

STAFF MEMO

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Are inflation expectations anchored in Norway?¹

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In this article, we investigate whether inflation expectations in Norway are anchored, in the sense that they show little response to new information and remain stable and close to the inflation target of 2.5 percent a few years ahead. We do this by analysing the responses of different groups in Norges Bank's expectations survey concerning their inflation expectations. Overall, the results indicate that inflation expectations are anchored. A substantial percentage of respondents in the groups expect inflation to be between 2.0 and 3.0 percent in two years' and in five years' time. The groups' average inflation expectations have been fairly stable and close to the inflation target over time. For one of the groups in the survey – financial economists – expectations for inflation five years ahead have been somewhat lower than the inflation target in recent years.

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Key words: inflation expectations, monetary policy, anchoring.

1. Introduction

Norges Bank's operational target for monetary policy is annual consumer price inflation of close to 2.5 percent over time. The public's expectations for inflation affect the economy in a number of ways, for example by influencing saving and investment decisions, firms' price-setting behaviour and wage negotiations. What inflation expectations are and how they are formed are therefore of considerable importance for monetary policy.

A potential benefit of an inflation targeting regime is that public expectations with regard to future inflation can be anchored around a specific numerical target for the rate of inflation. Anchored inflation expectations reduce price-setting uncertainty for firms, which is particularly important for firms that change their prices infrequently, and uncertainty in wage negotiations, where the main focus is usually on wage earners' purchasing power. Stable inflation expectations also result in predictability in saving and investment decisions, as the real interest rate is then considered to be less uncertain. The effect of a given change in the central bank's key rate can then be stronger, and anchoring of inflation expectations makes it easier for monetary policy to achieve the inflation target. The more firmly anchored inflation

¹ This article builds on Midthjell (2017).

² The views and conclusions expressed in this publication are those of the authors and not necessarily those of Norges Bank and must not be reported as Norges Bank's views. We thank Anita Einarsdottir for assistance with data collection and Nina Langbraaten, Per Espen Lilleås, Einar W. Nordbø, Øistein Røisland, Ingrid Solberg, Njål Stensland, and Marianne Sturød for valuable input and comments.

expectations are, the more monetary policy can take factors other than price stability into account.

This article investigates empirically whether inflation expectations in Norway are anchored. We refer to inflation expectations as anchored when the public's medium- and long-term inflation expectations show little change in response to new information and remain stable and close to the inflation target over time.³ The reason why we focus most on inflation expectations somewhat further out is that it takes time for changes in monetary policy to have an effect on inflation. As a result, temporary economic or inflationary shocks can in the short term move inflation away from the target. However, if inflation expectations are anchored in the medium and long term, people look through these short-term fluctuations and expect inflation to return to target. Anchoring of inflation expectations somewhat further out can thus be interpreted to mean that the public has confidence in monetary policy.

We measure inflation expectations using data from Norges Bank's quarterly expectations survey. In this survey different population groups are asked about their expectations for inflation one, two and five years ahead. We test whether inflation expectations are anchored several ways. We use data at the individual respondent level to explore whether there is substantial variation in respondents' inflation expectations. Developments over time in the groups' average expectations for inflation are also analysed. We investigate whether inflation expectations are affected by developments in actual inflation and whether longer-term inflation expectations are formed independently of shorter-term expectations. In addition, we test the data to discover whether the average inflation expectations of any of the groups are influenced by Norges Bank's inflation projections. Finally, we also look briefly at developments in five-year and six- to 10-year inflation expectations as reported twice a year by Consensus Forecast.

Overall, the results indicate that inflation expectations in Norway as reported by the expectations survey are anchored. A substantial percentage of respondents in all the groups expect inflation to be between 2.0 and 3.0 percent in two and five years' time. The groups' average inflation expectations have been fairly stable and close to the inflation target over time. For one of the groups in the survey – financial economists – expectations for inflation five years ahead have been somewhat lower than the inflation target in recent years, possibly reflecting lower inflation projections from Norges Bank. Five-year inflation expectations generally show little change in response to developments in actual inflation and changes in inflation expectations in the short term, particularly among financial economists and for the employer organisations.

³ This definition is inspired by Gürkaynak, Levin and Swanson (2010) and Capistrán and Ramos- Francia (2010).

The article continues as follows: Section 2 discusses the theoretical relationship between monetary policy, inflation expectations and inflation and presents other empirical studies on this topic. Section 3 describes the data, while the empirical analysis is presented in Section 4. Section 5 concludes.

2. Theory and related literature

Under an inflation targeting regime, monetary policy seeks to control inflation, partly by affecting inflation expectations, while both inflation and inflation expectations can also influence both monetary policy and each other. The relationships between monetary policy, inflation and inflation expectations are described in Section 2.1 below. Section 2.2 presents an overview of other related empirical studies of inflation expectations.

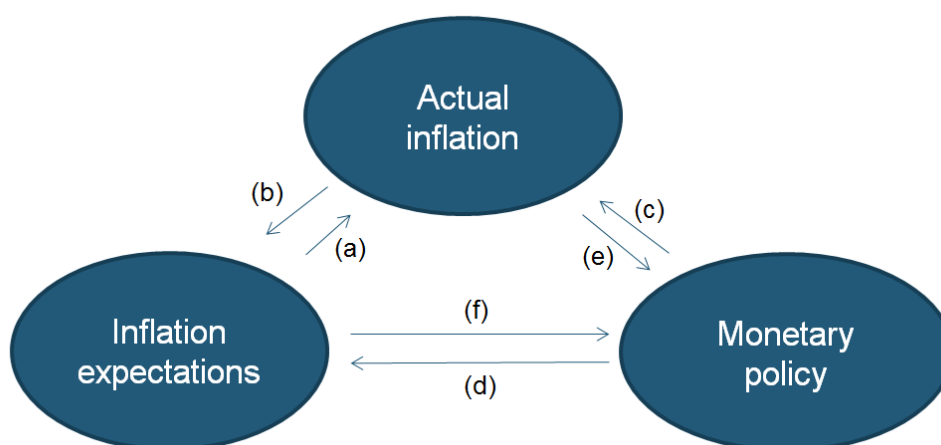
2.1. Theory

Inflation expectations can affect inflation (see arrow (a) in Chart 2.1) in a number of ways. In New Keynesian macro models, which provide the theoretical basis for inflation targeting, inflation expectations play a crucial role in stabilising inflation.⁴ Many firms change their prices for goods and services infrequently. One of the reasons may be because changing prices involves costs or firms may have implicit or explicit agreements with suppliers and customers not to change prices for a given period. When a firm that changes its prices infrequently does so, these models assume that the firm then takes account of expected inflation in the period to the next planned price change. If the firm expects that costs and competitors' prices in the relevant period will increase in pace with the inflation target, it is reasonable to expect that this firm will also increase its prices by approximately the same amount. Inflation expectations thus have a direct effect on actual inflation through firms' price setting.

Inflation expectations can also indirectly affect actual inflation through several channels. Wage negotiations typically take place only once a year, and in wage negotiations, the focus is on wage earners' purchasing power. Employer and employee inflation expectations for the coming agreement period thus affect wage determination. The agreed pay increases affect firms' costs, which in turn has an impact on inflation. Furthermore, inflation expectations can also indirectly affect actual inflation through expected developments in the real interest rate. The real interest rate influences households' and firms' saving and investment decisions, and thus also demand and inflation further out.

⁴In New Keynesian models, inflation is normally determined by an expectations-augmented Phillips curve equation, where actual inflation in period $t+1$ is explained by what economic agents in period t expect inflation to be in period $t+1$ and by economic pressures in period t (including any other explanatory variables).

Chart 2.1. Illustration of the relationship between monetary policy, inflation expectations and inflation.



While inflation expectations can affect inflation, inflation developments can also affect inflation expectations (arrow (b)). An inflationary shock usually lasts for a period, and, since monetary policy operates with a lag, there is little it can do to counteract a shock in the short run. Changes in inflation can thus influence short-term inflation expectations, often moving them in the same direction as inflation. Developments in actual inflation can also provide new information about economic activity and the output gap, which can also result in a change in public expectations for inflation further ahead. The effect will depend on whether inflation expectations in the longer term are anchored around the inflation target. If economic agents have confidence that the central bank will respond to new information and deliver inflation at the target further ahead, actual inflation will have little effect on longer-term inflation expectations.

Monetary policy affects inflation in a number of ways, for example through the demand and exchange rate channels (arrow (c)). If inflation looks likely to fall below target, the central bank can lower the key rate both to stimulate demand and to weaken the exchange rate, which in turn will push up inflation. Monetary policy can also affect inflation by influencing public inflation expectations (arrow (d)), particularly in the somewhat longer term. The effect depends on confidence that the central bank will ensure that inflation meets the target over time. The stronger confidence is, the more effective monetary policy can be in influencing inflation through the expectations channel.⁵

As actual inflation can provide a signal about the inflation outlook, it can thereby affect monetary policy (arrow (e)). In the same way, inflation expectations, since they affect the inflation outlook, can affect monetary policy (arrow (f)).

⁵ Falck, Hoffmann and Hürtgen (2017) show that the effect of monetary policy also depends on whether there are substantial differences in public inflation expectations. The greater these differences are, the less effective monetary policy will be.

2.2. Related literature

Few empirical studies on inflation expectations have been conducted in Norway. One of these is Bjørnstad, Cappelen and Nymoene (2009), who investigate whether professional forecasters' inflation projections for Norway are unbiased. The study finds no systematic forecast errors. In addition, some international studies, such as IMF (2014) and Levin (2014), find that long-term inflation expectations in Norway have fallen in recent years, often linking the fall to changes in Norges Bank's monetary policy. The two latter articles are based on inflation expectations six to 10 years ahead, as reported by Consensus Forecasts.⁶

Internationally, there are many empirical studies that investigate how well-anchored inflation expectations are. Levin, Natalucci and Piger (2004) find that in non-inflation targeting countries, long-term inflation expectations depend on actual inflation, while this is not the case in inflation-targeting countries. Swanson (2006) studies US forecasters' inflation projections and finds that forecasts have diverged to a lesser extent with the increase in Federal Reserve transparency. Lyziak and Paloviita (2016) investigate whether inflation expectations in the euro area are anchored and whether the formation of expectations has changed since the financial crisis. They find that long-term inflation expectations have responded more to changes in both actual inflation and in short-term inflation expectations since the financial crisis. They also find that, in the same period, more weight has been given to the inflation projections from the European Central Bank to explain experts' inflation expectations. In this article, we conduct a number of the same tests on Norwegian data as conducted by Lyziak and Paloviita for the euro area.

3. Data

Internationally, inflation expectations are usually measured either via inflation-indexed securities or through surveys of inflation expectations. Inflation-indexed securities do not exist in Norway, but a number of inflation expectations surveys are conducted, and among these, Norges Bank's expectations survey is the most extensive, and the analyses in this article are primarily based on data from this survey. We also look briefly at five-year and six- to ten-year inflation expectations as reported by Consensus Forecasts.

⁶ Consensus Forecasts is a monthly publication by Consensus Economics Inc. that reports the inflation forecasts of various institutions in a large number of countries. A further description is given in Section 3.2.

3.1. Norges Bank's expectations survey

The expectations survey is a survey conducted by Epinion on behalf of Norges Bank and has been published on a quarterly basis since the first quarter of 2002.⁷ In the survey, six different population groups, ie households, business leaders, economists on the staff of universities and colleges (academia) and in the financial sector, and representatives from employer and employee organisations, are asked about their expectations for inflation, in terms of the twelve-month rise in the consumer price index (CPI). All the groups are asked about their inflation expectations one and two years ahead.⁸ The two groups of economists and the two groups of social partner representatives – hereafter referred to as expert groups – are also asked about their expectations five years ahead.

Households are interviewed by phone, while the other groups respond to the survey questions online. The survey is usually conducted in the first half of the middle month of the quarter to which the survey applies. As the groups are interviewed over a slightly varying, though overlapping, period of time, the information on which the various respondents base their answers at the time of the survey varies somewhat.

The number of respondents varies widely across the groups and the response rate also varies. About 1 000 households are interviewed each quarter. Of these, about 60 percent respond to the question of what they think inflation will be in one year's time,⁹ while around 80 percent of households report what they think inflation will be in two to three years' time. About 500 business leaders take part in each survey, and the response rate is about 90 percent for the questions of what they think inflation will be at the one-year and the two-year horizon. There are considerably fewer respondents in each of the expert groups. Just over 30 economists in academia take part in the survey, while about there are about 20 respondents in each of the other groups of experts, ie financial economists and the two groups of representatives from employer and employee organisations. Most of these respondents report what they think inflation will be one, two and five years ahead.

In this survey, average inflation expectations are calculated for each group excluding outliers. For the four expert groups, outliers are defined as a forecast for CPI inflation of more than 8 percent or less than -8

⁷ Epinion has been responsible for the expectations survey since the first quarter of 2015. The survey was previously conducted by Opinion and TNS Gallup.

⁸ Households are asked about their expectations regarding inflation two-three years ahead. However, for the sake of simplicity, we refer to this as a two-year horizon in this article.

⁹ Households are first asked whether they think prices for goods and services, as measured by the CPI, will in the course of the next twelve months be higher, approximately unchanged, or lower than now. Only those answering higher or lower are asked to quantify their response by indicating how much higher or lower they think prices will be. The roughly 20 percent of households that answer 'approximately unchanged' are not included in the calculation of the average.

percent, while the corresponding threshold values for business leaders and households are +/-11 percent.

In the first quarter of 2015, some of the questions for households and business leaders were reformulated to make the questions easier to understand. The change in the way the questions were formulated may have resulted in a break in these time series.

3.2. Consensus Forecasts

Each month, Consensus Economics polls institutions, mainly banks and other financial institutions in a number of countries, to obtain their forecasts for inflation and other indicators for the next couple of years. Twice-yearly surveys are also conducted – in April and October – to obtain the institutions' forecasts for inflation up to six to ten years ahead. For Norway, inflation forecasts for the next couple of years are usually provided by between eight and ten institutions, while there are fewer institutions offering long-term forecasts.¹⁰ Owing to the low number of respondents to Consensus Forecasts, these figures, particularly at long horizons, must be interpreted with caution. However, as this is the only survey that measures inflation expectations further ahead than five years, we show how these expectations have developed over time in Section 4.5.

4. Analysis

This section presents the empirical analysis. The distribution of inflation expectations at individual level is explored in more detail in Section 4.1, while developments over time in the groups' average inflation expectations are analysed in Section 4.2. Section 4.3 tests whether inflation expectations are influenced by new information about the near-term outlook for inflation, while Section 4.4 explores whether changes in Norges Bank's inflation projections affect inflation expectations. Section 4.5 presents a comparison of financial economists' inflation expectations at the five-year horizon with their long-term expectations, as reported by Consensus Forecasts.

4.1. Inflation expectations at individual level

Charts 4.1a-c show the distribution of inflation expectations within the groups over the past three years.¹¹ In all six groups and at all horizons,

¹⁰ About half of the institutions on the *Consensus Forecasts* panel are Norwegian, and some of these are also on the panel of financial economists in Norges Bank's expectations survey.

¹¹ Note that the ranges in the charts have been determined by the authors. The respondents report one figure, which is either a whole number or with one or two decimal digits, for each horizon.

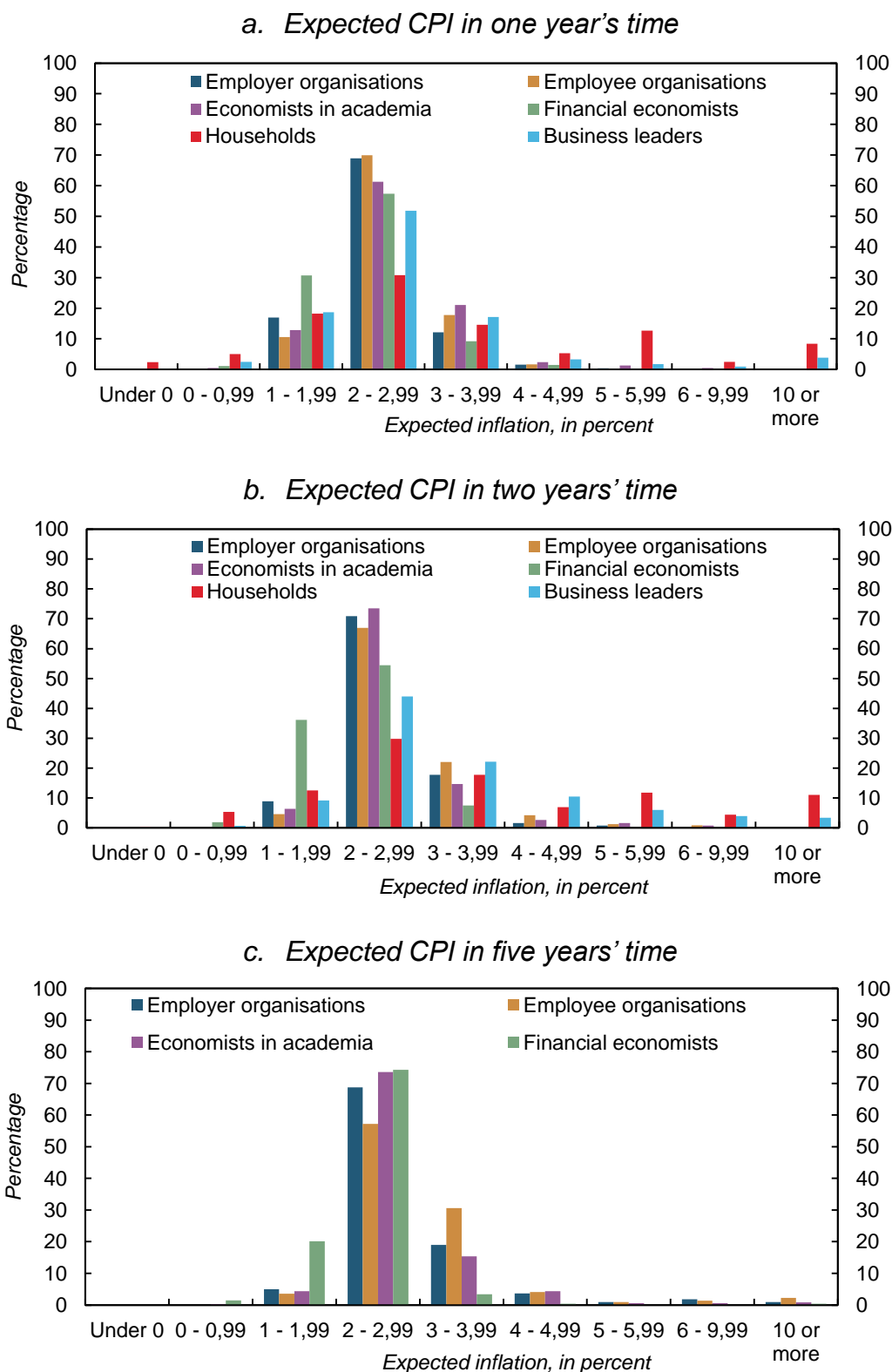
an inflation forecast of between 2.0 percent and 3.0 percent is reported by the largest number of respondents. Over 60 percent of the respondents in the expert groups forecast inflation to be within this range five years ahead. A substantial percentage of these respondents forecast inflation to be 2.5 percent at the five-year horizon, and for three of the expert groups, 2.5 percent is the mode of the distribution. For financial economists however, the mode is 2.0 percent. Financial economists also differ in that a somewhat larger percentage of respondents in this group expect inflation five years ahead to be below 2.0 percent.

The difference in inflation expectations across individuals in the expert groups is quite small. In these groups, very few respondents expect inflation to be above 5 percent or below 1 percent. For households and business leaders the difference is greater. About 25 percent of households expect inflation to be 5.0 percent or higher at both the one and two year horizons, while just over 5 percent expect inflation to be below 1.0 percent.¹² A not unsubstantial percentage of business leaders also expect inflation to be 5.0 percent or higher. However, few business leaders expect inflation to be below 1.0 percent.

¹² In addition, about 20 percent of households expect prices to be approximately unchanged in one year's time. These households are not included in this subgroup (see footnote in Section 3.1 for more detail).

Chart 4.1a-c Expected inflation. Frequency distribution. Twelve-month change. Percent. 2015 Q1 – 2017 Q4

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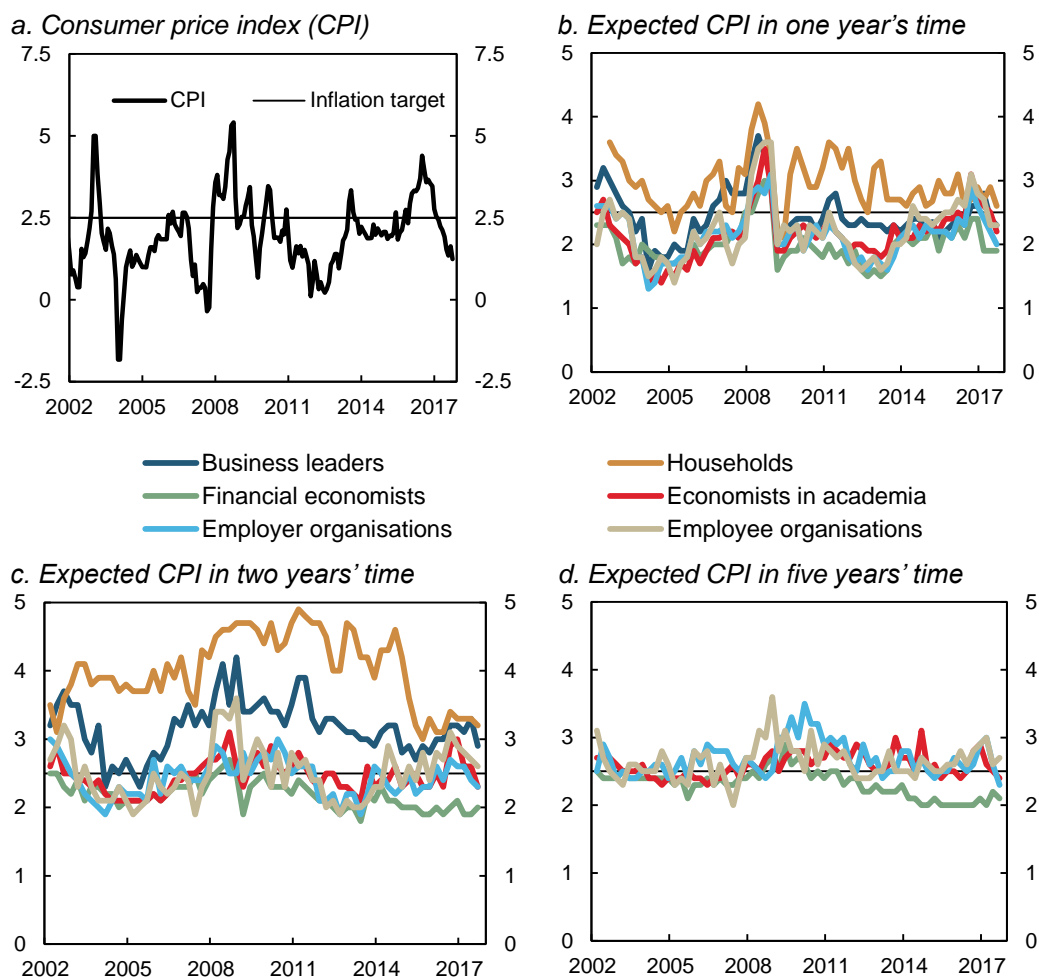


Notes: The charts show the frequency distribution of the forecasts for twelve-month CPI inflation in one year's time, two years time (two-to-three years' time for households), and five years' time. The respondents report their inflation forecast as whole numbers or with one or two decimal digits. The x-axis shows expected inflation as a range of percentages. The y-axis shows the percentage of respondents in each group. Sources: Epinion and Norges Bank.

4.2. Are inflation expectations stable and close to the target over time?

The average inflation expectations of the groups in the survey have as a whole been fairly close to the inflation target of 2.5 percent over time (Chart 4.2b-d and Table 4.1). There are however differences across the groups. Inflation expectations are highest for the household group at both of the horizons they are asked about, while the group of financial economists have the lowest expectations for inflation in one, two and five years' time. For all the groups, inflation expectations are on average lower for the one-year horizon than for the two- and five-year horizons.

Chart 4.2a-d Actual inflation (CPI) and expected inflation (average of the groups). Twelve-month change. Percent



Notes: Chart a. shows actual inflation, as measured by the twelve-month rise in the consumer price index (CPI), from January 2002 to November 2017. Charts b.-d. show the groups' average expected inflation, as measured by the twelve-month rise in the CPI, in one year's time, two years' time (two-to-three years' time for households) and five years' time, from 2002Q1 to 2017Q4. The series for households' expectations for inflation in one year's time starts in 2002 Q3. The questions for households and business leaders were reformulated in 2015 Q1. This may have resulted in a break in the series. Sources: Epinion, Opinion, Statistics Norway and TNS Gallup.

For the four expert groups, inflation expectations vary less at the two- and five-year horizons than at the one-year horizon (see the standard deviations in Table 4.1). For these groups, average expectations for inflation at the two- and five-year horizons are fairly close to the inflation target. Inflation expectations for the group of financial economists, however, have been somewhat lower than the inflation target in recent years.

For households and business leaders, there are small differences in the variation over time between expectations for inflation in one and two years' time. Both groups expect inflation to be further away from the inflation target in two years' time than in one year's time. In principle, this could indicate a lesser degree of anchoring around the inflation target. Expectation figures for inflation for these two groups must, however, be interpreted with caution. As mentioned in Section 3.1, the questions for households and business leaders were reformulated in 2015 Q1. The reformulation makes it clearer that respondents are asked about the level of the twelve-month rise in the CPI in two years' time and not about cumulative inflation over the next two years. After the question was reformulated, expectations for inflation at the two-year horizon reported by households fell considerably, while business leaders' expectations showed a smaller decrease (Chart 4.2c). This may indicate that the question was misunderstood by a number of respondents in previous surveys, which may have pushed up the average inflation expectations for these groups.

Table 4.1 Inflation expectations and actual inflation (CPI). Averages and standard deviations (in parentheses). 2002 Q1 – 2017 Q4. Percent. Figures in parentheses are standard deviations.

	1 year	2 years	5 years
Economist in academia	2.16 (0.4)	2.46 (0.24)	2.59 (0.18)
Financial economists	2.00 (0.31)	2.18 (0.2)	2.32 (0.2)
Employee organisations	2.22 (0.48)	2.50 (0.4)	2.64 (0.26)
Employer organisations	2.15 (0.36)	2.43 (0.27)	2.68 (0.25)
Households	2.95 (0.42)	4.01 (0.53)	
Business leaders	2.45 (0.39)	3.16 (0.39)	
Actual inflation (CPI)		1.94 (1.14)	

Notes: The table shows the different groups' average expectations for inflation in one year's time, two years' time (two-to-three years' time for households) and five years' time, 2002 Q1 – 2017 Q4. The series for household expectations for inflation in one year's time starts in 2002 Q3. The questions for households and business leaders were reformulated in 2015 Q1. This may result in a break in these series. Actual inflation is calculated as the average twelve-month change in the consumer price index (CPI) between January 2002 and November 2017. Figures in parentheses are standard deviations. Sources: Epinion, Opinion, Statistics Norway, TNS Gallup, and Norges Bank.

The twelve-month rise in the consumer price index (CPI) has averaged 1.9 percent from January 2002 to November 2017, varying between -1.8 percent and 5.4 percent in this period (Chart 4.2a). All the groups' average inflation expectations have varied considerably less than actual inflation.

4.3. Are inflation expectations affected by new information?

A criterion for defining medium- to long-term inflation expectations as anchored is that they show little change in response to new information affecting the short-term inflation outlook. Section 4.3.1 tests whether inflation expectations are affected by developments in actual inflation, and Section 4.3.2 explores whether longer-term inflation expectations are formed independently of shorter-term inflation expectations.

4.3.1 Effect of actual inflation on inflation expectations

To test whether average inflation expectations are affected by actual inflation, the following equation is estimated for each of the groups at each of the horizons for which they report inflation forecasts:

$$(1) \quad E_t^{g_i} \pi_{t+n} = c + \beta \pi_{t-1} + \varepsilon_t,$$

where $E_t^{g_i} \pi_{t+n}$ is group i 's average expectation in period t for inflation in period $t + n$, where $n = 1, 2$ and 5 years. π_{t-1} is actual inflation measured as the latest available figures for twelve-month CPI inflation at the time of the survey, while c is the constant term and ε_t is the residual term.¹³ The coefficient β represents the degree to which inflation expectations change if inflation at the time of the survey is changed by one percentage point. If inflation expectations are anchored around the inflation target, actual inflation should not affect longer-term inflation expectations. β will then be 0.

We find that actual inflation at the time of the survey has a significant effect on expectations for inflation at the one- and two-year horizons for most of the groups (see estimated values of β in Table 4.2). For all four expert groups, the estimated effect of actual inflation falls the longer the horizon for inflation expectations is. For expectations for inflation at the five-year horizon, we find that actual inflation has no significant effect for three of the four expert groups. For employee organisations, however, the results indicate that expectations for inflation at the five-year horizon are also affected by actual inflation.

¹³ In the equations for households' and business leaders' expectations for inflation in one and two years' time, we have also tested whether the reformulated questions introduced in 2015 Q1 have had a significant effect. We do this by including a dummy variable in the equations, set at 1 as from 2015 Q1 and at 0 before that.

Table 4.2: Estimation results equation (1): Effect of actual inflation on inflation expectations

Expected inflation in:	Economists in academia	Financial economists	Employee organisations	Employer organisations	Households	Business leaders
1 year	0,21*** (0,05)	0,13** (0,05)	0,31*** (0,05)	0,22*** (0,03)	0,08 (0,05)	0,15*** (0,05)
2 years	0,08*** (0,03)	0,03 (0,03)	0,21*** (0,04)	0,10*** (0,03)	0,11*** (0,03)	0,16*** (0,05)
5 years	0,03 (0,02)	0,00 (0,04)	0,12*** (0,04)	0,02 (0,03)	-	-

Notes: The table shows the estimated value of β in equation (1). The model is estimated using OLS on data from 2002 Q1 to 2017 Q4. Figures in parentheses are Newey-West HAC standard deviations, which correct for potential autocorrelation in the error terms. *, ** and *** denote statistical significance at the 10, 5 and 1 percent level respectively. Actual inflation is defined as the latest available figures for twelve-month CPI inflation at the time of the survey.

4.3.2 Relationship between inflation expectations at different horizons

Another way of investigating whether longer-term inflation expectations are anchored is to test whether they are formed independently of shorter-term inflation expectations. If longer-term inflation expectations are anchored, changes in conditions affecting shorter-term inflation expectations will not result in substantial changes in longer-term expectations. We therefore test the relationships between the groups' average expectations for inflation at the different horizons in more detail, based on the following equation:

$$(2) E_t^{gi} \pi_{t+n} = c + \beta E_t^{gi} \pi_{t+m} + \varepsilon_t, \text{ where } n > m$$

and $E_t^{gi} \pi_{t+n}$ is longer-term inflation expectations, $E_t^{gi} \pi_{t+m}$ is shorter-term inflation expectations and c and ε are the constant term and the error term respectively. The coefficient β measures the degree of change in longer-term expectations when shorter-term expectations are changed by one percentage point. If longer-term inflation expectations are anchored, β will be close to zero.

The estimation results do not provide a clear answer (Table 4.4). The estimated values of β show that expectations for inflation in five years' time are not influenced by changes in one-year inflation expectations for financial economists or for employer organisations. For the other two expert groups, on the other hand, there is a significant relationship between the two. This may be an indication that inflation expectations are not as well anchored among economists in academia and in employee organisations as for financial economists and employer organisations.

Table 4.4: Estimation results equation (2): Effect of shorter-term inflation expectations on longer-term inflation expectations

Dependent variable: Expected inflation in	Explanatory variable: Expected inflation in	Economists in academia	Financial economists	Employee organisations	Employer organisations	Households	Business leaders
5 years	1 year	0,19*** (0,06)	0,03 (0,12)	0,30*** (0,06)	0,04 (0,10)	-	-
5 years	2 years	0,46*** (0,08)	0,68*** (0,12)	0,41*** (0,09)	0,51*** (0,16)	-	-
2 years	1 year	0,49*** (0,05)	0,35*** (0,09)	0,74*** (0,03)	0,51*** (0,09)	0,38** (0,17)	0,78*** (0,10)

Notes: The table shows the estimated effect of shorter-term inflation expectations on longer-term inflation expectations. The estimates are calculated using OLS on data from 2002 Q1 to 2017 Q4. The figures in parentheses are Newey-West HAC-adjusted standard deviations, used to correct for potential autocorrelation. *, ** and *** denote statistical significance at the 10, 5 and 1 percent level respectively.

The relationship between expectations at the one- and two-year horizons and the two- and five-year horizons is significant for all groups. These results probably reflect the fact that many respondents report exactly the same figure at these horizons (see Appendix 1).

4.4. Do Norges Bank's inflation projections influence the groups' inflation expectations?

Norges Bank publishes quarterly inflation projections for the next three to four years in the Bank's monetary policy reports (Norges Bank, 2002-2017). The inflation projections may indicate the time Norges Bank wishes to take to bring inflation back to target. Changes in Norges Bank's inflation projections can therefore influence other agents' inflation expectations.

To test whether Norges Bank's inflation projections influence various agents' inflation expectations, we base our analysis on equation (3) below, which is an expanded version of equation (1). The equation explains developments in each of the groups' average inflation expectations in a period of actual inflation, Norges Bank's inflation projections and of the groups' inflation expectations in the previous period:¹⁴

$$(3) E_t^{gi} \pi_{t+n} = c + \beta_1 \pi_{t-1} + \beta_2 E_{t-1}^{gi} \pi_{t+n-1} + \beta_3 E_{t-1}^{NB} \pi_{t+n} + \varepsilon_t,$$

where $E_t^{gi} \pi_{t+n}$ is group i 's average expectation in period t for inflation in period $t+n$,¹⁵ where $n = 1, 2$ or 5 (years). π_{t-1} is, as previously, actual inflation measured as the latest available figure for twelve-month CPI

¹⁴ Since Norges Bank's inflation projections are probably influenced by driving forces that also affect other agents' inflation expectations, the estimated effect of Norges Bank's inflation projections may be overestimated. The problem will probably be reduced by controlling for the group's inflation expectations in the previous period.

¹⁵ The notation for the periods is not entirely accurate with regard to month, quarter and year.

inflation at the time of the survey, $E_{t-1}^{NB}\pi_{t+n}$ is Norges Bank's inflation projection published in the previous quarter for period $t+n$ and $E_{t-1}^{g_i}\pi_{t+n-1}$ is group i 's inflation expectations in the previous period.¹⁶ As above, c is the constant term and ε_t the residual term. The β 's are the coefficients to be estimated.

Coefficient β_1 measures the effect of actual inflation on the groups' average inflation expectations. It is significantly higher than zero for most of the groups at the one- and two-year horizons. The only exception is households' expectations at the one-year horizon and financial economists' expectations at the two-year horizon. This is the same finding as in the estimation of equation (1) above, but all the coefficients are now somewhat lower. At the five-year horizon, the estimated value of β_1 is significant for both economists in academia and for employee organisations, while in the estimation of equation (1), only the latter coefficient diverged significantly from zero. Coefficient β_2 , which measures the effect of the same group's inflation expectations in the previous period, is significantly higher than zero for all the groups at all the horizons.

Coefficient β_3 , which is our primary focus here, measures the effect of Norges Bank's inflation projections on the groups' average inflation expectations for the same period. In all the estimations, β_3 is either positive, indicating that the groups' inflation expectations move in the same direction as Norges Bank's inflation projections, or close to zero. At the one-year horizon, β_3 is significantly higher than zero for financial economists, employee organisations and employer organisations, while it is not significant for any of the groups at the two-year horizon. At the five-year horizon, however, Norges Bank's inflation projections have significant explanatory power for financial economists' inflation expectations.

These results can be interpreted in several ways. One reason why β_3 is significantly higher than zero may be the emergence of new information about the economy that affects Norges Bank's inflation projections and the groups' inflation expectations in the same direction. This is probably particularly the case for short-term inflation expectations.

For financial economists' expectations for inflation in five years' time, another interpretation could be that Norges Bank's projections for inflation three to four years ahead are perceived as a signal about the Bank's monetary policy trade-offs. In recent years, Norges Bank's longest inflation projection has on average been somewhat lower than in the preceding years (Chart 4.5a). The downward revision of the inflation projections reflects Norges Bank's policy in recent years of

¹⁶ Norges Bank's projections for inflation in the following year are used for inflation expectations at the one-year horizon. For the two-year horizon, Norges Bank's projections for inflation two years ahead are used, while for projections for inflation five years ahead, we use the projections for the last year in Norges Bank's forecast horizon, which are normally projections of inflation three to four years ahead.

periodically keeping the key rate higher than implied by the medium-term outlook for inflation and output in isolation. Such a strategy may mean that it may take longer to achieve the inflation target (see Olsen (2014)).

To test whether there is a break in the relationship between Norges Bank's inflation projections and the groups' inflation expectations, we estimate an expanded version of equation (3). More specifically, we test whether there is a difference in the values of β_3 before and after the lowering of these projections (see Appendix 2 for the model and results). With the exception of employee organisations' expectations for inflation five years ahead, there are no significant changes resulting from the effect of Norges Bank's inflation projections on the groups' inflation expectations in these two periods. For employee organisations' expectations for inflation five years ahead, Norges Bank's inflation projections explain significantly less in the latter period than in the former.

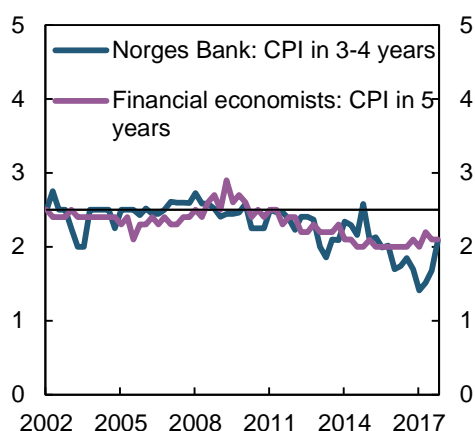
Table 4.5 Estimation results equation (3): Effect of Norges Bank's projections on inflation expectations

Expected inflation in:	Coefficient	Economists in academia	Financial economists	Employee organisations	Employer organisations	Households	Business leaders
1 year	β_1	0,08*** (0,03)	0,07** (0,03)	0,19*** (0,05)	0,13*** (0,03)	0,02 (0,03)	0,05* (0,03)
	β_2	0,57*** (0,11)	0,38* (0,19)	0,34** (0,15)	0,42*** (0,13)	0,56*** (0,09)	0,69*** (0,09)
	β_3	0,10 (0,08)	0,15* (0,08)	0,22*** (0,08)	0,14** (0,06)	0,05 (0,12)	0,06 (0,09)
	R^2 (just.)	0,66	0,51	0,7	0,7	0,34	0,63
2 years	β_1	0,05** (0,02)	0,01 (0,01)	0,14*** (0,04)	0,05* (0,03)	0,06*** (0,02)	0,08** (0,04)
	β_2	0,54*** (0,11)	0,66*** (0,11)	0,43*** (0,11)	0,53*** (0,11)	0,66*** (0,08)	0,64*** (0,10)
	β_3	0,02 (0,05)	-0,01 (0,05)	0,08 (0,12)	0,09 (0,08)	0,00 (0,07)	0,07 (0,10)
	R^2 (just.)	0,4	0,42	0,5	0,45	0,78	0,53
5 years	β_1	0,03* (0,01)	0,02 (0,01)	0,10*** (0,03)	0,02 (0,02)		
	β_2	0,48*** (0,15)	0,73*** (0,08)	0,30*** (0,08)	0,59*** (0,10)		
	β_3	-0,01 (0,07)	0,11** (0,04)	0,11 (0,08)	0,08 (0,08)		
	R^2 (just.)	0,23	0,67	0,37	0,35		

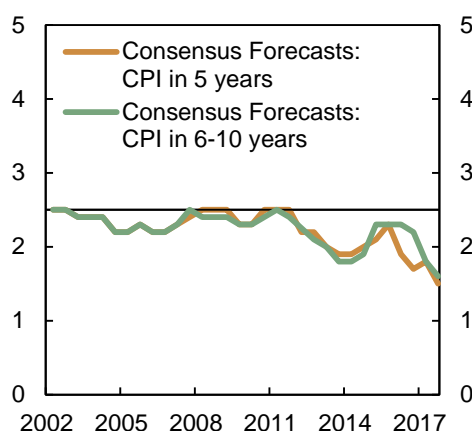
Notes: The table shows estimated coefficients of actual inflation (β_1), the respondents' inflation expectations in the previous period (β_2) and the effect of Norges Bank's inflation projections (β_3) on the various groups' expectations for inflation at the different horizons. The estimates are calculated using OLS on data from 2002 Q1 to 2017 Q4. The figures in parentheses are Newey-West HAC-adjusted standard deviations, used to correct for potential autocorrelation in the residual terms. *, ** and *** denote statistical significance at the 10, 5 and 1 percent level respectively. Actual inflation is defined as the latest available figures for twelve-month CPI inflation at the time of the survey.

Chart 4.5a-b Inflation expectations

a. Norges Bank and financial economists' expectations survey



b. Consensus forecasts



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Notes: Chart a. shows Norges Bank's projections for annual CPI inflation in the last year of the forecast period in different monetary policy reports (Norges Bank, 2002-2017) and financial economists' five-year inflation expectations as reported in the expectations survey. Chart b. shows expected CPI inflation five and six to ten years ahead in Consensus Forecasts in April and October, 2002-2017. Sources: Consensus Economics Inc., Epinion, Opinion, TNS Gallup and Norges Bank.

4.5. Expectations for inflation six to ten years ahead

As discussed above, financial economists' expectations for inflation in five years' time have declined and have in recent years been around 2 percent. The estimation results indicate that the decline in these expectations may be related to the reduction of Norges Bank's inflation projections. One interpretation could be that the respondents expect that it will take more than five years for inflation to return to the target of 2.5 percent. The expectations survey does not include questions about expectations for inflation further than five years ahead.

Consensus Forecasts, on the other hand, include average forecasts from a range of institutions for inflation both five years ahead and six to ten years ahead. The forecasts for both of these horizons are now about 0.5 percentage point lower than financial economists' expectations of inflation in five years' time as measured by Norges Bank's expectations survey, and 1 percentage point lower than the inflation target, see Chart 4.5b. This indicates that these institutions' long-term inflation expectations are less well anchored around the inflation target. Owing to the low number of respondents to the Consensus Forecasts survey (see Section 3.2), however, these figures must be interpreted with caution. The higher degree of variability of the Consensus figures relative to the figures of the financial economists in the expectations survey may be due to the sample size.

5. Concluding remarks

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STAFF MEMO
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In this article, we have investigated whether inflation expectations in Norway are anchored, in the sense that expectations for inflation in two and five years' time show little change in response to new information and remain stable and close to the inflation target over time. Overall, the results suggest that inflation expectations in Norway as reported by the expectations survey are anchored. Our analysis of the data at individual level shows that a substantial percentage of respondents expect inflation to be between 2.0 and 3.0 percent at all horizons. The groups' average inflation expectations at the two- and five-year horizons have been relatively stable over time and have remained fairly close to the inflation target. For one of the groups in the survey – financial economists – expectations for inflation five years ahead have in recent years been somewhat lower than the inflation target. The lowering of Norges Bank's inflation projections in the same period may have contributed to this decline. Expectations for inflation five years ahead generally show little change in response to developments in actual inflation and changes in short-term inflation expectations, particularly for financial economists and employer organisations.

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Appendix 1

Table A1 Share of respondents that expect exactly the same rate of inflation at various horizons. 2015 Q1 – 2017 Q4

Group	Same expected rate of inflation in:			
	One and two years	One and five years	Two and five years	One, two and five years
Economist in academia	30 %	22 %	43 %	18 %
Financial economists	25 %	24 %	36 %	16 %
Employee organisations	25 %	13 %	28 %	11 %
Employer organisations	22 %	22 %	32 %	13 %
Households	31 %	-	-	-
Business leaders	22 %	-	-	-

Notes: The table shows the share of respondents in each group in Norges Bank's expectations survey that report exactly the same rate of expected inflation, as measured by the twelve-month rise in the CPI, at various horizons in the period from 2015 Q1 to 2017 Q4. Households are asked about expected inflation in one year's time and in two-three years' time, while business leaders are asked about expected inflation in one year's time and in two years' time. The other four groups are asked about expected inflation in one, two and five years' time. Sources: Epinion and Norges Bank.

Appendix 2

To investigate whether there has been a break in the relationship between Norges Bank's inflation projections and the inflation expectations of the survey groups in recent years, cf. the discussion in Section 4.4, we estimate the following equation:

$$(4) \quad E_t^{g_i} \pi_{t+n} = c + \beta_1 \pi_{t-1} + \beta_2 E_{t-1}^{g_i} \pi_{t+n-1} + \beta_3 R + \beta_4 (1 - R) E_{t-1}^{NB} \pi_{t+n} + \beta_5 R E_{t-1}^{NB} \pi_{t+n} + \varepsilon_t,$$

where R is a dummy variable that is 1 as from 2012 Q2 and 0 before that.¹⁷ The other variables and the coefficients β_1 and β_2 are defined as in equation (3). The coefficient β_3 captures whether there are any differences in the groups' inflation expectations on average before and after 2012 Q2, while the coefficients β_4 and β_5 measure whether there are any differences in the relationship between Norges Bank's inflation projections and the groups' inflation expectations before and after 2012 Q2 respectively.

Overall, the estimation results show slight changes in the relationship between the explanatory variables and the groups' inflation expectations before and after 2012 Q2. For employee organisations, however, expectations for inflation five years ahead are significantly higher in the latter period than in the former (see estimated value of β_3 in Table A2). At the same time, the effect of Norges Bank's longest inflation projection on these expectations in the same period is less pronounced. For financial economists, expectations for inflation in five years' time are significantly lower in the latter period, while there is no significant change in the relationship between these expectations and Norges Bank's inflation projections in the two periods.

¹⁷ The timing of a potential break is not obvious. We have chosen 2012 Q2 because Norges Bank's inflation forecasts at the end of the projection period have, on average, been lower since Monetary Policy Report 1/12, which was published in March 2012, than in the preceding reports.

Table A2 Estimation results equation (4): Effect of Norges Bank's inflation projections on inflation expectations

Expected inflation in:	Coefficient	Economists in academia	Financial economists	Employee organisations	Employer organisations	Households	Business leaders
1 year	β_3	0,28 (0,22)	0,03 (0,23)	0,09 (0,26)	0,04 (0,21)	-0,05 (0,33)	0,11 (0,30)
	β_4	0,13 (0,10)	0,16* (0,10)	0,23** (0,10)	0,15* (0,08)	0,06 (0,16)	0,09 (0,13)
	β_5	0,03 (0,06)	0,13 (0,10)	0,19*** (0,08)	0,12* (0,06)	0,03 (0,07)	0,01 (0,07)
	Wald-test	0,74	0,07	0,09	0,13	0,03	0,24
	$\beta_4 = \beta_5$	[0,39]	[0,79]	[0,76]	[0,72]	[0,86]	[0,62]
2 years	β_3	-0,09 (0,23)	-0,29 (0,19)	-0,25 (0,67)	-0,19 (0,33)	0,30 (0,31)	-0,05 (0,50)
	β_4	0,00 (0,08)	-0,03 (0,07)	0,01 (0,27)	0,04 (0,14)	0,06 (0,12)	0,03 (0,20)
	β_5	0,03 (0,06)	0,02 (0,03)	0,12 (0,11)	0,10** (0,04)	-0,07 (0,07)	0,02 (0,06)
	Wald-test	0,08	0,45	0,12	0,18	1,02	0,00
	$\beta_4 = \beta_5$	[0,79]	[0,51]	[0,73]	[0,68]	[0,32]	[0,98]
5 years	β_3	-0,33 (0,42)	-0,32* (0,19)	0,97** (0,41)	0,15 (0,49)		
	β_4	-0,10 (0,14)	-0,03 (0,06)	0,40** (0,17)	0,10 (0,18)		
	β_5	0,04 (0,11)	0,04 (0,06)	-0,02 (0,06)	0,02 (0,13)		
	Wald-test	0,64	0,61	5,48**	0,14		
	$\beta_4 = \beta_5$	[0,43]	[0,44]	[0,02]	[0,71]		

Notes: The table shows the estimated coefficients β_3 , β_4 and β_5 in equation (4). The estimates are calculated using OLS, over the period 2002 Q1 – 2017 Q4. The figures in parentheses are Newey-West HAC standard deviations, which correct for potential autocorrelation in the error terms. The Wald test tests whether there is a statistically significant difference in the effect between the period before and the period after 2012 Q2. For the Wald test, the F-value is reported on the upper line and the p-value in square brackets. *, ** and *** denote statistical significance at the 10, 5 and 1 percent level respectively.