistein Røisland: Rules and Institutional Arrangements for Monetary Policy, Oslo 2000 (Doct.d.)
Nr. 30 Viking Mestad: Frå fot til feste – norsk valutarett og valutapolitikk 1873–2001, Oslo 2002
Nr. 31 Øyvind Eitrheim og Kristin Gulbrandsen (red.): Hvilke faktorer kan forklare utviklingen i valutakursen? Oslo 2003
No. 32 Øyvind Eitrheim and Kristin Gulbrandsen (eds.): Explaining movements in the Norwegian exchange rate, Oslo 2003
No. 33 Thorvald G. Moe, Jon A. Solheim and Bent Vale (eds.): The Norwegian Banking Crisis, Oslo 2004
Nr. 34 Norske finansmarkeder – pengepolitikk og finansiell stabilitet, Oslo 2004
No. 35 Øyvind Eitrheim, Jan T. Klovland and Jan F. Qvigstad (eds.): Historical Monetary Statistics for Norway 1819–2003, Oslo 2004
Nr. 36 Hermod Skånland: Doktriner og økonomisk styring. Et tilbakeblikk, Oslo 2004
Nr. 37 Øyvind Eitrheim og Jan F. Qvigstad (red.): Tilbakeblikk på norsk pengehistorie. Konferanse 7. juni 2005 på Bogstad gård. Oslo 2005
No. 38 Øyvind Eitrheim, Jan T. Klovland and Jan F. Qvigstad (eds.): Historical Monetary Statistics for Norway – Part II, Oslo 2007
No. 39 On keeping promises, Oslo 2009

No. 40 Wilson T. Banda, Jon A. Solheim and Mary G. Zephirin (eds.): Central Bank Modernization, Oslo 2010
No. 41 On transparency, Oslo 2010
No. 42 Sigbjørn Atle Berg, Øyvind Eitrheim, Jan F. Qvigstad and Marius Ryel (eds.): What is a useful central bank?, Oslo 2011
No. 43 On making good decisions, Oslo 2011
Nr. 44 Harald Haare og Jon A. Solheim: Utviklingen av det norske betalingssystemet i perioden 1945–2010, med særlig vekt på Norges Banks rolle, Oslo 2011
No. 45 On managing wealth, Oslo 2012
No. 46 On learning from history – Truths and eternal truths, Oslo 2013
No. 47 On institutions – Fundamentals of confidence and trust, Oslo 2014
Nr. 48 Harald Haare, Arild J. Lund og Jon A. Solheim: Norges Banks rolle på finanssektorområdet i perioden 1945–2013, med særlig vekt på finansiell stabilitet, Oslo 2015
Nr. 49 Martin Austnes: Kampen om banken. Et historisk perspektiv på utformingen av det nye Norges bank- og pengevesen ca. 1814–1816, Oslo 2016
Nr. 50 Øyvind Eitrheim, Ib E. Eriksen og Arild Sæther (red.): Kampen om speciedaleren
Nr. 51 Øistein Røisland (red.): Review of Flexible Inflation Targeting (Refit). Sluttrapport
No. 51 Øistein Røisland (Ed.): Review of Flexible Inflation Targeting (Refit). End of Project Report
Nr. 52 Knut Getz Wold: I samarbeid
No. 53 Øistein Røisland and Tommy Sveen: Monetary Policy under Inflation Targeting
Nr. 54 Helge Syrstad: Statlig pengeteori? Pengebegrep, pengekrav og statsmyndighet
No. 55 Fabio Canova, Francesco Furlanetto, Frank Smets and Volker Wieland: Review of macro modelling for policy purposes at Norges Bank

NORGES BANK
Bankplassen 2, P.O. Box 1179 Sentrum, N-0107 Oslo
www.norges-bank.no

ISSN 0802-7188 (print), ISSN 1504-0577 (online)
ISBN 978-82-8379-135-8 (print), ISBN 978-8379-136-5 (online)

Norges Banks skriftserie | Occasional Papers | No. 56