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1. Introduction and Summary

Following the relatively high levels of inflation in the 1970’s and early 1980’s, lowering the rate of inflation became a stated goal of many central banks from the first part of the 1980’s and onwards. Even so, having an explicit target for the level of inflation as a monetary policy has a more recent history, and when Norway adopted an explicit inflation target on the 29. Mars 2001, it was only about ten years after the first country (New Zealand).

However, during the 1990’s several countries, with both developed and developing economies, and high and low rates of inflation, adopted explicit inflation targets. Therefore a lot of experience and knowledge was gained, which undoubtedly helped Norway designing their specific inflation targeting monetary policy.

Norway chose a long-term annul rate of inflation of 2.5%, which balances the trade-off of making the zero boundary limit for the nominal interest rate binding, and the cost of having a too high rate of inflation. But more importantly it was in line with what their major trading partners that had already adopted an explicit inflation.

The target horizon Norway chose, which later has been revised twice, was too reach the inflation target rate around two years, which the prevailing literature at the time though to be enough time for the central banks short term interest rate to work on the economy, and also give the central bank enough time to make small adjustments in their short term interest rate, thereby not jeopardizing financial stability. The latter point was, besides achieving a stable rate of inflation, the mandate given to Norges Bank by the Norwegian Government.

Even though inflation targeting has become increasingly popular over the last 15 years, there is no general consensus as to the effect inflation targeting has had on the countries that have implemented it. Mishkin and Schmidt-Hebbel (2001) conducts a comparison of countries that have an explicit inflation target on one hand, and industrial countries that do not have an explicit target on the other hand, and concludes that although the adoption of an inflation target has been a success at
lowering the rate of inflation, either prior to the adoption, or after, these countries have not been able to out-perform the control group of non-inflation targeting countries. Bernanke et al. (1999) and Corbo and Schmidt-Hebbel (2000) on the other hand argue that countries that have adopted an inflation target have been able to lower the sacrifice ratio between output and inflation, and also lower the output volatility.

Although there is no general consensus to the effect inflation targeting has had on the countries that have adopted it, there is broader agreement of what elements that need to be in place an inflation target to work properly. Mishkin (2004) outlines the following five elements as being the key characteristic of inflation targeting: Forward-looking medium-term target for the rate of inflation, price stability as the ultimate long-term goal for monetary policy, increased commitment for transparency by publishing plans and objectives, a strategy that emphasises information, and increased accountability for the monetary authorities.

As mentioned, since the early 1980’s lowering the rate of inflation had received high priority from Norges Bank, and following the Governmental decree that was issued on the 5. Of May 1992, which stated that Norges Bank should aim at keeping the exchange rates stable and at about the current levels vis-à-vis major European currencies, they implicitly also got a target for the rate of inflation.

The main objective of this thesis has been to analyse whether adopting an explicit inflation target has been an improvement in Norwegian monetary policy, or if it has just made the policies already in place, and clearly understood by the public, explicit, with no effects on the rate and volatility of inflation or people’s expectations.

The main empirical findings have been that adopting an inflation target by the Norwegian Government have had very limited effects, when measured in terms of variances, on inflation, ambiguous effects on the exchange rates, and a slight reduction in output volatility, although there are several elements of uncertainty associated with the last result.

However, by making the monetary policy more explicit the Norwegian Government has made Norges Bank more accountable for its actions, as it has been easier to
measure their performance ex-post, and it has also improved the communication between Norges Bank and the market through publications and a more understandable target.

This can be seen from the correlations between the sight deposit rate and the 3-, 5- and 10-year Government bonds, and between the sight deposit rate and bank deposits and loans, which have increased quite considerably, arguably meaning that market expectations have become more in line with those of Norges Bank.

The above results show that adopting an inflation target, as mentioned, has not caused Norges Bank to focus too strongly on reaching the explicit rate of inflation causing excessive fluctuations in other key variables, which have been argued by several economists to be a major disadvantage of having an explicit target for the rate of inflation. This can probably be contributed to the fact that Norges Bank has a flexible approach to inflation targeting, implying that they pay attention to other variables when setting their monetary instrument, although reaching the inflation target is the overriding goal in the case of a conflict.

So, even though we have developed the perspective that adopting an explicit inflation target by the Norwegian Government has not been a large revolution compared to the way monetary policy was previously conducted in Norway, it has certainly improved the communication between Norges Bank and the market, making market expectations more in line with those of Norges Bank, and it has also made it easier to judge the performance of Norges Bank and thus making them more responsible for their actions.

The thesis continues as follows: Chapter 2 presents inflation targeting as a monetary policy, how it compares with some other monetary policies and how Norway has designed their inflation target based on the experience of others. Chapter 3 analyses the effect implementing an inflation target has had on some key variable, and chapter 4 concludes the thesis.

All the calculations are done using MS Excel and the statistical software R.
2. Inflation targeting as monetary policy

2.1. Brief historical overview over recent monetary policies in Norway

Following the break-down of the Bretton Woods treaty system of fixed exchange rates at the beginning of the 1970’s the Norwegian krone (NOK) joined what was known as the “European Snake” where the members agreed on mutual exchange rates parities with narrow bands, but the currencies constituting the “European Snake” were allowed to fluctuate within a wider band with other currencies including the US dollar.¹ At the end of 1978 Norway left the European Snake and the NOK was instead fixed to a trade-weighted currency basket, which lasted until 1990 when the trade-weighted currency basket was replaced with the European Currency Unit (ECU), which is the predecessor of the EURO.²

In December 1992 the NOK was floated following a year of financial volatility and speculative attacks, which also saw the Swedish Krone, the Finnish Mark and the Sterling Pound become floating currencies that same year.³ From the second part of the 1980’s Norway went through a period with relatively high interest rates in order to curtail a rather extensive period of inflation, and thus also inflation expectations, which by this time was firmly entrenched in people’s minds.⁴ At the most extreme in 1986 the interest rate differential between Norway and the European average was about 8 percent, which thus discouraged investment and is also pointed out as one of the main factors that lead to a prolonged recession in Norway in the late 1980’s.⁵ The tight monetary policy conducted by Norges Bank, contributing to a sharp increase in the level of unemployment at the end of the 1980’s and start of the 1990’s, combined by the subsequent relative moderate wage settlements following the wage laws (“lønnslovene”) from 1988 and 1989, and a declining rate of inflation internationally reduced Norway’s rate of inflation considerably over this period. (NOU, 2001:14) It has been argued that the reduction in the rate of inflation and the subsequent decrease

¹ http://www.norges-bank.no/english/nb/history.html
² Ibid.
³ Ibid.
⁵ http://odin.dep.no/odinarkiv/english/brundtland_II/fin/006005-090022/dok-bn.html
in both the short term and long-term interest rates more consistent with international rates was a sign that markets had gained credibility in the Norwegian economy. (NOU 2001:14) Although Norway only implemented an explicit nominal anchor in the form of an inflation target on the 29. Mars 2001, a Governmental decree was issued on the 5. May 1992 which said that Norges Bank should aim at keeping the exchange rate stable and at about the current levels vis-à-vis major European currencies. Since this implies targeting about the same level of inflation and thus also the rate of interest in a deregulated economy, this implicitly gave Norway a target for the rate of inflation. The following graph shows that the change in the consumer price index (CPI) for Norway did in fact converged towards the same level as some of its major trading partners in the late 1980’s, early 1990’s consistent with the new mandate given to the central bank. In chapter 3 it will empirically and analytically be tested whether the implementation of an inflation target has had any effect on people’s expectations, since Norway, as mentioned, already implicitly targeted a low and stable rate of inflation prior to mars 2001.

**Figure 1.1:** The annual percentage change in consumer price index for Norway and some of its main trading partners.

![CPI Graph](http://odin.dep.no/odinarkiv/english/brundtland_III/fin/006005-090022/dok-bn.html)

Source: OECD

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2.2. Inflation targeting compared to other monetary policies

Experiences from several countries show those countries that have implemented inflation targets, both developed and developing, have usually invested heavily in lowering the rate of inflation prior to announcement of their target. (Mishkin and Schmidt-Hebbel, 2001) This is also highlighted by the fact that officials of many central banks often give different dates for the implementation of the inflation target than non-central bankers do, indicating arguably also that implementing an inflation targeting is a process that can take considerable time and is implemented gradually (Mishkin and Schmidt-Hebbel, 2001). However, other countries have used an inflation target as a means to achieving a lower rate of inflation and building up credibility by setting ever lower achievable inflation targets, which they have met and thus demonstrated their commitment and as a result gained credibility. (Mishkin and Schmidt-Hebbel, 2001) This illustrates the importance for the central banks to be credible in their policy setting, regardless of having an explicit inflation target or implicitly targeting inflation.

Eggertsson and Woodford (2003a,b) go one step further and argue that shaping people’s expectations through commitment and steadfastness in the conduct of policy is the only effective tool the central bank possesses in affecting the economy. It has been argued that although inflation expectations have declined and become more in line with the central bank’s projections in countries that have implemented inflation targets, it has only been through commitment and the achievement of results that the central bank has gained credibility regardless of the adoption of an explicit inflation target, or a more implicit monetary target of a low and stable rate of inflation. (Mishkin and Schmidt-Hebbel, 2001) A relevant question in this respect is why do countries that already have achieved a low rate of inflation, a credible central bank and already have a nominal anchor in place then choose to implement an explicit inflation target?

Mishkin and Schmidt-Hebbel (2001) conducts a comparison of countries that have an explicit inflation target on one hand, and industrial countries that do not have an
explicit target on the other hand, and concludes that although the adoption of an inflation target has been a success at lowering the rate of inflation, either prior to the adoption or after, these countries have not been able to out-perform the control group of non-inflation targeting countries. However, this comparison probably underestimates the performance of inflation targeting relative to other monetary policies, as several of the economies in the control group of industrialized countries, including USA, Germany and Switzerland, are argued to have had monetary regimes that resembles inflation targeting when Mishkin and Schmidt-Hebbel conducted their analysis (Bernanke and Mishkin, 1997).

Even though the USA does not have an explicit nominal anchor when conducing their monetary policy, one can argue that their monetary policy do fit several of the above characteristics, and most importantly they have a low and stable level of inflation in the long-run as their overriding goal (Mishkin, 2004). The former Federal Reserve Bank Chairman in the US Alan Greenspan defined their goal of price stability as when “expected changes in the average price level are small enough and gradual enough that they do not materially enter business and household decisions.”(King, 2002, p.1) Germany, before the adoption of the Euro, and Switzerland, prior to 2000, are also two well-known examples of countries with credible central banks that have focused strongly on inflation without having an explicit targeting regime.

Therefore, even though the Federal Reserve has a lot of features that is consistent with an inflation targeting central bank, several economists argue that the Fed’s mandate is inferior to an explicit inflation targeting bank’s mandate, especially when it comes to openness and having a clear, easily understandable target. (Mishkin, 2004) Without this set target the Fed’s monetary policy might increase the uncertainty about future policy, increase the volatility of the long-term market rates and thus inhibit long-term investment. (Mishkin, 2004) King (2002) points out that volatile long-term interest rates reflects uncertainty about the future conduct of monetary policy, and a monetary policy that therefore is able to reduce the volatility of the long-term interest rates will facilitate financial stability. Whether this has been the case for Norway will be empirically analyzed in chapter 3. Another advantage that has been outlined in countries that have adopted inflation targeting is that the debate in these countries have increased in horizon, focusing more on the long run rather than the short-run
issues of economic fluctuations and unemployment (Mishkin, 2004). A more ambiguous finding, which goes against the findings of Mishkin and Schmidt-Hebbel (2001), is that countries that have adopted an inflation target have been able to lower the sacrifice ratio between output and inflation, and also lower the output volatility (Bernanke et al. 1999 and Corbo et al. 2000). There will be more to say about the characteristics of inflation targeting as a monetary policy goal in the section below, which might help to explain why Norway adopted an inflation target in 2001.

2.3. Designing and implementing an inflation target

After the initial adoption by New Zealand in 1990, inflation targeting has been the choice of mandate given to a growing number of central banks in industrial and emerging economies, and many more are considering future adoption of this relatively new monetary framework (Bernanke and Mishkin, 1997). Depending on the definition used, there were about 19 countries that had implemented an inflation target in November 2000, consisting both of industrial and emerging economies, and at different stages on their road to adopting an inflation target (Mishkin and Schmidt-Hebbel, 2001). Several of the countries that implemented inflation targets initially were rather different with respect to the state of their economy, and as a consequence a lot of knowledge was gained as to which factors that needs to be in place for inflation targeting to be successfully implemented (Mishkin and Schmidt-Hebbel, 2001). These factors are sometimes referred to as the five pillars, and include: “absence of other nominal anchors, an institutional commitment to price stability, absence of fiscal dominance, policy instrument independence and policy transparency and accountability.” (Mishkin and Schmidt-Hebbel, 2001, p.3). The reason for their importance is because they help to strengthen people’s belief that the central banks are committed to achieving the inflation target, which is essential for a proper conduct of any monetary policy where inflation targeting is no exception (Mishkin and Schmidt-Hebbel, 2001).

Although several countries have had success in adopting inflation targeting and thus made a low and stable rate of inflation their nominal anchor, there is still a lot of discussion as to how an inflation target should be designed with respect to the horizon
of reaching the set target, what inflation rate to target and whether inflation targeting is a stringent monetary rule or rather a framework for the central bank to operate within. The next sections will outline some of the main views that have been put forward on these issues.

2.3.1. Target rate

In choosing a long-term inflation target there are two important factors that has to be addressed. The general consensus among economist today is that there is a negative correlation between the rate of inflation and economic growth, and that it’s increasingly negative the higher the rate of inflation (Mishkin and Schmidt-Hebbel, 2001).

In a study where 133 market economies were investigated over the last 50 years the authors argued that the idea of the 1960’s and 1970’s that inflation was a good thing had no root in the real world, or put in their own words: “the old idea that in some sense inflation may be good for growth or is perhaps an inevitable part of the growth process should remain buried in the cemetery of harmful policy ideas.” (King, 2002, p.12). Targeting a too high inflation rate is thus costly in terms of the level of economic growth. Most countries in the western world had experienced high levels of inflation during the 1970’s and early 1980’s with rather dire consequences to output and unemployment, and the fight against high rates of inflation therefore received heightened attention from monetary authorities during the 1980’s (Bernanke and Mishkin, 1997). However, as some countries have experienced recently, there is also a potential cost of having a too low inflation target, as there might be an increased risk of having a binding zero bound limit (ZBL) for the nominal interest rate, which means that the central bank looses control over its main monetary instrument (Eggertsson and Woodford, 2003). The lower the inflation target, obviously the larger the risk of this happening. Although Japan does not have an inflation target, their recent experience with a binding ZBL for the nominal interest rate and deflation, whereby people now expect deflation, illustrates the importance of setting a target rate significantly above zero and thus reducing the risk of deflation and a binding ZBL (Eggertsson and Woodford, 2003).
Norges Bank also show concern about this matter as they say that the very low levels of interest that has prevailed recently is to ensure that inflation expectations of the general public doesn’t get stuck at the last couple of years low levels of inflation (Norges Bank, Inflation Report, 03/06). They further argue that it’s important to safeguard against a binding ZBL when the rate of inflation is already low by committing to low interest rates over time and thus hopefully not causing people to revise their expectations when they fail to reach the inflation target within the set horizon (Norges Bank, Inflation Report, 03/06). This thus further highlights that it is very important that the central bank has gained credibility by previous commitment, as they then might be able to stimulate the economy by signalling a future strategy even though the ZBL is binding (Bernanke et al. 2004). Most inflation targeting central banks have adopted a target of between 2 and 3 percent, which is consistent with the above discussion (Eggertsson and Woodford, 2003). Bernanke et al. (2004), although agreeing on having an “inflation buffer” as a necessary measure in minimizing the risk of making the ZBL binding, they argue that a more credible central bank will not need as big inflation buffer as a central bank that lacks credibility.

There are also other important reasons why central bank should target a rate of inflation that is “well above” zero. Inflation rates have been shown to overestimate the true underlying rates of inflation, partly because they fail to account for quality changes in the products measured, and also because in a world with numerous substitutes for most products, price indices fail to incorporate the effects of substitutions when there are price changes within certain product groups (Bernanke and Mishkin, 1997). In other words, there will be a substitution away from products that increase relatively a lot in price over time, so an inflation index that has the same weight on this product will risk overestimating the "true" value of inflation over time (King, 2002). In the US, these effects are estimated to understate the actual rate of inflation between 0.5 to 2.0 percent per annum, and it’s no reason to expect that the numbers for Norway are any different (Bernanke and Mishkin, 1997).

Nominal wage-rigidity is another reason that inflation targeting countries should target a rate of inflation “well above” zero (Bernanke and Mishkin, 1997). Akerlof,
Dickens, and Perry (1996), argue that as the evidence support there being downward wage rigidity, which implies that the real wages can only be lowered in the short run by having a positive rate of inflation, and as such might reduce the impact a recession has on the level of unemployment. As a consequence most countries that have implemented an inflation target have chosen an inflation target around 2 to 3 percent, which is a moderate inflation target, but still substantially higher than zero (Mishkin and Schmidt-Hebbel, 2001). Norway also settled for an inflation target within this range when they chose 2.5 percent as their target, which is also in line with some of its major trading partners.

2.3.2. Target horizon

As the central bank can only affect the future rate of inflation as their monetary instruments work with lags, it has to implement current polices based on forecasts about future rates of inflation (Svensson, 1997). These lags might be quite long, as much as two years or more (Mishkin and Schmidt-Hebbel, 2001). By having a too short horizon the central bank might be running into trouble even though it conducts an optimal monetary policy based on the forecasts on hand at the time of policy implementation (Mishkin and Schmidt-Hebbel, 2001). A central bank missing its target might thus be induced to blame factors outside of their control, perhaps rightly so, as the reason for their failure (Svensson, 1997). Nonetheless, the public might loose confidence in the central bank even though they conducted monetary policy in an optimal way (Svensson, 1997). It’s therefore essential that the monetary policy be designed in such a way that it minimises the risk of the central bank not hitting its target when following an optimal policy (Svensson, 1997).

There might also be adverse signalling effects from the central bank if they are required to frequently re-optimize their policy in order to reach the set target within a very short time frame, as the public might get confused about the future conduct of policy, thus undermining one of the main features that has been put in favour of having a inflation target in place (Eggertsson and Woodford, 2004). Kydland and Prescott (1977) showed that if a central bank re-optimizes too frequently, whereby setting the “best” policy at all times given their most recent forecast, the following
outcome might be suboptimal relative to a more long-term commitment with respect to output and inflation fluctuations (Bergo, 2007). This might particularly be a problem in a small open economy as the central bank in an attempt to hitting its target might be tempted to manipulate the exchange rate in its favour, as these changes have a quicker impact on inflation than the interest rate controlled by the monetary authorities (Mishkin and Schmidt-Hebbel, 2001). It has been argued that the 1997 recession in New Zealand was brought about as a direct result of initially having a too short target horizon and thus trying to manipulate the exchange rate, which caused an overly tight monetary policy (Mishkin and Schmidt-Hebbel, 2001). On the other hand, by having a very long horizon it will be hard for the public, as well as the government, to judge the performance of the central bank, which arguably also means loosing one of the main advantages of having an explicit inflation target (Bernanke and Mishkin, 1997). A very long horizon can also mean that in the short run the rate of inflation can deviate considerable away from its long-term target without jeopardizing the central banks mandate, which might make it harder to discipline wage setting, potentially causing even larger fluctuations (Bergo, 2007).

It has been shown theoretically that the speed of adjustment towards the interest rate target is directly related to how the central bank targets output fluctuations relative to inflation fluctuations (Svensson, 1997). The higher this ratio, the slower the adjustments towards the long-term inflation target. In other words: a longer target horizon therefore means that the central bank can have a higher weight on output fluctuations in its loss function, as they can adjust their short-term interest rate more slowly. The mandate given to Norges Bank, which places emphasis on both price stability and financial stability, justifies that they have a flexible inflation target in place, which means that they target both inflation and output fluctuations, but with inflation being the overriding goal in a situation of conflict.  

It can be argued that the recent rhetoric of “small, not too frequent steps” is consistent with having a significant positive weight on output fluctuations relative to the fluctuation of inflation, requiring a relative longer horizon regardless of the type of shock that hits the economy. Norges Bank states that their recent conduct is consistent with having a loss function with a weight of 0.3 on output fluctuations, thus perhaps justifying their

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7 http://www.lovdata.no/all/hl-19850524-028.html
horizon of between 1 and 3 years, or in their own words: “The operational target of monetary policy is low and stable inflation, with annual consumer price inflation of approximately 2.5% over time. ... Monetary policy influences the economy with long and variable lags. Norges Bank sets the interest rate with a view to stabilizing inflation at the target within a reasonable time horizon, normally 1–3 years. The relevant horizon will depend on disturbances to which the economy is exposed and how they will affect the path for inflation and the real economy in the period ahead.” (Norges Bank, Inflation Report, 03/06, p.4). Norges Bank target horizon is also consistent with the horizon adapted by most of the inflation targeting countries. (Mishkin and Schmidt-Hebbel, 2001). It should be noted that Norges bank changed their target horizon in 2004, following several price shocks that made the current horizon, of about 2 years at the time, rather undesirable, as it would probably have caused a too expansive monetary policy with the potential to threaten financial stability (Norges Bank, Inflation Report, 01/04). Svensson (1997) argues that if the central banks loss function puts any weight on output fluctuations in their loss function, central banks should have a horizon that is longer than the lags associated with the implementation of their monetary policy instrument, usually said to be up to around two years (Mishkin and Schmidt-Hebbel, 2001). The reason is that the explicit level of inflation targeted might then be approached more slowly, which implies that the central bank can use more gradual and small steps when adjusting their monetary instrument, which arguably reduces the output volatility (Mishkin and Schmidt-Hebbel, 2001). However, as noted, this has to be balanced with having a “too long” horizon, which might reduce credibility as it takes a long time before the public knows if they have hit the target or not, and thus create uncertainty about the short-term inflation rates (Mishkin and Schmidt-Hebbel, 2001). Partly as a response to this potential problem and to increase the precision of communication some central banks, including Norges Bank, now publish reports containing forecasts of inflation and output, and at the same time having a reasonable long target horizon (Mishkin and Schmidt-Hebbel, 2001). That Norges Bank changed its horizon in 2004 is therefore consistent with Svensson’s findings, and also in line with the recommendations given in the 2006 Norges Bank Watch Report, which states that when faced with changed

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8 This was changed from around two years in June 2004 (Inflation report, Norges Bank, 02/2004) and was again changed in Mars 2007, where they now aim to reach the inflation target of 2.5% over time (Monetary policy report, Norges Bank, 01/2007)
circumstances that make the current mandate give an inferior policy, Norges Bank should ask the Government for a new mandate (Norges Bank Watch Report, 2006).

2.3.3. Point target versus target interval

Having a point target as opposed to a target range for the rate of inflation can help a central bank to more easily communicate the goal for its new policy, which might be crucial if the central bank lacks credibility and the public has a great deal of backward-looking expectation (Mishkin and Schmidt-Hebbel, 2001). If on the other hand the central bank is not able to hit its point target they might as a consequence loose credibility even though they would clearly be in any relevant target interval (Mishkin and Schmidt-Hebbel, 2001). Building credibility is crucial for a central bank committed to lowering an initial high level of inflation, it has therefore been argued that a point estimate is better for high inflation countries, as it is easier for the public to judge their commitment (Mishkin and Schmidt-Hebbel, 2001). It has nonetheless proved costly for high inflation countries in terms of output and unemployment to lower the rate of inflation, as the public have backward-looking expectations when setting prices and during wage negotiations (Mishkin and Schmidt-Hebbel, 2001). Norway some years prior to the adoption of the inflation target had put considerable effort into lowering the rate of inflation, which meant that they had a rather low rate of inflation and arguably also a relatively credible central bank. They nonetheless adopted a point target of 2.5 percent, which also is consistent with what most of their major trading partners have in place (Bernanke and Mishkin, 1997).

2.3.4. Central bank independence

It’s crucial for the success of inflation targeting as a monetary policy goal that the central bank, or other monetary authorities outside the control and influence of politicians, is independent on a day-to-day basis in setting their policy instrument (Mishkin and Schmidt-Hebbel, 2001). A main reason for this is that the public believes in policies stated by the central bank regardless of the political party in power, and / or how long it is before the next election (Mishkin and Schmidt-Hebbel, 2001). However as the government usually sets the monetary policy goal, in inflation
targeting countries as well as countries that have other monetary policies in place, they are indirectly able to affect the conduct of the central bank (Mishkin and Schmidt-Hebbel, 2001). Svensson (1997) argues that by choosing the weights the central bank puts on the different variables in their loss function, a government might be able to determine how quickly the central bank should respond to shocks. That is, the aggressiveness of the central banks in setting its monetary instrument(s) is to a certain degree dictated by the mandate set out by the government.

2.3.5. Escape clauses

Although the above sections highlights the importance of having a properly designed policy in place, there are always potential situations that are impossible for the central bank to predict, and also certain scenarios where it will be suboptimal for the central bank to target the explicit rate within the set horizon. In order to cope with supply shocks and other factors affecting inflation, which is outside the central banks sphere of influence, most central banks have implemented formal escape clauses and/or other measures that seek to more properly judge the performance of the central bank (Mishkin and Schmidt-Hebbel, 2001, Table 2). By having formal escape clauses in place the central bank can hedge against large supply shocks causing the central bank to step outside its mandate. Large supply shocks are however rather seldom, and is thus not the most pressing issue on a day-to-day basis with regards to missing the target even though monetary policy was conducted optimally based on their forecasts.

One way of doing this is by targeting core inflation, an inflation measure that usually excludes energy prices as well as other products with highly volatile prices (Bernanke and Mishkin, 1997). Most countries have opted for this option, including Norway where the core inflation target takes out the effect of energy prices and tax effects (Norges Bank, Inflation Report, 03/06). This can however have unintended effects as energy and food prices are often left out of these inflation measures, which can be discriminating against certain population groups as these products make up a large fraction of their consumption bundles. A core inflation measure can thus fail to measure the underlying living expenses for these population groups. The following graph shows the expenditure on two income groups on products that might be omitted
from core inflation measure for Norway. As the graph shows, there is a relatively large difference between the high income group on one hand, and the low income group on the other, when it comes to the category consisting of housing, water, electricity, gas and other fuels, which outlines the above point.

**Figure 1.2:** The difference in expenditure as a per cent of total income for two different income groups.

Finally the central bank can have a broader bandwidth, which undoubtedly means that the central bank will hit its inflation target more often (Mishkin and Schmidt-Hebbel, 2001). As abovementioned, this will however raise the question of credibility, as a broad target band will arguably be confusing for people (Mishkin and Schmidt-Hebbel, 2001), and its doubtful if wage negotiators will base their negotiations on the belief that the central bank will be in the lower part of the inflation band, particularly if inflation has been rather volatile. It is therefore argued that the best and most credible way of dealing with lags as well as uncertainty is to increase the length of the target horizon (Mishkin and Schmidt-Hebbel, 2001). This is what was done in New Zealand following the 1997 recession, and also in Norway in 2004.
2.3.6. Targeting other variables

Several economists have criticized an inflation targeting monetary policy on the ground that is focuses too strongly and narrowly on the rate of inflation at the expense of other key economic variables including asset prices and exchange rates (Bernanke and Mishkin, 1997). However, Bernanke et al. (1999) argues that the actual conduct of central banks that target the inflation rate show a genuine concern for other macroeconomic variables when setting their monetary instrument. Which is consistent with that most central banks that focuses on the rate of inflation are not "inflation nutters", an expression originated by King (1997) (Kuttner and Posner, 1999). In fact, Bernanke and Mishkin (1997) argue that an inflation target should be viewed as a framework for the central banks to operate within rather than a stringent policy rule that dictates in a mechanical way the conduct of the central bank in every contingency. Throughout the above discussion of inflation targeting design it is also outlined that most inflation targeting countries have a policy in place that makes room for short-run objectives besides the rate of inflation. Some countries, including Norway, also sets out a mandate for the central bank to ensure financial stability as well as a low and stable rate of inflation, underscoring the above point that the actual conduct of central banks imply that they’re not “inflation nutters” (Norges Bank, Inflation Report, 03/06). This however raises the question of how much emphasis central banks should place on other variables when setting their monetary instrument.

In most inflation targeting countries the monetary policy is set to minimize output and inflation fluctuations; that is, minimizing the central banks loss function (Akram et al. 2005). However, other economic variables have the potential to have large and lasting effects on output and inflation fluctuations. In the literature there are different views of whether or not the central bank should react to large asset price changes or not (Bean, 2003). Exchange rate movements are obviously of great concern for all central banks regardless of monetary policy goal. This will be particularly true for small open economies where a relatively large fraction of goods consumed are imported.

This next section builds on the work of Mishkin and Schmidt-Hebbel (2001) unless otherwise noted.
As mentioned above, the effects of the exchange rate work quicker on the rate of inflation than the short-term interest rate controlled by the central banks. An appreciation of the domestic currency vis-à-vis its major trading partners currencies, also referred to as a deterioration of the terms of trade, will most likely put the central bank under great political pressure to alter monetary policy as it makes domestic producers uncompetitive. A real depreciation following a tight monetary policy in order to reduce inflation might be of particular concern in emerging economies where the central bank has limited credibility and support. The reason for this is that a real depreciation might lead to a large current account deficit, which makes it very vulnerable to currency crisis if a previous inflow of capital suddenly turns to an outflow of capital, as their debt is usually denominated in foreign currency. This might, as such, lead central banks in particularly emerging economies to focus so much on the exchange rate that it becomes a nominal anchor that is more important than the inflation target. Mishkin and Schmidt-Hebbel (2001) argue that this may have unwanted consequences as it can cause the central bank to respond to the wrong type of shock as it did in New Zealand in 1997 and 1998. Central banks should thus not try to target the exchange rate, as “it is likely to worsen the performance of monetary policy”, (Mishkin and Schmidt-Hebbel, 2001, p.25) but rather take it into account when making an overall forecast of the state of the economy as it’s nonetheless very important for the rate of inflation. They also reach the same conclusion for asset prices including stock prices, housing prices and bonds. Another opinion, emphasised following the dot com bubble in the late 1990’s, is that the central bank can in fact improve its performance by explicitly having a positive weight of different asset price changes in its objective function (Bean, 2003). Champions of this idea argue that a smooth path for the level of inflation can only be achieved by also targeting asset prices and thereby reducing the possibility of bubbles and, in their opinion, also boom-bust cycles (Bean, 2003). Critics argue that an inflation targeting central bank should only care about asset prices insofar that they signal a higher future level of inflation, (Bean, 2003) consistent also with the above opinion of Mishkin and Schmidt-Hebbel (2001).

A flexible inflation target conducted properly is also argued to reduce the volatility of other key macro economic variables including output and financial assets (Ball and Sheridan, 2003). An inflation targeting monetary policy, either explicitly or
implicitly, should thus not respond to asset prices except when they signal a future change in the rate of inflation (Bernanke and Gertler, 2000). Although bubbles should not be targeted per se, bubbles are usually found when the underlying economic fundamentals are good, but as this will normally lead to a higher level of inflation, which also means a higher interest rate (Bernanke and Gertler, 2000). This thus implies that a central bank that is committed to a low and stable level of inflation and financial stability will also reduce the risk of bubbles incurring in the first place (Bernanke and Gertler, 2000). Another argument is also that it’s very hard to know the fair value of any asset, and would be rather ambitious of a central bank to think that it’s better at estimating the fair value of an asset than the market (Akram et al. 2005). As most asset prices are rather volatile, and that monetary policy only reacts with a lag, by targeting the asset prices a central bank runs the risk of conducting an overly active monetary policy that might create financial instability (Bean, 2003). Asset prices might in fact change quite significantly over short periods of time, even within a day, as they might be driven by market psychology rather than the underlying fundamentals, making them unreliable for the central bank to base their policy on.

The former Fed chairman Alan Greenspan have argued that the ability for the central bank to conduct monetary policy in such a way as to achieve financial stability, low rate of inflation and stopping financial bubbles from forming as an illusion (Bean, 2003). He instead focuses on mitigating the consequences from bubbles when they burst (Bean, 2003).

In setting its main monetary instrument, Norges Bank makes use of all relevant information about future economic conditions (Norges Bank, Inflation Report, 03/06). This is consistent with the view Bernanke and Mishkin (1997) have about inflation targeting, which they view as being a framework for the central bank to operate within rather than a stringent monetary policy rule, as mentioned above.

As noted earlier the US has a monetary policy that closely resembles that of inflation targeting. There are however important differences between a full fledged inflation targeting country like Norway, and the USA, where people’s expectations are based more on the current Federal Reserve Chairman and the signals they send, than on the institution as such (Mishkin and Schmidt-Hebbel, 2001). Another important difference is that the Federal Reserve lacks transparency, which might create
uncertainty about their future policy as thus inhibit long-term investments. A third point is that the central bank is arguably more prone to political pressure when there is no explicit nominal anchor in place, which with changing political climate might increase the likelihood of a time-inconsistent policy (Mishkin and Schmidt-Hebbel, 2001). These features of the Fed’s monetary policy is therefore said to augment the uncertainty about future policy, increase the volatility of the long-term market rates and thus inhibit long-term investment (Mishkin, 2004). The next chapter will build on the discussion of this chapter, and sets out to empirically and analytically test whether a country like Norway have in fact benefited from implementing an inflation target with respect to improving its communication with the public, and even more importantly a noted several times in this chapter, whether the inflation target has helped in forming the expectations of the public.

3. Empirical analysis and results

This chapter will consist of some empirical tests based on the discussion in the previous chapter. The emphasis will be on Norway’s experience with implementing an inflation target as its monetary policy goal and the effect it has had on some key variables. The results obtained will hopefully shed some light on whether inflation targeting has been an improvement in Norwegian monetary policy, or if it has just made the policies already in place, and clearly understood by the public, explicit, with no effects on the rate and volatility of inflation or people’s expectations.

3.1. The level and volatility of inflation over time

As pointed out in the previous chapter lowering the rate of inflation became a primary goal for central banks during the 1980’s, following the high inflation rates that had prevailed over the last 20 to 30 years (Bernanke and Mishkin, 1997). As can be seen from the following graph, Norway was no exception. With a combination of tight monetary policy, relatively low wage settlements, also compared to our major trading partners, and a decreasing rate of imported inflation, the annual CPI rate was lowered
from just below 14% in the early 1980’s, to around 2% in 1992, and has been kept at relatively low levels ever since.

**Figure 3.1:** The figure shows the annual consumer price index (CPI) growth in Norway.

![Norwegian annual CPI](source: Statistics Norway)

Following the Governmental decree that was issued on the 5. May 1992, which stated that Norges Bank should aim at keeping the exchange rate stable and at about the current levels vis-à-vis major European currencies, Norway implicitly, also got a target for the rate of inflation. Since some of our major trading partners already had an explicit inflation target in place, including the UK, while others, including Germany and the USA were implicitly targeting a low and stable rate of inflation, it meant that Norway was also targeting a low and stable rate of inflation. The convergence of the inflation rates between Norway and some of its major trading partners from the late 1980’s and onwards can be seen from figure 1.1.

Hence, we may ask: if Norway was implicitly already targeting a low and stable rate of inflation, have they gained anything from making it explicit? In order to test this, one of the criterions will be whether or not the volatility of the rate of inflation has changed following the implementation of the inflation target. The volatility in the two periods will be compared using Fischer’s F-test, as the data series for the two periods will be treated as samples from a larger “trend of conduct” by the Norwegian central

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9 http://odin.dep.no/odinarkiv/english/brundltland_III/fin/006005-090022/dok-bn.html
bank, and because the two samples are taken from different periods, they will thus also have been subjected to different exogenous shocks.

The reason for using volatility as a measure of performance is because it is argued that it is not the rate of inflation that is damaging to investment, as long as it is moderate, which just by looking at Figure 3.1 has clearly been the case since 1992. It is rather the uncertainty caused by the volatility in the rate of inflation which discourages investment and thus potentially also long-run growth, as this uncertainty might lead some investors to regret their investment decisions ex post. Volatile inflation rates also create an arbitrary redistribution of wealth between lenders and borrowers, as debt is usually denominated in nominal terms (King, 2002).

**Table 3.1**: The means and standard deviations are calculated based on the monthly change in the consumer price index (CPI) for Norway.

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1992 - Mars 2001</td>
<td>0.00295</td>
<td>0.0019</td>
<td>107</td>
</tr>
<tr>
<td>April 2001 - December 2006</td>
<td>0.00498</td>
<td>0.0011</td>
<td>69</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

The above table shows that the volatility in the consumer price index has in fact increased since the introduction of inflation target and not decreased as might have been expected. This is also confirmed by the calculations in appendix A where the volatilities of the two series are formally compared using Fischer’s F-test, which gives a p-value of 0.0000 meaning that the null hypothesis stating that the two samples are taken from populations with similar variance have to be rejected in favour of the alternative hypothesis stating that the samples are not taken from populations with similar variance. However, when conducting a F-test it is important to examine the distributions of the two samples, as the validity of the conclusion requires the distributions of the two samples to be approximately normal. This is discussed more in detail in appendix A.

This may be rather surprising, as having an explicit inflation target should mean placing more emphasis on inflation, which arguably should mean less volatile rates of
inflation. The graph below shows that there are some rather perverse numbers, which undoubtedly is affecting the results in the above table.

**Figure 3.2:** The monthly change in consumer price index (CPI) for Norway

![Norwegian CPI monthly change](image1)

Source: Statistics Norway

As mentioned in chapter 2, the CPI measure incorporates some rather volatile prices, energy prices being a prime example. This thus highlights the discussion in the previous chapter that central banks should be careful when choosing what inflation measure to target, and arguably explains why most central banks have opted to target core inflation.

**Figure 3.3:** Shows the monthly percentage change in the El-spot average prices in NOK/MWh for Oslo, Norway.

![Elspot monthly average prices in NOK/MWh](image2)

Source: Nord Pool
The above graph shows just how volatile electricity prices have been, and when compared to the figure for monthly percentage change in CPI for Norway helps to explain some of the outliers in the latter graph.

CPI-AE is an inflation measure that takes out the effect of energy prices from inflation, which mentioned, have the most volatile prices in the CPI measure. Although the CPI-ATE, which also takes out the tax effects, is the most commonly used measure of core inflation, CPI-AE will be used as the time series covers much more of the relevant period than CPI-ATE does. However, since statistics Norway has only published statistics for the CPI-AE time series from January 1995, there might be some errors when using it as a proxy for the volatility in core inflation over the period starting in May 1992, when the aforementioned Governmental decree was issued. However, when examining the CPI numbers from May 1992 to January 1995 they seem to be very similar to the rest of the time series ending on Mars 2001, thereby hopefully not distorting the results substantially.

The following table shows the volatility in the CPI-AE, in terms of standard deviations, in the two periods given in the table. Although the period from February 1995 to when Norway adopted an explicit inflation target on the 29 Mars 2001 still has a lower volatility than the period after and to the present, it is much more similar than when energy prices is not taken into account. When comparing the variances in the two periods using Fischer’s F-test (see appendix A), the null hypothesis cannot be reject in favour of the alternative hypothesis, which means that there is not enough statistical evidence to infer that the two samples are taken from populations with different variances.

This shows that energy prices have been relatively more volatile in the last period. Still, this might be rather unexpected as one can argue that the volatility in the inflation rate should have decreased as it has gotten more attention when explicitly targeted and not increased, although the increase has only been marginally when measured by CPI-AE, and as mentioned not statistical significant.
Table 3.2: Standard deviations based on the monthly percentage changes in the CPI-AE (AE = after energy prices has been taken out) for Norway over the two periods given in the table.

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 1995 – Mars 2001</td>
<td>0.002832071</td>
<td>0.00194</td>
<td>74</td>
</tr>
<tr>
<td>April 2001 – Dec 2006</td>
<td>0.00325377</td>
<td>0.00095</td>
<td>69</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

The next figure shows the monthly percentage change in CPI-AE for Norway over the same interval as in the above table, and as can clearly be seen even when accounting for the relatively volatile energy prices there has still been some rather large shocks. Some of these shocks have been particularly predominant in the period following the adoption of an inflation target. However the shocks following Mars 29 2001 can hardly be blamed on policy error by the central bank, as the first major shock happened only about four months following this change in policy, which would arguable not have been enough time for their policy to seriously affect the economy, as monetary policy works with a lag, and such errors should arguable also translate into more persistence in the CPI-AE rate than what is evident from the graph.

Figure 3.4: Percentage change from the previous month in the CPI-AE for Norway.

Source: Statistics Norway.
The rather significant decrease in both CPI and CPI-AE between June and July 2001 was in fact due to a large tax reform on goods and services (GST), which went into effect on July 1 2001.\(^\text{10}\)

Although constituting a rather ad-hoc approach, when the effects of the tax reform on July 1 2001 is taken out of the monthly percentage change in the CPI-AE for Norway, in order to make the two periods more comparable, the volatility of the two periods remain pretty much the same, as shown in the table below.

**Table 3.3:** Standard deviations calculated on the basis of monthly percentage changes in the CPI-AE, for the periods given in the table

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 1995 - Mars 2001</td>
<td>0.002832071</td>
<td>0.00194</td>
<td>74</td>
</tr>
<tr>
<td>April 2001 - Dec 2006</td>
<td>0.002861318</td>
<td>0.00114</td>
<td>68</td>
</tr>
</tbody>
</table>

Source: Statistics Norway.

So, when accounting for the tax reform that took place in the middle of 2001, period from April 2001 to December 2006, and the period from February 1995 to Mars 2001 have the same volatilities when measured using monthly change in Norwegian GDP, which is also supported by the results obtained when using Fischer’s F-test using any relevant significant level (See appendix A).

Thus, when tested in terms of the volatility in inflation as measured by CPI-AE, the implementation of an inflation target cannot be said to have made any difference. This at least underscores the point made by Bernanke and Mishkin (1997) that an inflation target is a framework for the central bank to operate within rather than a stringent and mechanical tool that dictates how the central bank should respond in order to minimize the inflation volatility around the explicit target set in its mandate, with limited attention given to other variables. This last point will be examined in the next section.

\(^{10}\)www.regjeringen.no/nb/dep/fn/tema/andre/Merverdiavgift/Slik-virker-momsreformen.html?id=413764
3.2. The performance of other variables under inflation targeting

As mentioned in chapter 2.3.2, Norges Banks mandate make the central bank not only responsible for targeting a rate of inflation of 2.5% over a horizon of 1 to 3 years\(^{11}\), but also ensuring financial stability, which means that Norges Bank also have to pay attention to other variables not only as far as their effect on inflation, but also to make sure that they do not jeopardize financial stability.

This section therefore sets out to examine whether the adopting of an inflation target has had any discernible effect on other variables such as exchange rate indices and output.

3.2.1. Output

Norges Bank conducts a flexible approach to inflation targeting, implying that it pays attention to other variables when setting their monetary instrument, although reaching the inflation target is the overriding goal in the case of a conflict.\(^{12}\) Output, or rather its deviation away from its long-term trend, is not only important as an indicator for inflation, but also in its own right (Bjørnland et al. 2006). It is argued that only when output is growing smoothly and close to trend over time are the economic resources utilized efficiently, which also facilitates a stable growth in the level of employment. (Bjørnland et al. 2006)

This section will therefore examine whether by implementing an inflation target Norges Bank have placed too much emphasis on reaching the explicit inflation target within the set horizon, and as a consequence have increased the volatility of output, and / or have caused output to be extensively below or above its long term trend.

Increased output volatility following the implementation of an inflation target, can signal that Norges Bank have placed more emphasis on reaching the set inflation

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\(^{11}\) This was changed from around two years in June 2004 (Inflation report, Norges Bank, 02/2004) and was again changed in Mars 2007, where they now aim to reach the inflation target of 2.5% over time (Monetary policy, Norges Bank, 01/2007)

\(^{12}\) http://www.lovdata.no/all/hl-19850524-028.html
target, thereby putting less weight on output volatility. But as a change in output volatility also can have been caused by several changes in the long-term growth rate, a better measure of whether or not the output volatility has changed is arguably to examine the output gap, which measures the deviation of output from its long-term trend. The next two subsections will thus test whether or not the output volatility has changed, and whether output has deviated more around its long-term trend, following the implementation of an inflation target.

3.2.1.1. Output volatility

The table below shows the volatility, as measured by the standard deviation, and the mean of quarterly change in Norwegian GDP. The first period is from the third quarter in 1992, as this is the first quarter after May 5, 1992 when the aforementioned Governmental decree was issued, and lasts until March 31, 2001, which is only days after adopting an inflation target and has thus probably very little effect on the accuracy of the results. The second period covers the period after Norway adopted an inflation target.

**Table 3.4:** Standard deviations and means calculated on quarterly changes in GDP for Norway, for the periods given in the table

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd Quarter 1992 - 1st Quarter 2001</td>
<td>1.84</td>
<td>1.09</td>
</tr>
<tr>
<td>2nd Quarter 2001 - 4th Quarter 2006</td>
<td>1.88</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

As can be seen from the table the output volatilities are very similar for the two periods, and when using a F-test, as done in appendix A, it cannot be rejected that the samples from the two periods are taken from populations with the same variances.

This is at odds with the rather surprisingly results that was obtained in chapter 3.1, namely that the volatility in inflation, when measure as CPI-AE, has not changed following the adoption of an inflation target by the Norwegian Government. This arguably means that the Norges Bank has not combated inflation more aggressively, which has thus not caused more deviation in output.
Svensson (1997) argues that the weights put on inflation relative to output in the central banks loss function is directly related to the speed of adjustment towards the long-term inflation goal. As Norges Bank operates with a relatively long horizon; they may approach their explicit target relatively slowly, thereby also facilitating financial stability (Svensson, 1997).

When measured in terms of output and inflation volatility, adopting an inflation target has not been a radical change in the way Norway’s monetary policy is conducted.

3.2.1.2. Output gap

As mentioned above, judging the performance of an inflation target based on output volatility can be at the very least misleading when potential, or long-term, GDP growth is changing rapidly, which might be caused by anything from technological improvements to changes in the regulatory framework. This therefore arguably makes the output gap, or rather changes in the output gap, a better measure of the effects implementing an explicit inflation target has had on the smoothness of output growth, as it accounts for changes to the long-term growth rate.

The following figure shows quarterly real and potential, or de-trended, GDP from the third quarter in 1992 to the end of 2006. The trend is extracted, as shown in appendix B, using a Hodrick-Prescott filter (HP-filter), which works by extracting the value of potential output by minimizing the difference between actual and potential output but at the same time imposing a restriction on this difference (Björnland et al. 2006).
**Figure 3.5:** Real and de-trended GDP where 2003 has been set equal to 100.

Note: The trend has been extracted using a Hodrick-Prescott filter with $\lambda = 1600$, which is recommended when using quarterly data. (Bjørnland et al. 2006)

Source: Statistics Norway and own calculations.

The percentage difference between real and potential GDP, or the output gap, is shown in the figure 3.6. As can be seen there have been considerable fluctuations in the output gap over the given time-series. The graphed series will be used as a basis for analysing the effect the implementation of an inflation target has had on Norwegian output.
The results in the table below compare the same two periods as in table 3.4, and as mentioned is based on the series graphed in Figure 3.6. As can be seen from the standard deviation column, the volatility in the output gap has in fact decreased considerably after Norway adopted an inflation target. The volatility in the second period has also decreased in amplitude when measured by max and min, relative to the first period.

As mentioned, the outcomes in table 3.5 are based on an output gap, which is obtained using a HP-filter with a $\lambda = 1600$. It is important to note that the HP-filter is known to be quite uncertain especially towards the end of time series, and that is also create business cycles when using random walk time-series (Bjørnland, 1999). The results for especially the second period may therefore be associated with uncertainty.

Compared to the estimates Norges Bank has of the output gap given in their inflation report published in November 2006, the HP-filter with a $\lambda = 1600$ gives a slightly
higher output gap at the start of 2006, and also has a much steeper downturn in the output gap from the middle of 2006, reaching a neutral level at the end of 2006.

That the output gap is currently neutral is extremely hard to believe when examining other macroeconomic data, including the production-to-production capacity ratio for Norwegian firms, arguably illustrating the uncertainty associated with the HP-filter at the end of series.

The numbers of observations are also rather limited for both periods as the calculations are based on quarterly data. This might further distort the results given in table 3.5, and also in appendix A, as the distributions for the two periods are rather different. However, as the F-test is relatively robust, the main conclusion should still hold.

Table 3.5: The calculations are based on the difference between potential GDP, which has been extracted using a HP-filter with a $\lambda = 1600$, and real GDP using quarterly data for Norway

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Max</th>
<th>Min</th>
<th>Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Quarter 1992 - 1. Quarter 2001</td>
<td>0.0349</td>
<td>0.28%</td>
<td>9.12%</td>
<td>-7.09%</td>
<td>35</td>
</tr>
<tr>
<td>2. Quarter 2001 - 4. Quarter 2006</td>
<td>0.0239</td>
<td>-0.45%</td>
<td>7.42%</td>
<td>-4.24%</td>
<td>23</td>
</tr>
</tbody>
</table>

Source: Statistics Norway and own calculations.

At first glance the outcome in the table above might be a bit puzzling, especially as a major criticism to inflation targeting is that an explicit inflation target will make the central bank focus to strongly and narrowly on the rate of inflation at the expense of other key variables, including output (Bernanke and Mishkin, 1997). However as Bernanke et al. (1997) points out, and also supported by the results for inflation and output volatility presented here, that central banks has showed great concern for inflation as well as output fluctuations both prior to and after adopting an inflation target. As mentioned, this is also in line with the mandate given to Norges Bank.13

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13 http://www.norges-bank.no/
The findings presented here are also in line with those of Ball and Sheridan (2003) mentioned in chapter 2, who argue that a flexible inflation target conducted properly should in fact decrease the volatility of other key economic variables including output and the exchange rate.

3.2.2. Exchange rates

Since the 1960’s the Norwegian krone (NOK) has gone through a transition from a fixed exchange rate under Bretton Woods lasting to the start of the 1970’s, to a stage when the NOK was pegged to different currencies and basket of goods, and finally to become a floating currency in 1992. The figure below shows the NOK exchange rates with different currencies from January 1960 to January 2007.

**Figure 3.7:** The exchange rate between NOK and different currencies

Note: The exchange rates are the prices that have to be paid for the other currencies in terms of NOK. For USD, EUR, GBP, CAD, AUD and NZD the price is for one unit, while for DKK and SEK the price is for 10 units, and for JPY the price is for 100 units.

Source: Norges Bank

The following table summarizes the volatilities in the exchange rates, as measured by standard deviations, between the NOK and the same currencies as in the graph.
Table 3.6: The table shows the volatilities, as measured by standard deviations, for the NOK against the currencies in the table

<table>
<thead>
<tr>
<th>Periode</th>
<th>USD</th>
<th>EUR</th>
<th>GBP</th>
<th>DKK</th>
<th>CAD</th>
<th>JPY</th>
<th>AUD</th>
<th>NZD</th>
<th>SEK</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1992 - Mars 2001</td>
<td>0.851</td>
<td>0.163</td>
<td>1.201</td>
<td>0.326</td>
<td>0.419</td>
<td>0.921</td>
<td>0.290</td>
<td>0.368</td>
<td>0.047</td>
</tr>
<tr>
<td>April 2001 - January 2006</td>
<td>0.952</td>
<td>0.326</td>
<td>0.553</td>
<td>0.433</td>
<td>0.363</td>
<td>0.579</td>
<td>0.300</td>
<td>0.358</td>
<td>0.040</td>
</tr>
</tbody>
</table>

Source: Norges Bank

The volatility of the NOK exchange rate has increased vis-à-vis the USD, EUR and DKK, while it has decreased vis-à-vis the GBP, CAD, JPY and SEK, and remained relatively constant with respect to the AUD and NZD.

There is thus no clear-cut change in the overall volatility of the NOK exchange rate from May 1992 to when Norway adopted an inflation target in Mars 2001, and after adopting an explicit inflation target and until January 2007. This supports the conclusion given in the previous sub-sections, namely that Norway has a flexible inflation target with a relatively long horizon, which means that they can approach the explicit inflation target more slowly and thus not jeopardize the smoothness of other variables including the exchange rate. It is also consistent with the finding of Ball and Sheridan (2003) as mentioned above.

3.2.3. The sight deposit interest rate and market interest rates

The results presented in this chapter thus far show that adopting an inflation target by the Norwegian Government have had very limited effects on inflation, ambiguous effects on the exchange rates, and a slight reduction in output volatility, although there are several elements of uncertainty associated with the last result.

However, the question about whether adopting an inflation target has been an improvement to Norwegian monetary policy, which was asked at the start of chapter 3, cannot be answered without seeing if the new monetary policy regime has had any effect on market expectations, argued in to be essential for conducting any monetary
policy, and even argued by Eggertsson and Woodford (2003a,b) to be the only effective instrument in conducting a proper monetary policy.

To test whether adopting an inflation target has meant that market expectations of future interest rates have become more in line with the expectations of Norges Bank, the sight deposit rate will be examined against market rates with different maturities, to see if the correlations between these rates have changed.

The following figure shows the three months average interest rate for the sight deposit rate, average bank loans and deposits, and Government bonds with different maturities.

**Figure 3.8:** Shows the three months average interest rates of the sight deposit- and some different market interest rates

Note: The bank loans and deposits are calculated as the average weighted interest rates, loaned by and deposited by the public, respectively.
Source: Norges Bank and Statistics Norway

The following two tables show the correlation between the sight deposit rate, the Norwegian inter bank overnight rate (NIBOR) with three and twelve months maturity and Government bonds with three, five and ten year maturities, respectively, and the correlation between the sight deposit rate and bank deposit- and bank loan rates, respectively.
Table 3.7: Correlation between the sight deposit rate, Norwegian inter bank overnight rates (NIBOR) with three and twelve months maturity and Government bonds with three, five and ten year maturities, respectively

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sight deposit rate</td>
<td>0.926365</td>
<td>0.993258</td>
</tr>
<tr>
<td>3 month</td>
<td>0.894934</td>
<td>0.974229</td>
</tr>
<tr>
<td>12 month</td>
<td>0.744354</td>
<td>0.964443</td>
</tr>
<tr>
<td>3 year</td>
<td>0.607604</td>
<td>0.952561</td>
</tr>
<tr>
<td>5 year</td>
<td>0.419714</td>
<td>0.924157</td>
</tr>
<tr>
<td>10 year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Norges Bank

As can be seen in the above table the correlation between the sight deposit rate and all the financial instruments in the table have increased, some quite considerably, since the Norwegian Government adopting an inflation target.

When it comes to the Government bonds they have all had extreme increases in the correlation with the sight deposit rate. Comparing this increase in correlation with that of the NIBOR rates with three and twelve month maturity, and the increase in correlations between the sight deposit rate and the bank deposits and loans, which are depicted in the following table, it is very unlikely that all of the increase can be attributed to adopting an inflation target.

The majority of the increases in the correlations between the Norwegian Government bonds and the sight deposit rate arguably come from relatively recent changes in the bond markets. As the Norwegian Government have gone from being a net borrower to a net lender over the course of the last ten – fifteen years, the Norwegian Government have issued fewer and fewer bonds.14

However the demand for bond denominated in Norwegian Kroner has increased, due to increasing oil prices and turmoil in the middle-east, which have made Norwegian

---

krone denominated assets sought after. This increased demand have meant that the Eurobond market have seen a significant increase in Eurobonds issued in Norwegian kroner. This again means that the liquidity have increased, causing the liquidity in the market for Norwegian Government bonds to increase as they are substitutes for the Eurobonds denominated in Norwegian kroner, and vice versa. So fewer Government bonds issued by the Norwegian Government have ironically increased the liquidity in the market for them, which arguably also explains why the correlation between the sight deposit rate and the ten year Government bonds has increased relatively more than the correlation of the two other Government bonds, as the liquid premium paid on longer term bonds is relatively higher than that of shorter term bonds, in an illiquid market.

Table 3.8: Correlation between the sight deposit rate and bank loans and bank deposits, respectively

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sight deposit rate</td>
<td>Bank loans 0.898893</td>
<td>Bank loans 0.994430</td>
</tr>
<tr>
<td></td>
<td>Bank deposits 0.975275</td>
<td>Bank deposits 0.998270</td>
</tr>
</tbody>
</table>

Note: The bank loans and deposits are calculated as the average weighted interest rates, loaned by and deposited by the public, respectively. Source: Statistics Norway

The correlations between the sight deposit rate and bank loans and deposits, as shown in the above table, have also increased after adopting an inflation target. Both bank loans and deposits are today very highly correlated with the sight deposit rate.

The increased correlations between the overnight deposit rate, and the longer term market rates in the two previous tables arguably means that market expectations have become more in line with that of Norges Bank. As have been mentioned several times already, the ability of the central bank to affect market expectations is essential for conducting an effective monetary policy. The sight deposit rate controlled by Norges Bank has on its own very limited effect on the rate of inflation. It is rather the ability

15 Ibid.
16 Ibid.
it has to influence the longer-term markets rates, and thereby aggregate demand that potentially makes it an effective monetary instrument. As such, when based on the above results, adopting an inflation target must be said to have been an improvement in Norwegian monetary policy as the sight deposit rate is more correlated with the longer-term market rates today than prior to adopting an inflation target.

However, as mentioned with respect to the increased correlation in Government bonds, there have also been other factors that have affected the correlation between the sight deposit rate and the different market rates, including a deeper secondary market for government bonds as well as globalization of financial markets, which might also distort some of the other correlations.

3.2.4. Housing prices

As mentioned previously one of the key objections against an explicit inflation target is that it will cause a too strong focus on reaching this target and will therefore cause an increased volatility in other economic variables.

As can be seen from the previous discussion this has arguably not been the case for Norway with regards to output, the output gap or rate of inflation, while for the exchange rate the volatility has increase vis-à-vis some currencies, while decreased vis-à-vis others.

However, as financial assets and particularly housing is a very important part of peoples wealth and long term investment decision, it is arguably also very important to examine whether adopting an inflation target has caused an increase in the volatility, and thus also increased uncertainty, of housing prices.
From about 1992 there has been a rather impressive increase in the average square meter prices for dwellings in Norway, as can be seen from figure 3.9. However, there have been relatively extensive fluctuations in the prices on a quarterly basis, which is shown in figure 3.10.

The main point here, as initially pointed out, will be whether the fluctuations in the quarterly prices have changed, or rather increased, since adopting an inflation target,
as have been pointed out by sceptics as being a potential consequence of having an explicit inflation target (Bernanke and Mishkin, 1997).

Table 3.9: Standard deviations and means for the two periods in the table, calculated based on quarterly changes the average square meter price in Norway

<table>
<thead>
<tr>
<th></th>
<th>3. Quarter 92 - 1. Quarter 01</th>
<th>2. Quarter 01 - 4. Quarter 06</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>House</td>
<td>Shared House</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.0368</td>
<td>0.0345</td>
</tr>
<tr>
<td>Mean</td>
<td>2.16%</td>
<td>2.64%</td>
</tr>
</tbody>
</table>

Source: NEF, EFF, Econ, Finn.no

The volatility, as measured by the standard deviation, has remained pretty much unchanged for houses from the 3. Quarter 1992 to the 1. Quarter 2001, while it has decreased slightly for shared houses and rather extensively for apartments, over the same period.

This is also confirmed in appendix A, where the hypothesis that the samples for the two periods are taken from populations with the same variances cannot be rejected, for houses and shared houses, whilst the same hypothesis is rejected in favour of the alternative hypothesis that the two samples are taken from populations with different variances for apartments, given a “normal” significance level. However, as with output, the results for dwellings are based on quarterly data, so there are relatively few observations available since adopting an inflation target. But contrary to output, the distributions for the two periods, which are displayed in appendix A, are relatively similar, hopefully meaning that the samples taken are quite representative for the populations as a whole, again meaning that the results, or at least the conclusions, are dependable.

The results for dwellings again illustrate that adopting an inflation target has not meant that the volatilities have increased, and if anything have decreased. This is, as pointed out several times already, probably reflected in the fact that Norges Bank
conducts a flexible inflation target, where other key economic variables are taken into account when setting their main monetary instrument. As such, implementing an inflation target has not meant a great deal when measured as the volatilities for dwelling, which is one of people’s most important financial asset, and therefore also investment decision.

4. Conclusion

Targeting an explicit level of inflation as a monetary policy has a rather recent history, and when Norway adopted an explicit inflation target on mars 29 2001, it was only about ten years after the first country (New Zealand). However, during the 1990’s several quite different countries adopted explicit inflation targets, and as such a lot of experience and knowledge was gained, which undoubtedly helped Norway designing their specific inflation targeting monetary policy.

Since the early 1980’s lowering the rate of inflation had received high priority from Norges Bank, and following the Governmental decree that was issued on may 5 1992, which stated that Norges Bank should aim at keeping the exchange rates stable and at about the current levels vis-à-vis major European currencies, they implicitly also got a target for the rate of inflation. So when Norway adopted an explicit inflation target as their monetary policy on Mars 29 2001, it was arguably not a big change in the way that monetary policy had been conducted for nearly a decade.

The main empirical findings in this thesis supports the the above point of view as there have been very limited effects from adopting an explicit inflation target on the volatility of core inflation, the exchange rates and housing prices, while there has been a slight reduction in output volatility, although there is several elements of uncertainty associated with this last result.

However, by making the monetary policy more explicit the Norwegian Government has made Norges Bank more accountable for its actions, as it has been easier to measure their performance ex-post, and it has also improved the communication
between Norges Bank and the market through publications and a more understandable target.

This can be seen from the correlations between the sight deposit rate and the 3-, 5- and 10-year Government bonds, and between the sight deposit rate and bank deposits and loans, which have increased quite considerably, arguably meaning that market expectations have become more in line with those of Norges Bank.

The above results show that adopting an inflation target, as mentioned, has not caused Norges Bank to focus too strongly on reaching the explicit rate of inflation causing excessive fluctuations in other key variables, which have been argued by several economists to be a major disadvantage of having an explicit target for the rate of inflation. This can probably be contributed to the fact that Norges Bank has a flexible approach to inflation targeting, implying that they pay attention to other variables when setting their monetary instrument, although reaching the inflation target is the overriding goal in the case of a conflict, which is also in line with the mandate given to them by the Norwegian Government.

Hence, even though we have developed the perspective that adopting an explicit inflation target by the Norwegian Government has not been a large revolution compared to the way monetary policy was previously conducted in Norway, it has certainly improved the communication between Norges Bank and the market, making market expectations more in line with those of Norges Bank, and it has also made it easier to judge the performance of Norges Bank and thus making them more accountable responsible for their policy decisions.
5. Bibliography:


Norges Bank (2006): Inflation Report with monetary policy assessments No. 03/06


APPENDIX A – F-test two-sample for variances

The volatility of the CPI, CPI-AE and GDP are compared for two periods using Fischer’s F-test.

**CPI:**

The following table was presented as table 3.1 in chapter 3.

**Table A.1:** Standard deviations and means for the two periods in the table calculated from monthly change in CPI for Norway

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1992 - Mars 2001</td>
<td>0.00295</td>
<td>0.0019</td>
<td>107</td>
</tr>
<tr>
<td>April 2001 - December 2006</td>
<td>0.00498</td>
<td>0.0011</td>
<td>69</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

The F-test two-sample for variances is a statistical test where the null hypothesis; that the two samples are taken from populations with the same underlying variance and denotes $H_0$, against the alternative hypothesis that the samples are taken from populations with different variances, denoted $H_1$.

**Table A.2:** F-test two-sample for variances calculated for monthly change in CPI for Norway over the two periods shown in the table.

<table>
<thead>
<tr>
<th>Two-Sample F-test for Variances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Variance</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>
The p-value in the above table shows the probability of getting the results for the two variances in the same table when it cannot be rejected that the two samples are taken from populations with the same variances, or put in another way, when H-naught cannot be rejected.

As can be seen from the table the p-value is extremely small, which makes it very unlikely that samples are taken from populations with the same variances. However the theory underlying the above result requires that the samples are approximately normally distributed, or since the F-test is relatively robust, that the two sample distributions are not “very” different in other respects than their variances.

The following figures show the distributions for the two samples. As can be seen they are relatively similar, which supports the results in table A.2 namely that the two samples are taken from populations with different variances.
Figure A.1: Distribution for monthly changes in the CPI for Norway from May 1992 to Mars 2001, and April 2001 to December 2006, respectively.

Source: Statistics Norway

CPI-AE:

Table A.3 is shown in chapter 3.

Table A.3: Standard deviations and mean for the two periods in the table calculated from monthly change in CPI-AE for Norway

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 1995 – Mars 2001</td>
<td>0.002832071</td>
<td>0.00194</td>
<td>74</td>
</tr>
<tr>
<td>April 2001 – Dec 2006</td>
<td>0.00325377</td>
<td>0.00095</td>
<td>69</td>
</tr>
</tbody>
</table>

Source: Statistics Norway
As can be seen from table A.4 the p-value is much larger than in table A.2. With a significance level equal to 0.10 or 0.05, which are very often used, the hypothesis that they are taken from populations with equal variances cannot be rejected here.

**Table A.4:** Two-sample F-test for variances calculated for monthly change in CPI-AE for Norway over the two periods shown in the table.

<table>
<thead>
<tr>
<th>Two-Sample F-test for Variances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Variance</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>P-value(F&lt;=f) one-tail</td>
</tr>
<tr>
<td>F Critical one-tail</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

Again the samples have to have distributions that are relatively similar, and as can be seen from the figures below this requirement seems to be fulfilled.
**Figure A.2:** Distribution for monthly changes in the CPI-AE for Norway from May 1992 to Mars 2001, and April 2001 to December 2006, respectively.

![Histogram of monthly changes in CPI-AE for Norway from February 1995 to March 2001](image1)

![Histogram of monthly changes in CPI-AE for Norway from April 2001 to December 2006](image2)

Source: Statistics Norway

**Table A.5:** Standard deviations and means for the two periods in the table calculated from monthly change in CPI-AE for Norway, but where the tax reform in 2002 is taken out

<table>
<thead>
<tr>
<th>Period</th>
<th>Standard deviation</th>
<th>Mean</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 1995 - Mars 2001</td>
<td>0.002832071</td>
<td>0.00194</td>
<td>74</td>
</tr>
<tr>
<td>April 2001 - Dec 2006</td>
<td>0.002861318</td>
<td>0.00114</td>
<td>68</td>
</tr>
</tbody>
</table>

When the effects of the tax reform in 2001 is taken out of the time-series, the volatilities of the two periods are very similar, which is also reflected in the relatively
high p-value in table A.5, meaning that using any relevant significant level it cannot be rejected that the two samples are taken from populations with identical variances.

Table A.6: Two-sample F-test for variances calculated for monthly change in CPI-AE for Norway where the effect of the tax reform in 2001 is taken out, over the two periods shown in the table.

<table>
<thead>
<tr>
<th>Two-Sample F-test for Variances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Feb 95 - Mars 01</td>
</tr>
<tr>
<td>Apr 01 - Dec 06</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>0.001940586</td>
</tr>
<tr>
<td>0.001138881</td>
</tr>
<tr>
<td>Variance</td>
</tr>
<tr>
<td>8.02063E-06</td>
</tr>
<tr>
<td>8.18714E-06</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>74</td>
</tr>
<tr>
<td>68</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>73</td>
</tr>
<tr>
<td>67</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>0.979661573</td>
</tr>
<tr>
<td>P-value (F&lt;=f) one-tail</td>
</tr>
<tr>
<td>0.464536764</td>
</tr>
<tr>
<td>F Critical one-tail</td>
</tr>
<tr>
<td>0.674148925</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

Again the samples have to have approximately equal distributions, but as the distributions are practically identical as those in figure A.2 they will also here arguably be fulfilled.

Output

Table A.7: Two-sample F-test for variances calculated based on quarterly change in GDP for Norway over the two periods in the table.

<table>
<thead>
<tr>
<th>Two-Sample F-test for Variances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>1.094286</td>
</tr>
<tr>
<td>0.882609</td>
</tr>
<tr>
<td>Variance</td>
</tr>
<tr>
<td>3.393496</td>
</tr>
<tr>
<td>3.541502</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>23</td>
</tr>
</tbody>
</table>
Table A.6 summarizes the results from a F-test, where the means and standard deviations are those presented in table 3.4 in chapter 3. As can be seen the p-value is quite large, meaning that $H_0$, the hypothesis that states that the two samples are taken from populations with the same variances, cannot be rejected.

However, the two samples have rather different distributions as can be seen from the figures below, which means that the results in the above table might be misleading, or even wrong. Still, given that the Fischer F-test is a rather robust statistical test, and that the distributions of the two samples are not very different, the conclusion that it cannot be rejected that the two samples are taken from populations with the same variances arguably still holds.
Figure A.3: Distributions of quarterly change in GDP for Norway over the two periods given in the figures.

Output gap

The output gap is measured as the difference between real GDP and potential, or trend, GDP, where the trend has been extracted using a Hodrick-Prescott filter with a $\lambda = 1600$ as output is measured as quarterly change in GDP.

Appendix B contains more detailed information about the output gap, or more precisely, the Hodrick-Prescott filter, including how it extracts the trend, and its pros and cons.
**Table A.8:** Two-sample F-test for variances calculated for the quarterly change in the output gap, i.e. the difference between real and trend GDP, where the trend has been extracted using a Hodrick-Prescott filter with $\lambda = 1600$.

<table>
<thead>
<tr>
<th>Two-Sample F-test for Variances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Variance</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>P-value ($F \leq f$) one-tail</td>
</tr>
<tr>
<td>F Critical one-tail</td>
</tr>
</tbody>
</table>

Source: Statistics Norway

In the above table the hypothesis that the two samples for the output gap are taken from populations with the same variance is tested against the alternative hypothesis that the two samples are taken from populations with different variances.

As can be seen from the p-value, the initial hypothesis that states that the two samples are taken from populations with the same variances cannot be rejected in favour of the alternative hypothesis that they are.

However, since the output gap is calculated based on quarterly change in the GDP over the previous mentioned periods, there are very few observations particularly in the period after adopting an inflation target on Mars 29 2001.

This is arguably also reflected in figure A.4, where the two distributions are very different. This will quite possibly distort the results in the table above, but hopefully not enough to change the above conclusion.
Figure A.4: Distributions for quarterly change in the output gap, i.e. the difference between real and trend GDP, where the trend has been extracted using a Hodrick-Prescott filter with a $\lambda = 1600$, over the two periods in the graphs.

Source: Statistical Norway

Housing Prices

In the following three tables the hypothesis that the samples for the two periods are taken from populations with the same variances is tested against the alternative hypothesis that the two samples are taken from populations with different variances.

For single houses and shared houses the hypothesis that the two samples are taken from populations with the same variances cannot be rejected, whilst the same hypothesis is rejected in favour of the alternative hypothesis that the two samples are taken from populations with different variances for apartment, given a “normal” level of significance.
Table A.9: Two-sample F-test for variances calculated for the quarterly change in the average square meter price for houses in Norway.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.021590</td>
<td>0.019678</td>
</tr>
<tr>
<td>Variance</td>
<td>0.001352</td>
<td>0.001092</td>
</tr>
<tr>
<td>Observations</td>
<td>35</td>
<td>23</td>
</tr>
<tr>
<td>df</td>
<td>34</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>1.237806</td>
<td></td>
</tr>
<tr>
<td>P-value (F&lt;=f) one-tail</td>
<td>0.303641</td>
<td></td>
</tr>
<tr>
<td>F Critical one-tail</td>
<td>1.962739</td>
<td></td>
</tr>
</tbody>
</table>

Source: NEF, EFF, Econ, Finn.no

Table A.10: Two-sample F-test for variances calculated for the quarterly change in the average square meter price for shared houses in Norway.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.026375</td>
<td>0.012196</td>
</tr>
<tr>
<td>Variance</td>
<td>0.001188</td>
<td>0.000735</td>
</tr>
<tr>
<td>Observations</td>
<td>35</td>
<td>23</td>
</tr>
<tr>
<td>df</td>
<td>34</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>1.616068</td>
<td></td>
</tr>
<tr>
<td>P-value (F&lt;=f) one-tail</td>
<td>0.119875</td>
<td></td>
</tr>
<tr>
<td>F Critical one-tail</td>
<td>1.962739</td>
<td></td>
</tr>
</tbody>
</table>

Source: NEF, EFF, Econ, Finn.no
Table A.11: Two-sample F-test for variances calculated for the quarterly change in the average square meter price for apartments in Norway.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.028777</td>
<td>0.020686</td>
</tr>
<tr>
<td>Variance</td>
<td>0.001645</td>
<td>0.000544</td>
</tr>
<tr>
<td>Observations</td>
<td>35</td>
<td>23</td>
</tr>
<tr>
<td>df</td>
<td>34</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>3.023276</td>
<td></td>
</tr>
<tr>
<td>P-value (F&lt;=f) one-tail</td>
<td>0.004114</td>
<td></td>
</tr>
<tr>
<td>F Critical one-tail</td>
<td>1.962739</td>
<td></td>
</tr>
</tbody>
</table>

Source: NEF, EFF, Econ, Finn.no

However the conclusions based on the results in the above tables rely on the distributions in the two samples being relatively normal, but as the F-test is rather robust, the distributions of the two samples should at least be relatively similar.

The following three figures compare the distributions of the samples for single houses, shared houses and apartments for the period from the 3. Quarter 1992 to the 1. Quarter 2001, and from the 2. Quarter 2001 to the 4. Quarter 2006, respectively.
Figure A.5: Distributions for quarterly change in the square meter price for houses in Norway for the two periods in the graphs.


2. Quarter 2001 - 4. Quarter 2006

Source: NEF, EFF, Econ, Finn.no
Figure A.6: Distributions for quarterly change in the square meter price for shared houses in Norway for the two periods in the graphs.

Source: NEF, EFF, Econ, Finn.no
**Figure A.7**: Distributions for quarterly change in the square meter price for apartments in Norway for the two periods in the graphs.

As with output, the results for dwellings are based on quarterly data, so there are relatively few observations available since adopting an inflation target. But contrary to output, the distributions for the two periods, which are displayed in the graphs above, are relatively similar, hopefully meaning that the samples taken are quite representative for the populations as a whole, again meaning that the results, or at least the conclusions, are reasonably dependable.
APPENDIX B – The Hodrick-Prescott filter

The Hodrick-Prescott filter is a de-trending method that works by extracting the value of potential output by minimizing the difference between actual and potential output but at the same time imposing a restriction on this difference (Bjørnland et al. 2006). The restriction is imposed using a smoothing parameter, $\lambda$, which penalises the volatility in the growth rate around the trend (Bjørnland, 1999). The larger $\lambda$, the more smooth the trend and vice versa. As can seen from the following equation, which is the mathematical definition of the Hodrick-Prescott filter, when $\lambda$ is equal to zero, the trend is just the series itself.

$$\min_{\{y_t\}_{t=1}^T} \left[ \sum_{t=1}^T (y_t - g_t)^2 + \lambda \sum_{t=2}^T \left( (g_t - g_{t-1}) - (g_{t-1} - g_{t-2}) \right)^2 \right]$$

$y$ = output

$G$ = stochastic trend

Since the choice of lambda is essential for the trend that is obtained some justification should be made when choosing it. Here it is set at 1600, as this is what Kydland and Prescott (1990) argued to be a “reasonable” choice for this parameter when using quarterly US data, which is arbitrarily used for Norwegian data (Bjørnland, 1999).

The advantage of the Hodrick-Prescott filter is that it is easy to apply and therefore often used (Bjørnland, 1999). The downside however is that it is known to create business cycles when non are present in the data, and also that it often gives very uncertain estimates of the trend at the end of time series (Bjørnland, 1999). Caution should thus be made when making conclusion based on trends obtained using the Hodrick-Prescott filter.