Evaluation of the Riksbank's forecasts

Riksbank Studies, May 2017

SVERIGES RIKSBANK

Production: Sveriges Riksbank
Stockholm May 2017
ISBN 978-91-87551-04-8

Contents

Foreword

The Riksbank is an authority under the Riksdag, the Swedish Parliament, with responsibility for monetary policy in Sweden. The Executive Board of the Riksbank normally makes decisions on monetary policy six times a year. Monetary policy affects the economy and inflation with a time lag. Monetary policy therefore needs to be based on forecasts of economic developments in general, and of inflation in particular. Moreover, the Riksbank needs to make an assessment of how monetary policy affects economic developments.

This study evaluates the Riksbank's forecasts for a number of central economic variables and compares them with forecasts made by other forecasters. The study is a complement to the report *Account of Monetary Policy 2016*. The forecast evaluation focuses on the period 2007-2016, with a special analysis of the forecasts for 2016.

This is a report from the Monetary Policy Department. Many staff members at the department have contributed in various ways to this study. The main work has been done by Paolo Bonomolo, Ard Den Reijer, Jesper Johansson, Mårten Löf, Ingvar Strid, and Ulf Söderström.

Anders Vredin
Acting Head of the Monetary Policy Department

1 Introduction

Economic developments over the past ten years have been marked by the effects of the financial crisis and the ensuing sovereign debt crisis in Europe. This has meant that both growth and inflation have been unusually low in many parts of the world. The Riksbank and other forecasters have overestimated both general economic developments and inflationary pressures during this period, both in Sweden and abroad.

The Riksbank has in recent years devoted a lot of time to analysing the causes of the low inflation since 2011.[1] The results are relatively concordant: weak international economic developments and low commodity prices – especially for energy – have held back cost increases. Swedish demand has also been held back by international developments, which has contributed to low domestic price increases in general. In addition, supply factors may also have played a role: companies' margins appear to have developed more weakly than normal. Stiff competition and rapid structural change, for instance due to increased sales through e-commerce, appear to have continued to hold back prices.[2]

The weak economic activity is also discussed in international studies as an important explanation for the low inflation rate in many countries, including Sweden. The International Monetary Fund (IMF) assesses that low resource utilisation and low commodity prices are the primary driving forces behind the low inflation since the financial crisis.[3] The IMF observes that there has been a broad downturn in inflation in many countries and that the low rate of price increases is more evident with regard to goods than services. The fact that prices have been under greater pressure in the goods sector reinforces the theory that the downturn in inflation is at least partly explained by global factors. The European Central Bank (ECB) writes, in a study about the causes of the low inflation in the euro area, that the development of inflation has been more difficult to predict after the financial crisis.[4] At first, inflation was higher than expected, despite the crisis being deep and protracted. In recent years, however, inflation has been lower than expected. The ECB assesses that the low inflation is primarily due to cyclical factors, both global and domestic.

In this study, we analyse and evaluate the Riksbank's forecasts for both inflation and other economic variables. The study begins with an analysis of inflation in 2016 and why this was lower than expected, compared with the forecasts made by the Riksbank at the beginning of 2015. A qualitative analysis identifies three different factors – food prices on the world market, rents and unit labour costs – that have all been weaker than expected. At the same time, the krona has been weaker than expected, which has to some extent had the opposite effect. Other factors have also contributed to inflation being lower than expected. The Riksbank had forecast that companies would increase their margins as economic activity strengthened, which did not happen to the extent expected. Another factor that may have contributed to keeping inflation low is the falling inflation expectations in previous years, which may have held back prices more than expected, although this question is not explicitly analysed. An analysis using two different macroeconomic models indicates that the unexpectedly low inflation is partly due to economic developments abroad being weaker than expected, but also that companies' margins for domestically-produced goods and services have decreased and productivity in the economy has increased more than expected.

The following section evaluates the Riksbank's forecasts and compares them with the forecasts made by other forecasters. First, the forecasts over a longer period from 2007 to 2016 are analysed, and then the forecasts for 2016 are studied. The evaluation of the longer period shows that the Riksbank and other forecasters have on average overestimated

1 See, for instance, Andersson et al. (2015).
2 See, for instance, The Riksbank's Business Survey, September 2016.
3 See IMF (2016).
4 See ECB (2017).

GDP growth in Sweden over the past 10 years. They have also consistently overestimated inflationary pressures in the Swedish economy. With regard to the forecasts for 2016, GDP growth was approximately in line with what most forecasters had expected, and inflation became lower than expected, while also unemployment was lower than anticipated. The Riksbank's forecasts for GDP growth and unemployment have been relatively accurate, both over the longer period and for 2016. The accuracy of the forecasts for CPIF inflation have been more or less in line with the average among all forecasters, while the Riksbank's forecasts for the repo rate and CPI inflation have been among the least accurate. For 2016, the Riksbank overestimated CPIF inflation more than others, especially with regard to the forecasts made at the beginning of 2015.

The fact that the Riksbank shows relatively low accuracy in its inflation forecasts mainly applies to forecasts more than one year ahead. The Riksbank has in recent years made relatively good short-term forecasts, both in relation to other forecasters and in relation to historical forecast errors. However, the forecasts for inflation in the longer run have been poorer. This may be related to the Riksbank's inflation forecasts being based on a monetary policy that normally ensures that inflation approaches the target of 2 per cent within a couple of years. In its forecasting work, the Riksbank therefore needs to make an assessment regarding which monetary policy that can achieve this. This has been difficult in recent years, as global interest rates have shown a falling trend and monetary policy in many countries has been unusual, with negative policy rates and large purchases of financial assets both in Sweden and other countries. The Riksbank has in recent years conducted in-depth analysis of issues to do with the impact of monetary policy and various relationships in the economy, with the aim to improve the forecasts and the basis for monetary policy decisions.

2 An analysis of the low inflation in 2016

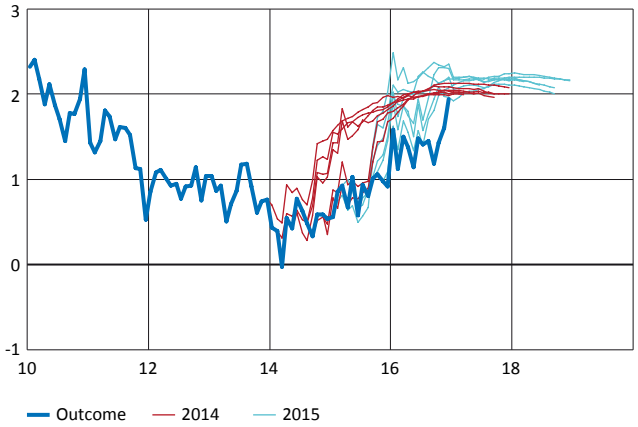
In recent years, the Swedish economy has been characterised by high growth, rising employment, falling unemployment and rising inflation and inflation expectations. But inflation was still low in 2016 in relation to the forecasts of both the Riksbank and other forecasters. In this section, we study different possible explanations for why inflation was lower than the Riksbank's forecast.

Inflation measured in terms of the consumer price index (CPI) and CPI with a fixed mortgage rate (CPIF) increased to 1.0 and 1.4 per cent respectively on average during 2016 compared with the previous year, which was 1.0 and 0.5 percentage points higher than in 2015. Inflation was affected to a high degree by the development of energy prices, and if these are discounted, inflation (measured in terms of the CPIF excluding energy) was 1.4 per cent, the same level as in 2015. Inflation expectations continued to rise during the year, and expectations two and five years ahead were on average 1.7 and 1.9 per cent.[5] GDP increased by 3.3 per cent and unemployment declined. The Riksbank's assessment is that resource utilisation in the economy during the year was about normal or just above, after having been lower than normal for a number of years.

Inflation in 2016 was, however, clearly lower than the Riksbank expected and was also low in relation to the forecasts of other analysts. The Riksbank's overestimation of inflation is illustrated in Figure 1, which shows CPIF inflation and the forecasts published by the Riksbank in 2014 and 2015.

5 According to TNS Sifo Prospera's monthly survey of average inflation expectations among money market participants.

Figure 1. CPIF, outcome and Riksbank forecasts made in 2014-2015
Annual percentage change



Note. The CPIF is the CPI with a fixed mortgage rate.
Sources: Statistics Sweden and the Riksbank

To analyse in more detail why inflation was lower than expected, we focus in this section on the forecast published by the Riksbank in the Monetary Policy Report in February 2015. We start by studying forecast errors for the variables that normally explain how inflation develops, and how different sub-aggregates of the CPI developed in 2016 compared with historical averages. We then analyse how two different macroeconomic models interpret the forecast error for inflation in 2016.

2.1 A qualitative analysis of the low inflation

Table 1 summarises the forecasts for the whole of 2016 made by the Riksbank in February 2015 and compares them with outcomes for a number of variables. CPIF inflation amounted on average to 1.4 per cent in 2016. Compared with the Riksbank's forecast from February 2015, this was 0.6 percentage points lower than expected. CPI inflation was 1.0 per cent in 2016, which was 0.9 percentage points lower than expected, and measured in terms of the CPIF excluding energy, the inflation rate was 1.4 per cent, 0.6 percentage points lower than the Riksbank's forecast from the beginning of 2015.

There is a whole range of factors that influence the inflation rate, including developments in labour costs, import prices, the exchange rate and demand. A common starting point is that companies set prices as a markup on their costs. The rate of price increase then depends on how costs develop and what scope companies have for increasing their prices, given the development of costs. High demand normally makes it easier for companies to pass on their cost increases to the end-customer by increasing prices. But companies' margins, or markups, are also determined by other factors, such as how much competition there is in the industry in which the companies operate. The fact that inflation was lower than expected can therefore be due to the overall macroeconomic development (and hence the companies' demand or cost development) being different to the Riksbank's forecasts, or to the Riksbank having misjudged certain relationships in the economy in its forecasting work, for example the degree of competition or the correlation between resource utilisation in the economy and inflation.

A review of how the economy developed in general, both in Sweden and internationally, shows that there are several factors that contributed to inflation being lower than expected. These factors are dealt with in the following section. First, we discuss how economic developments abroad have turned out in relation to the forecast, then how Sweden's growth and labour market have developed, and finally how inflation has developed in relation to common explanatory variables.

Table 1. The Riksbank's forecasts for 2016 published in February 2015 and outcomes for 2016

	Forecast	Outcome
GDP abroad, KIX-weighted	2.4	2.0
Inflation abroad, KIX-weighted	2.0	1.1
Policy rate abroad, KIX(4)-weighted, per cent	0.2	–0.1
Household consumption	2.8	2.2
Public consumption	1.9	3.1
Gross fixed investment	5.5	5.9
Exports	6.5	3.4
Imports	6.5	3.7
GDP	3.3	3.3
Hours worked, calendar-adjusted	1.0	1.7
No. of employed, 15-74 years	1.2	1.5
Labour force, 15-74 years	0.6	1.0
Unemployment, 15-74 years, per cent of labour force	7.1	6.9
Hourly wage, NM	3.4	2.3
Hourly labour costs, NA	3.7	3.6
Productivity	2.0	1.3
Unit labour costs	1.6	2.3
CPI	1.9	1.0
CPIF	2.0	1.4
CPIF excluding energy	2.0	1.4
KIX, index 18 November 1992 = 100	105.8	111.7
Repo rate, per cent	0.0	–0.5

Annual percentage change unless otherwise specified.
Note. NMO is the National Mediation Office's short-term wage statistics and NA is the National Accounts. Hourly labour cost is defined as the sum of actual wages, social-security charges and wage taxes divided by the seasonally adjusted total number of hours worked. Unit labour cost is defined as labour costs divided by the seasonally adjusted value added in fixed prices. The policy rate abroad is a weighted average of policy rates in the United States, the euro area, Norway and the United Kingdom.
Sources: Eurostat, IMF, National Mediation Office, national sources, OECD, Statistics Sweden and the Riksbank

Weak GDP growth and low inflation abroad

International developments in 2016 were marked by the oil price and other commodity prices being lower than expected. The Riksbank's analysis suggested that the fall in the oil price was due to both higher supply and lower demand and the assessment was that the effects on the global economy as a whole would be limited.[6] In retrospect, it seems as though the negative effects primarily on investment in oil-exporting countries were more significant than the positive effects on, for example, household consumption, which ensue from increased real incomes. Compared with the Riksbank's forecasts from the beginning of 2015, GDP growth in 2016 was clearly lower than expected in countries such as the United States and Norway, while growth in the euro area, which is a significant importer of commodities, was more or less as expected. Aggregate GDP growth in the countries included in the krona index (KIX) was 0.4 percentage points lower than expected (see Table 1).

Compared with the forecasts made at the beginning of 2015, inflation abroad was significantly lower than expected in 2016. This was mostly connected to the falling oil price

6 The oil price fell sharply during the autumn of 2014. According to the Riksbank's forecasts from early 2015, the decline was not expected to continue, but the price of oil was expected to rise again in line with pricing on futures markets. However, the price continued to fall, hitting a low of just under 30 US dollars a barrel at the beginning of 2016.

pushing down consumer prices, although subdued food price developments are also thought to have played a part. In 2015 and 2016, inflation expectations were also low in, for example, the euro area, which may have had repercussions for actually wage growth and inflation. The Riksbank does not publish forecasts for wage development abroad, but other analysts, such as the OECD and the European Commission, have had to revise down their forecasts for wage development that were made around the turn of the year 2014/15. The fact that inflation expectations have been low in certain countries may have been a factor behind this development.

Monetary policy abroad has adapted to weaker growth and low inflation. Compared with the forecast made by the Riksbank at the beginning of 2015, the average policy rate abroad has been about 0.3 percentage points lower than expected. In addition, central banks have taken other measures to make monetary policy even more expansionary, by, for example, retaining or increasing their purchases of financial assets.

Higher GDP level but lower cost pressures in Sweden

GDP growth in Sweden 2016 was more or less in line with the assessments made by the Riksbank at the beginning of 2015. Weaker development abroad is reflected in the fact that exports rose more slowly than expected. Household consumption also grew slightly more slowly than forecast, despite incomes rising more than expected. Households thus chose to save more. Public consumption and housing investments have, on the other hand, grown unexpectedly quickly.

However, the level of GDP in 2016 was more than 2 per cent higher than in the Riksbank's forecasts, as growth in both 2014 and 2015 was shown to have been higher than expected, and unemployment was 0.2 percentage points lower than expected. At the same time, labour productivity (GDP per hour worked) has increased unexpectedly quickly over the last three years and the productivity level was more than 1.5 per cent higher than expected in 2016, even though productivity grew more slowly than expected in 2016.

The higher level of productivity is one explanation for why unit labour costs have been slightly lower than was expected in the forecasts from the beginning of 2015. Wage growth has also been slightly lower than expected, but higher social security contributions for employers have made companies' total labour costs increase faster than expected.

An unusually low rate of increase in prices for services and food

In the forecast made in February 2015, the average rate of increase in both the CPIF and the CPIF excluding energy was expected to amount to 2 per cent in 2016. The outcomes were unexpectedly low and amounted to 1.4 per cent for both measures. This may, to a certain extent, be due to the fact that inflation was lower than expected abroad and that higher productivity in Sweden has dampened cost pressures.

A complementary way of analysing the development of inflation in 2016 is to study different price groups. Table 2 shows the rate of price increase in 2016 for different sub-groups in relation to their historical averages. Since 2000, CPIF inflation has been 1.5 per cent on average. The corresponding figure for CPIF inflation excluding energy is 1.3 per cent. Inflation in 2016 was therefore more or less in line with the historical average, while the Riksbank's forecasts pointed to an inflation rate that was higher than the historical average.

Prices for services increased slightly more slowly than their average (if we adjust for mobile phones being reclassified from services to goods) while prices for goods were unchanged, when they historically have fallen on average.[7]

7 At the turn of the year 2015/16, a time series break occurred in the Riksbank's classification of sub-groups in the CPI, as Statistics Sweden moved the telephones product group from telephony in the services sub-aggregate to home electronics in the goods sub-aggregate. These meant that prices for services increased, but with a corresponding decline in prices for goods.

Table 2. Weight and average annual rate of increase for sub-groups in the CPI
Per cent

	Weight	2000-2015	2016
Services	44.8	1.8 (2.3)*	2.0
Of which rents	11.7	2.0	0.9
Goods	25.5	–0.5 (–0.9)*	0.0
Food	17.8	1.9	1.1
Energy	7.6	3.5	1.4
Interest expenditure	4.2	0.3	–7.7
Of which Interest rate index	4.2	–4.4	–12.7
Of which Capital stock index	4.2	4.9	5.8
CPI		1.2	1.0
CPIF		1.5	1.4
CPIF excluding energy		1.3	1.4

* The figure in brackets shows the adjusted average that indicates what the average would have been if mobile phones had also been in the goods aggregate historically.
Note. Weight refers to the weight in the CPI in 2016. The interest expenditure index is calculated as the product of the interest rate index and the capital stock index. When calculating the CPIF, the interest rate index is held constant in the calculation of the interest expenditure index.
Sources: Statistics Sweden and the Riksbank

The fact that prices for goods increased more rapidly than their average in 2016 is primarily considered to be due to a weakening in the exchange rate in 2015, which affects the prices for goods with a certain time lag.[8] Food prices increased just under 1 percentage point more slowly than normal. A contributory cause may be the weak development of international food prices, in line with other commodity prices, in 2015 and 2016. Energy prices rose by an average of 1.4 per cent in 2016, which was slower than a historical average, but about as expected in the forecast from February 2015. Oil-related prices, such as fuel, fell while electricity prices increased unexpectedly.

Even if prices for services increased more quickly in 2016 than in 2015, the rate of increase was slightly slower than the historical average, despite changes in taxation during 2016 helping to push up prices for services more than normal. One factor that subdued the growth in prices for services was the unusually slow increase in rents, which in turn can be due to the low level of interest rates. Interest rates were lower than the Riksbank expected at the beginning of 2015. The fact that unit labour costs rose more slowly than normal in 2014-2016 may have influenced the development of inflation. In the services aggregate, prices for foreign travel have also developed weakly in 2016.

Summary of the qualitative analysis

Both in Sweden and abroad, inflation in 2016 was lower than anticipated. As for Sweden, lower food prices on the global market, lower rents and lower unit labour costs (for example as a result of higher productivity) could help to explain why inflation in 2016 was overestimated in the Riksbank's forecasts from early 2015. This is, however, just a partial analysis. To make it more complete, we now use two macroeconomic models.

8 See the article "The impact of the exchange rate on inflation" in the Monetary Policy Report, December 2016. The rate of increase in the prices for goods subsided at the end of 2016, however, after the krona appreciated from mid-2015 to mid-2016.

2.2 Interpretation of the forecast errors using two models

No interpretation was made in the qualitative analysis of why different explanatory variables developed differently to what was expected. One way of performing such an analysis is to use the Riksbank's macro models, in which it is possible to interpret forecast error in terms of unexpected shocks that have occurred. In this section, we use two models to shed light on the difference between the outcome for CPIF inflation in 2016 and the forecast published by the Riksbank in the Monetary Policy Report in February 2015: a dynamic general equilibrium model, Ramses, and a Bayesian vector autoregressive (VAR) model.

Ramses shows that developments abroad are important

Ramses is a dynamic general equilibrium model, largely based on economic theory, and estimated using Swedish and foreign data.[9] The model uses data for 18 variables and describes about 20 different shocks that are assumed to influence movements in these variables. Different shocks have different effects on the variables in the economy. Based on the forecast errors for all variables, the combination of shocks is selected that can best explain the forecast errors for all variables at the same time. To simplify the analysis and to enable a comparison with the results from the VAR model, the shocks have been grouped into six different overall factors.

Table 3 illustrates the direction in which different factors affect a number of central variables in Ramses.[10] Given the forecast errors for these variables, the table can be used to gain an understanding of the factors that may have been important in order to understand the forecast errors. The first row illustrates that a higher *risk premium* for Swedish government bonds compared to foreign government bonds (which can be interpreted as a lower demand for bonds in Swedish krona) causes the exchange rate to weaken (i.e. rise). This in turn causes net exports, and hence GDP, to increase and inflation to rise, and as a reaction to this, the Riksbank raises the policy rate. The effect of this shock will therefore be positive for all variables, which is illustrated by four plus-signs on the first row in the table.

Table 3. Qualitative effects of various factors on a number of central variables in the Riksbank's Ramses model

Factor \ Variable	Exchange rate	Repo rate	Inflation	GDP growth
1. Higher exchange rate risk premium	+	+	+	+
2. Less expansionary monetary policy	–	+	–	–
3. Lower margins among companies	+	–	–	+
4. Higher domestic supply	+	–	–	+
5. Higher domestic demand	–	+	+	+
6. Higher international demand	–	+	+	+
Forecast error 2016	+ Weaker than expected	– Lower than expected	– Lower than expected	≈0 Small forecast error

A tightening of *monetary policy* (the second row) means a higher repo rate, lower GDP growth and inflation and a stronger krona. Increased competition and hence *lower margins* for companies lead to lower inflation. The assumption is that the Riksbank then cuts the repo

9 The model is described in Adolfson et al. (2013).

10 To simplify the representation, supply and demand shocks and monetary policy shocks abroad have been grouped into one international factor. But different international shocks have different effects on the Swedish variables. Table 3 only shows the effects of shocks to international demand as these were the most important type of international shock in 2016.

rate, which weakens the krona and increases GDP growth. A higher *supply*, for example due to increased productivity, pushes up GDP growth but dampens cost increases for companies, leading to lower inflation. The fact that the repo rate will then be lower also weakens the krona. A higher *demand* either domestically or from abroad leads to higher inflation and hence a higher repo rate. If the increase is due to higher domestic demand, the krona appreciates as monetary policy abroad is assumed not to be affected. If instead international demand increases, the effects on the exchange rate depend in part on how interest rates in Sweden and abroad are affected. According to historical correlations, the krona usually appreciates even when international demand increases.

The last row in Table 3 shows the actual forecast errors for 2016. Qualitatively, the forecast errors bear a resemblance to the effects that can be expected after negative shocks to companies' margins or positive supply shocks more generally, or negative shocks to either domestic or international demand. It is therefore likely that a combination of these shocks has been an important part of the explanation for the unexpectedly low inflation.

As a first step, we are interested in differentiating the factors that are most important for our understanding of why inflation was lower than expected. As a second step, we are then interested in why the model has chosen these particular factors as important. This also includes studying the forecast errors for other variables in the model and how the model interprets these. The fact that the model selects certain shocks can sometimes be linked to movements in variables that are not included in the model, and it is interesting therefore to try to establish such links in order to deepen the analysis. One example is that certain markups, as they are measured in Ramses, sometimes covary with movements in the oil price, which are not explicitly included in the model. Major changes in the price of oil that affect inflation can therefore be interpreted by Ramses as changes in companies' margins.

Figure 2. Forecast error for CPIF inflation in the forecast from February 2015 and contribution from shocks according to Ramses
Annual percentage change and contribution in percentage points respectively

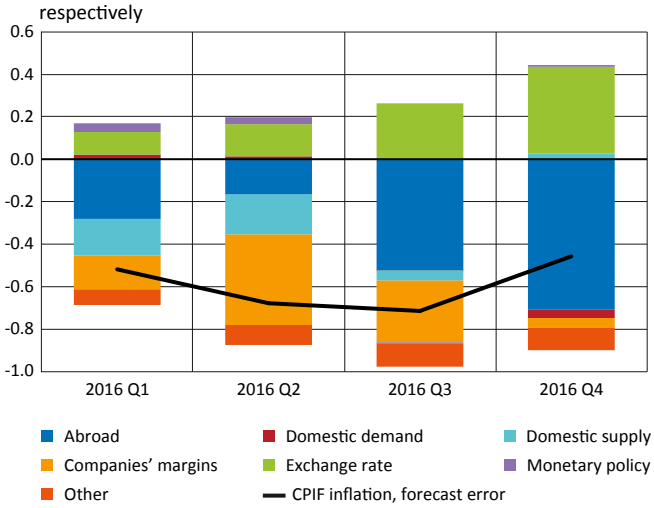


Figure 2 shows how Ramses interprets the forecast error for CPIF inflation in 2016 in terms of unexpected changes in the various factors. According to the analysis, the forecast error is mainly due to four factors:

1. Firstly, **developments abroad** were weaker than expected, which contributed to CPIF inflation being lower than expected (the dark blue areas in Figure 2). The Riksbank overestimated GDP growth, CPI inflation and policy rates abroad. It would be reasonable to interpret this as the Riksbank being surprised by the negative shock to international demand, which also tallies with how the model interprets the forecast errors for the international variables. But price pressures from abroad

were surprisingly weak even in light of the weak economic activity abroad. This is captured in the model by the fact that margins on imported goods were lower than expected.[11] But the low margins interpreted by Ramses can, to a certain extent, be due to the oil price being lower than expected, which largely explains why the Riksbank overestimated inflation abroad. According to the model, the unexpectedly weak international price developments have made a positive contribution to GDP growth in Sweden, for example due to lower import prices leading to an improvement in the terms of trade. Lower prices of imported goods also lead to lower inflation and consequently more expansionary monetary policy. The real interest rate then falls which in turn has positive effects on the real economy. At least to a certain extent, this makes it possible to understand why inflation was lower than expected while the Riksbank did not make any major forecast error for GDP growth.

2. Secondly, Ramses explains some of the forecast error for inflation as **domestic supply factors** (light blue areas in Figure 2). The fact that the productivity level in 2016 was higher than expected (see above) is interpreted by Ramses as a positive supply shock. Higher productivity implies that companies can produce a given volume of goods and services at a lower cost, or that they can produce more at a given cost. This in turn explains, at least to a certain extent, why inflation was lower than expected in 2016.
3. Thirdly, Ramses explains the forecast error as **company margins on domestic goods and services growing more weakly than expected** (orange areas in Figure 2). Demand and price growth were weaker than expected abroad and productivity was higher than expected in Sweden, which means that growth in companies' costs developed more weakly than expected. According to Ramses, however, this is not enough to explain the entire forecast error for inflation. We noted above that international price growth was weaker than expected, which has contributed to the forecast error for CPIF inflation. Ramses measures the price level for domestically produced goods and services using the GDP deflator. The rate of change in the GDP deflator was significantly higher than expected in 2014 and 2015, and significantly lower than expected in 2016. The model interprets this as companies' margins on domestically produced goods and services being unexpectedly high in 2015, but low in 2016. In the model, the low margins in 2016 are due to greater competition, which is supported by respondents in the Riksbank's company survey, who point out that greater competition has pushed down the margins but also created incentives for productivity improvements and cost savings.[12]
4. Fourthly, the exchange rate was weaker than expected in 2016, which, in the absence of other shocks, should have led to inflation being higher than expected, rather than the other way around (green areas in Figure 2). The effect on inflation is, however, due to how Ramses interprets the causes of the weaker exchange rate, and the model generally has difficulty describing movements in the exchange rate in a convincing manner. Many of the exchange rate movements tend to be interpreted as exogenous shocks to the risk premium for Swedish government bonds in relation to foreign government bonds. It is probable that the positive contribution slightly overestimates the significance of the exchange rate for inflation and a more thorough examination would demonstrate that the contribution is actually smaller.[13] This interpretation is supported by the results from the VAR model below.

11 Companies set their product prices based on production costs plus a markup. A lower markup means a lower margin for the product. In the model, the markup is directly linked to the degree of competition on the market on which the company operates, but in practice variations in markups can also be due to other factors.

12 See, for instance, the Riksbank's Business Survey in May 2016.

13 For a discussion on the exchange rate's impact on inflation and the difficulties in estimating it, see the article "The impact of the exchange rate on inflation" in the Monetary Policy Report of December 2016.

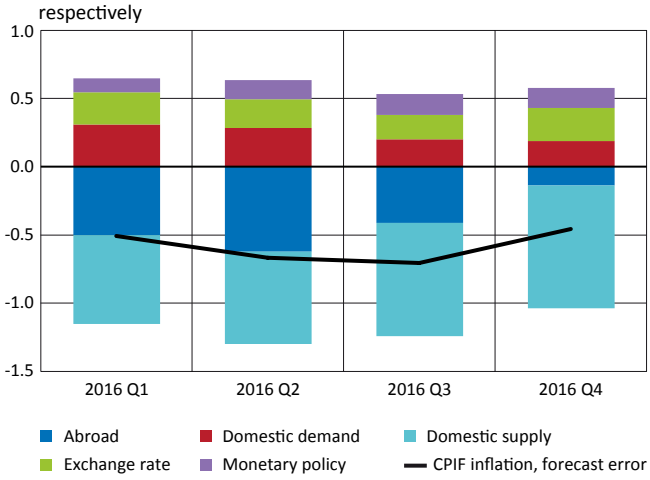
In summary, developments abroad and various supply factors are important when the model is to explain why inflation became lower than expected in 2016. International demand was weaker than expected, and on top of that, low international prices may have contributed further to lower-than-expected inflation. Lower margins than expected for domestically produced goods and services also contributed, as did higher productivity than expected, albeit to a lesser extent. The same factors also explain why the number of hours worked was slightly lower and why the rate of wage increases was weaker than expected. The fact that the Swedish krona was weaker than the Riksbank expected should in itself have contributed to higher inflation than in the forecast.

A VAR model produces similar results

The VAR model is a statistical time-series model, which, to a lesser degree than Ramses, is based on economic theory, and the relationships in the model are formed more by historical correlations in macroeconomic data. The model is estimated using Swedish and foreign data for 7 different variables, and 7 shocks have been identified that are assumed to influence movements in these variables. The variables in the model are GDP growth, CPI inflation and policy rate abroad (aggregated with the weights in the krona index, KIX), as well as Swedish GDP growth, CPIF inflation, the real exchange rate and repo rate. In simple terms, identifying the shocks involves naming them according to how they affect the various variables, approximately in line with Table 3.[14] The shock that leads to a higher repo rate but lower GDP growth and lower inflation is, for example, called "monetary policy".

The analysis using the VAR model is illustrated in Figure 3, and in general terms gives a picture that is similar to the one from Ramses. According to the model, the unexpectedly low rate of inflation in 2016 was primarily due to domestic supply factors surprising on the upside while developments abroad were weaker than expected (light blue and dark blue areas respectively in Figure 3). Domestic supply factors consist of both stronger productivity and lower margins for companies, but it is difficult to differentiate these in the VAR model.[15] The effects on inflation of the unexpectedly weak exchange rate are slightly less positive than in Ramses (green areas in Figure 3).

Figure 3. Forecast error for CPIF inflation in the forecast from February 2015 and contribution from shocks according to VAR model
Annual percentage change and contribution in percentage points respectively



14 The shocks in the VAR model are identified using so-called "recursive" (or "Cholesky") identification, which is based on assumptions as to how different shocks affect the variables in the economy within the same quarter. The plausibility of the effects of the various identified shocks is then assessed in light of economic theory.

15 A positive supply shock, for example a positive shock to productivity, leads to higher production and lower inflation. A negative markup shock that reduces companies' margins has similar effects. In Ramses, these shocks are differentiated with the help of theoretical assumptions, but this is not possible in the VAR model. It is therefore probable that "domestic supply factors" in the VAR model capture the effects from both these types of shocks.

In contrast with the analysis using Ramses, the interpretation made by the VAR model is that domestic demand surprised on the upside and that monetary policy was made more expansionary than expected. These factors were not prominent in the analysis using Ramses, and would in themselves have contributed to higher inflation than in the forecast (red and purple areas respectively in Figure 3).[16] But in the VAR model, the positive contribution to inflation from demand is neutralised by a larger negative contribution from supply factors than in Ramses. The fact that unexpectedly strong domestic demand contributed on the upside also means that it is difficult to explain companies' weak margins by citing weak demand. But even if there are certain differences in the interpretations, the explanations in both models for the forecast error for inflation in 2016 are relatively concordant.

2.3 Concluding discussion: Why was inflation lower than expected in 2016?

There are many explanations for why inflation was unexpectedly low in 2016 compared with the forecasts made at the beginning of 2015. In the model analysis, weaker developments abroad and higher productivity are identified as important factors that have contributed to the unexpectedly slow growth in wages and prices in Sweden. This is in line with the qualitative analysis, in which lower food prices on the global market and lower unit labour costs are deemed to help explain why inflation was unexpectedly low. The krona was weaker than expected and therefore acted as a counterbalance to some extent, due in part to monetary policy being made more expansionary. In addition to these factors, a disaggregated analysis shows that rents increased unexpectedly slowly, which may be due to unexpectedly low interest rates.

The overestimation of inflation may also in part be related to the Riksbank normally making inflation forecasts that are close to 2 per cent two years ahead, and making an assessment of the monetary policy needed to push inflation closer to the target on that time horizon.[17] According to Ramses and the VAR model, monetary policy in 2016 was slightly more expansionary than expected, which has contributed marginally to higher inflation. But this interpretation may depend on the model being based on "normal" policy that follows historical patterns, and where the repo rate is relatively high on average. For many years, global interest rates have been falling,[18] and policy rates in many countries are now lower than ever before. The Riksbank (and other analysts) may therefore have overestimated the normal level of the real interest rate, and also overestimated the expansiveness of the monetary policy conducted. This may have contributed to the Riksbank overestimating the inflationary pressure in 2016. (See also section 3.4 below).

3 Forecast evaluation

Each year, in its Monetary Policy Reports, the Riksbank publishes a number of forecasts for the development of the Swedish and the international economy. As the forecasts form a basis for the monetary policy decisions, it is important that they are evaluated regularly. Regular evaluation of the forecasts can help improve accuracy. In this section we therefore

16 The fact that the VAR model interprets monetary policy as having been unexpectedly expansionary is due to the implicit monetary policy rule in the VAR model being less aggressive than in Ramses. A larger part of the forecast error for the repo rate is therefore interpreted as unsystematic monetary policy, i.e. monetary policy "shocks", which in turn gives a positive contribution to inflation from monetary policy. In Ramses, the contribution from such unsystematic monetary policy is only negligible, which can be interpreted as the change in monetary policy during 2016 having been approximately as expected given the size of the inflation surprises on the downside. However, neither model considers the Riksbank's government bond purchases since 2015. These have been larger than could be expected in February 2015 and have contributed to higher inflation. At the same time, it could mean that the effects of the factors that have contributed to lower-than-expected inflation are underestimated in the model analysis.

17 See Nyman and Söderström (2016).

18 See, for instance, the article "The long-term repo rate" in the Monetary Policy Report of February 2017.

compare the Riksbank's forecasts with those of other forecasters to see how well the Riksbank has succeeded in its forecasting work.[19]

When comparing different forecasters, the analysis should be based on a longer period, as the result will then be less sensitive to random differences. The section therefore opens with an evaluation of forecasts for the period 2007-2016.[20] For each year, forecasts of developments up to two years ahead are studied. Following this, a more in-depth evaluation is made of the forecasts for 2016. Finally, we evaluate the Riksbank's short-term forecasts.

There are different ways of evaluating forecasts. One of the simplest ways is to calculate the average forecast error or "bias". This is calculated as the mean value of the outcomes minus the forecasts during a certain period of time. A negative average forecast error indicates that the forecasts, on average, have overestimated outcomes, while a positive value shows that the forecasts have underestimated outcomes. The measure thus shows whether a forecaster tends to systematically make errors in a certain direction. However, a lack of any such pattern, with an average forecast error close to zero, does not necessarily mean that the forecasts have been accurate. Large positive and negative forecast errors can offset one another and give a false impression of good accuracy. To avoid this problem, it is common to also report either the mean absolute forecast error or the root mean squared forecast error (RMSE).[21] A higher mean absolute error or RMSE implies a lower accuracy.

When comparing forecasts made by different forecasters, consideration should be paid to the fact that the forecasters made their forecasts at different times and have therefore had access to different quantities of information at the date of forecast. A forecaster making its forecasts after other forecasters, and thus basing its analysis on a larger amount of information, should have better accuracy. The Riksbank has developed a method that attempts to consider differences in access to information when assessing forecasts.[22] The method gives an adjusted mean absolute error that takes account of the fact that analysts make their forecasts on different dates and have access to varying amounts of information (see the Appendix).

3.1 An evaluation of the Riksbank's forecasts for 2007-2016

Figures 4–8 show average forecast errors (mean errors) and adjusted mean absolute errors for forecasts of five different variables, GDP growth, unemployment, CPI inflation, the repo rate and CPIF inflation, made by different Swedish forecasters for 2007-2016 with forecast horizons of up to two years.[23] The red columns show average forecast errors and, apart from one exception, the columns are negative, meaning that essentially all forecasters have systematically overestimated the outcomes for all variables. For GDP growth, this means that the forecasters have, on average, overestimated economic development, while the negative columns for unemployment mean that unemployment has been lower than expected. At the same time, the Riksbank and other forecasters have systematically overestimated the inflationary pressure in the economy and the level of the repo rate over this period.

19 See also National Institute of Economic Research (2017) for an evaluation of macroeconomic forecasts made by different forecasters.

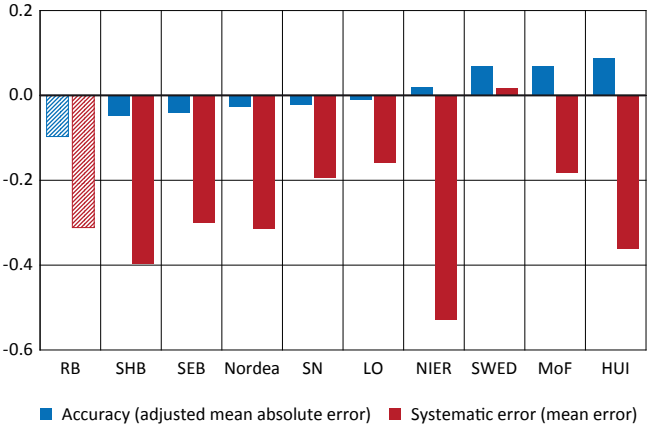
20 It is difficult to evaluate the Riksbank's forecasts prior to 2007. The forecasts were conditional on an unchanged repo rate over the forecast period until 2005, and then based on market expectations of the repo rate, in the form of forward rates, until the end of 2006. Consequently, the evaluation period starts in 2007. For a description of the problems involved in evaluating the Riksbank's forecasts prior to 2007, see Andersson and Palmqvist (2013).

21 The absolute value refers to a number's distance from zero. Both 1 and −1 therefore have the absolute value of 1. This study throughout uses the mean absolute error to evaluate the forecasts.

22 See Andersson and Aranki (2009) and Andersson et al. (2016).

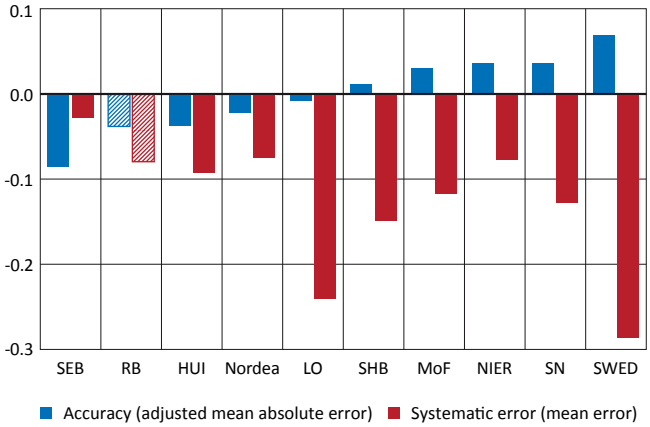
23 For GDP growth, unemployment and CPIF inflation, the evaluation is based on forecasts from 10 forecasters: the Riksbank (RB), the Ministry of Finance (MoF), HUI Research (HUI), the National Institute of Economic Research (NIER), the Swedish Trade Union Confederation (LO), Nordea, Skandinaviska Enskilda Banken (SEB), Svenska Handelsbanken (SHB), the Confederation of Swedish Enterprise (SN) and Swedbank (SWED). For CPIF inflation, there are no forecasts from HUI Research, and only five forecasters are included for the repo rate forecasts. The repo rate forecasts also include forecasts based on market expectations (Market), according to market pricing of forward rates, calculated using derivative contracts (RIBA and FRA) adjusted for credit risk premiums.

Figure 4. GDP growth, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



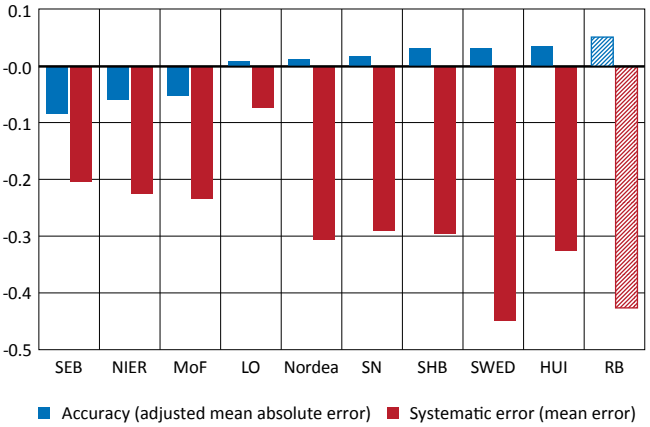
Sources: Respective analysts and the Riksbank

Figure 5. Unemployment, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



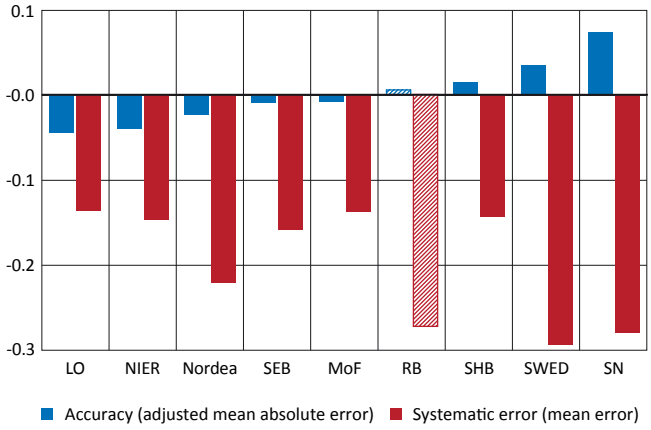
Sources: Respective analysts and the Riksbank

Figure 6. CPI inflation, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



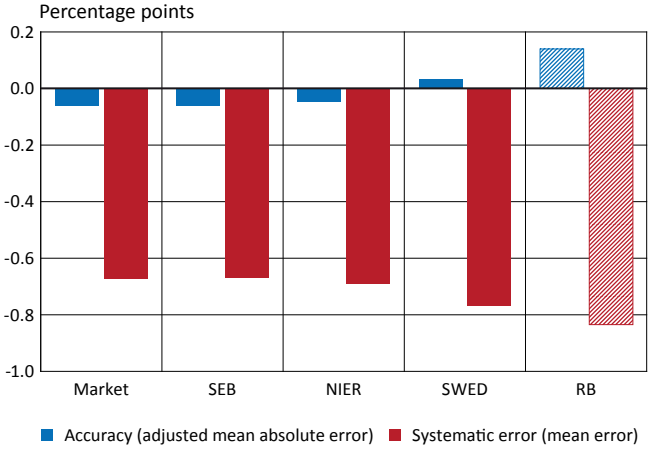
Sources: Respective analysts and the Riksbank

Figure 7. CPIF inflation, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



Sources: Respective analysts and the Riksbank

Figure 8. Repo rate, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



Sources: Respective analysts and the Riksbank

The blue columns in Figures 4-8 show adjusted mean absolute errors for the various forecasters. There are some differences in accuracy between the different analysts, but these differences are small, on the whole. The difference between the best and worst forecaster, for example for CPIF inflation, over this period is only about 0.1 percentage points (see Figure 7). The least accurate forecaster has thus, on average, about 0.1 percentage points greater forecast error than the most accurate, adjusting for when the forecasts were made.

Compared with other forecasters, the Riksbank's forecasts of GDP growth have high accuracy and the Riksbank has also been better than average at forecasting unemployment. However, at the same time, the Riksbank has had the least accurate forecasts of the repo rate and CPI inflation, and has been about average regarding forecasts of CPIF inflation.[24]

The ranking in Figures 4-8 is based on forecasts for all years 2007-2016. But the ranking differs, of course, from year to year. Table 4 shows the Riksbank's ranking for different years. It is notable that the Riksbank's ranking for CPIF inflation has deteriorated in recent years, at the same time as the Riksbank has continued to make relatively good forecasts for the development of the real economy. We will provide a more detailed analysis of this later on.

24 The repo rate plays a central role for the difference between the CPI and the CPIF. Lower accuracy for the repo rate tends to lead to lower accuracy for CPI inflation too. This is because the CPI includes a measure for mortgage rates, which are highly influenced by the repo rate. However, mortgage rates are held constant when the CPIF (the CPI with a fixed interest rate) is calculated.

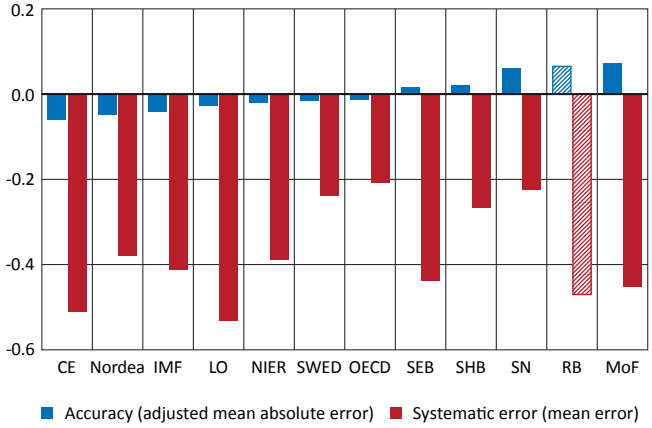
Table 4. Annual ranking of Riksbank forecasts for the Swedish economy 2007-2016

	GDP	Unemployment	CPI	CPIF	Repo rate
2007	1	5	4	9	4
2008	5	2	3	4	4
2009	5	7	10	7	5
2010	2	6	3	1	3
2011	3	3	4	2	4
2012	2	8	8	4	5
2013	5	2	8	6	5
2014	8	1	7	7	4
2015	3	2	7	8	5
2016	4	2	9	9	4
2007-2016	**1**	**2**	**10**	**6**	**5**
Number of institutions:	**10**	**10**	**10**	**9**	**5**

Note. The figure in the table gives the Riksbank's ranking, based on estimated accuracy according to the adjusted mean absolute error. The highest ranking is 1. The ranking differs from that presented earlier in the reports "Account of Monetary Policy" due to a change in method. The assessment of the repo-rate forecasts includes market expectations according to market pricing of forward rates. The forward rates are calculated using derivative contracts (RIBA and FRA) adjusted for credit risk premiums.
Sources: Respective forecasters, Statistics Sweden and the Riksbank

Figures 9-12 evaluate forecasters' forecasts of GDP growth and inflation in the United States and the euro area in 2007-2016.[25] The red columns show that, on average, all analysts overestimated GDP growth in both the United States and the euro area over this period. Inflation in the euro area was also overestimated by almost all analysts, while, for inflation in the United States, the mean errors, which are also relatively small, show no clear pattern. The blue columns in Figures 9-12 show that the Riksbank's accuracy regarding GDP growth in the United States and the euro area has been slightly worse than average. The Riksbank's forecasts of inflation in the euro area have also been less accurate than average, while forecasts of inflation in the United States have been slightly better. However, once again, the differences between different forecasters are minor.

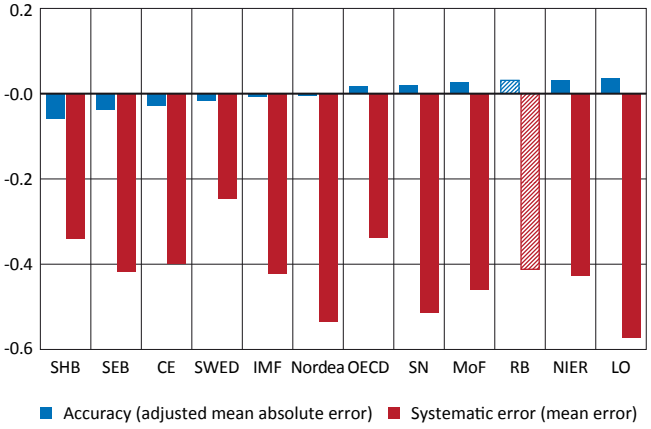
Figure 9. GDP growth in the US, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



Sources: Respective analysts and the Riksbank

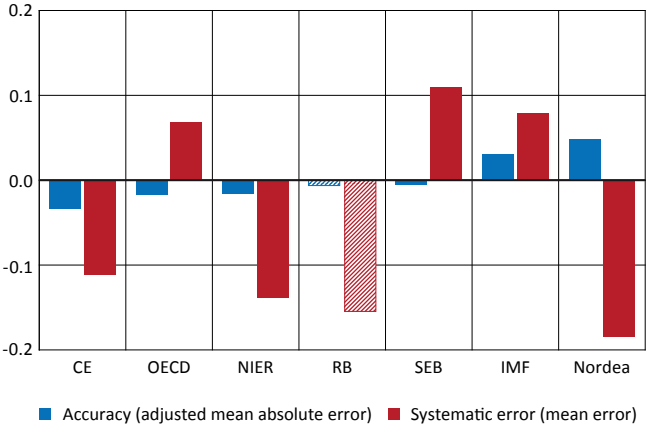
25 The international forecasts also include forecasts by the IMF, OECD and Consensus Economics (CE). See also Aranki and Reslow (2015).

Figure 10. GDP growth in the euro area, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



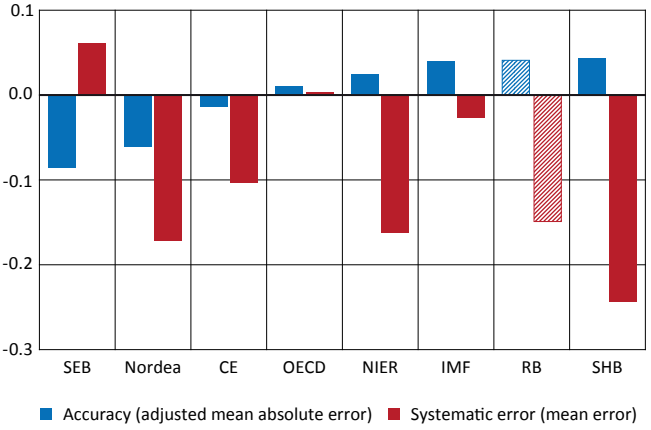
Sources: Respective analysts and the Riksbank

Figure 11. CPI inflation in the US, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



Sources: Respective analysts and the Riksbank

Figure 12. HICP inflation in the euro area, accuracy and systematic error in the forecasts of various analysts, 2007-2016
Percentage points



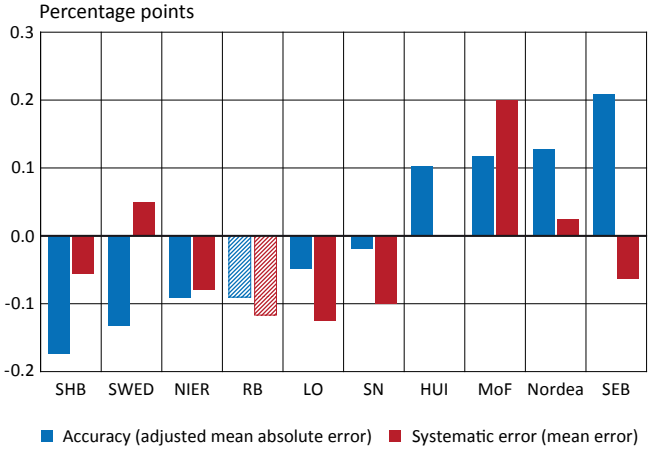
Sources: Respective analysts and the Riksbank

3.2 An evaluation of the Riksbank's forecasts for 2016

The analysis in the preceding section evaluated forecasts for the entire period 2007-2016. But, as shown in Table 4, forecasting ability varies over time. In this section, we therefore focus on forecasts for 2016 made in 2015 and 2016.

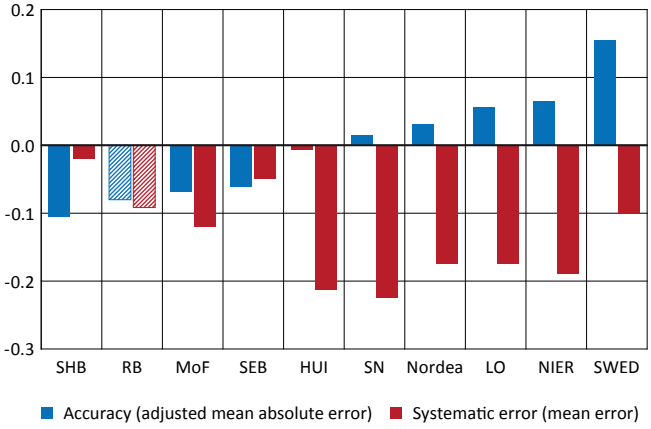
Figures 13-17 evaluate forecasts referring to 2016. In most cases, the red columns for GDP growth in Figure 13 are negative, but close to zero, which reflects most forecasters' expectations of slightly stronger GDP growth than the outcome. At the same time, unemployment has been lower than forecast by all analysts. But although the labour market developed more strongly than expected, the majority of the red columns are negative for both CPI and CPIF inflation, which means that the inflation outcome was lower than most forecasters had expected.

Figure 13. GDP growth, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



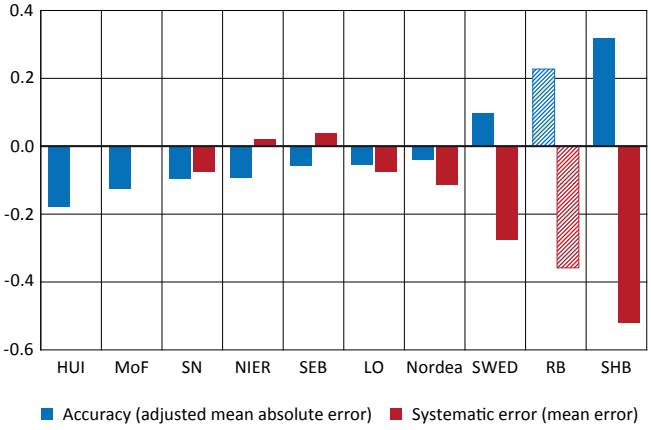
Sources: Respective analysts and the Riksbank

Figure 14. Unemployment, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



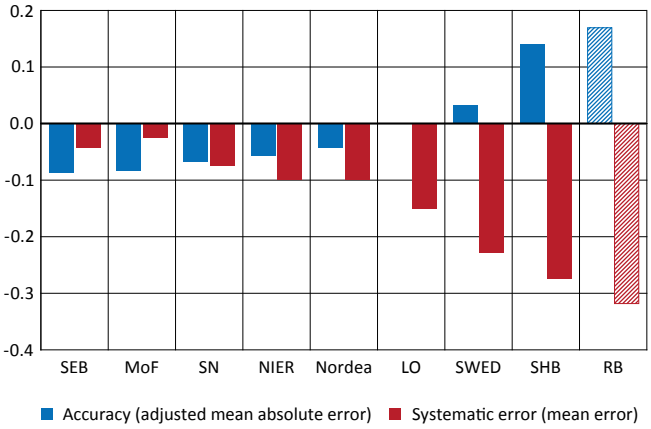
Sources: Respective analysts and the Riksbank

Figure 15. CPI inflation, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



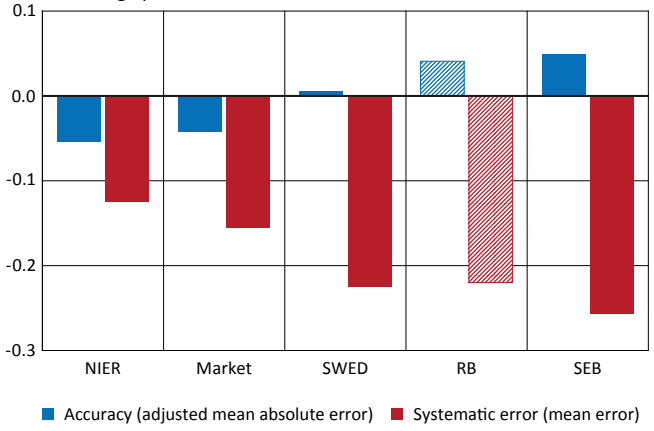
Sources: Respective analysts and the Riksbank

Figure 16. CPIF inflation, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



Sources: Respective analysts and the Riksbank

Figure 17. Repo rate, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



Sources: Respective analysts and the Riksbank

According to the blue columns in the same figure, there are some differences in accuracy between the various analysts, but the differences are slight. For example, the difference in accuracy between the best and worst forecaster of the CPIF is only just over 0.2 percentage points. As with the longer period, the Riksbank has made good forecasts of GDP growth and unemployment. But compared with other analysts, the Riksbank has made the least accurate forecasts for the repo rate and CPIF inflation.

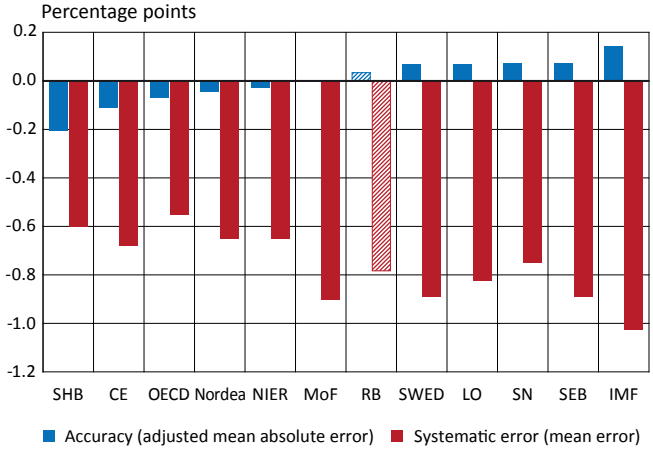
The Riksbank's forecasts for inflation in 2016 were thus higher and less accurate than those of other forecasters. There may be several reasons for why the Riksbank's inflation forecasts were higher than those of other forecasters. Firstly, in 2015 the Riksbank made slightly higher forecasts of GDP growth in 2016, which usually implies slightly higher inflation, at least if the higher growth is being driven by higher demand. Secondly, the Riksbank made lower forecasts for unemployment in 2015, with the exceptions of SEB and Handelsbanken. There is also usually a connection between a tighter labour market and slightly higher inflation. The Riksbank also predicted that wages would increase slightly faster in 2016 compared with other analysts. The differences are small but indicate that the Riksbank expected slightly higher cost pressures than other analysts. As regards the assessment of the exchange rate and the repo rate, it is difficult to discern any difference between the forecasters.

The Riksbank has thus forecast slightly stronger real development and slightly higher cost pressures than most other analysts. To a certain extent, this could also explain why the Riksbank also forecast higher inflation than other analysts.

Even if the Riksbank has made good forecasts of the development of the real economy, its forecasts of inflation have been less accurate. Many other forecasters have made better forecasts for inflation, but worse forecasts for GDP growth and unemployment. This indicates that both the Riksbank and other forecasters have found it difficult to capture the driving forces behind the low inflation.

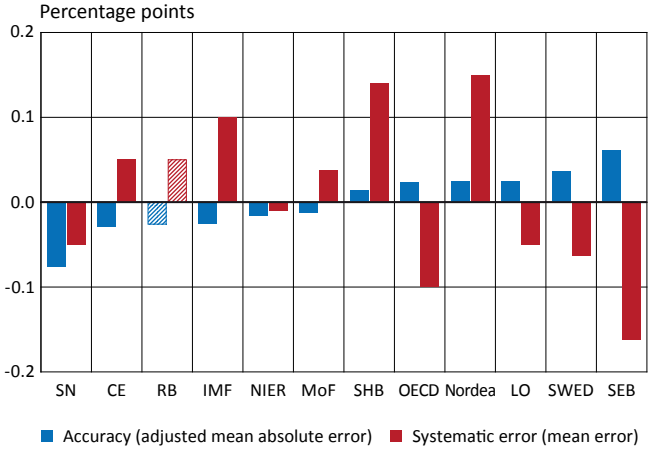
The red columns in Figures 18-19 show that all analysts overestimated GDP growth in the United States in 2016 by more than 0.5 percentage points, while the picture is more mixed for the euro area. There is also a pattern in the inflation forecasts where essentially all analysts have made too high forecasts for the United States and the euro area, see Figures 20-21. The blue columns in Figures 18-21 show that the Riksbank's accuracy for both GDP growth and inflation in the United States and the euro area have been close to average.

Figure 18. GDP growth in the US, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



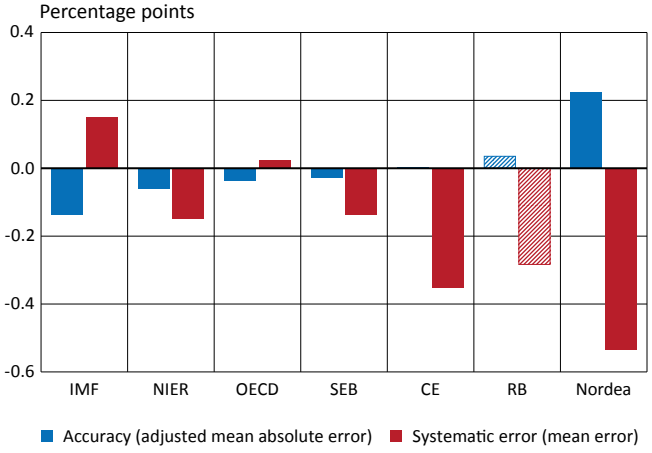
Sources: Respective analysts and the Riksbank

Figure 19. GDP growth in the euro area, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



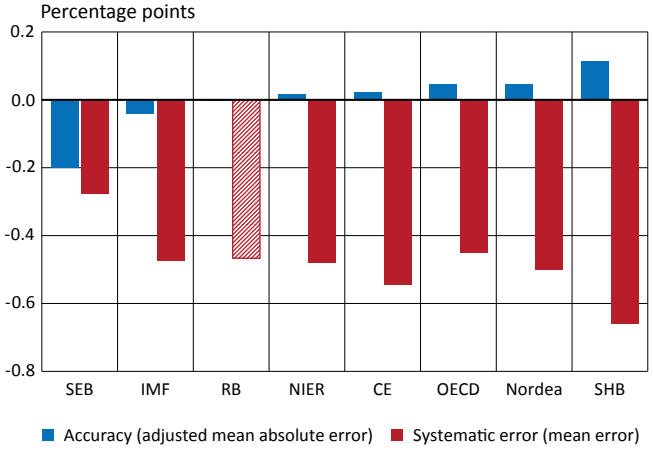
Sources: Respective analysts and the Riksbank

Figure 20. CPI inflation in the US, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



Sources: Respective analysts and the Riksbank

Figure 21. HICP inflation in the euro area, accuracy and systematic error in the forecasts of various analysts in 2016
Percentage points



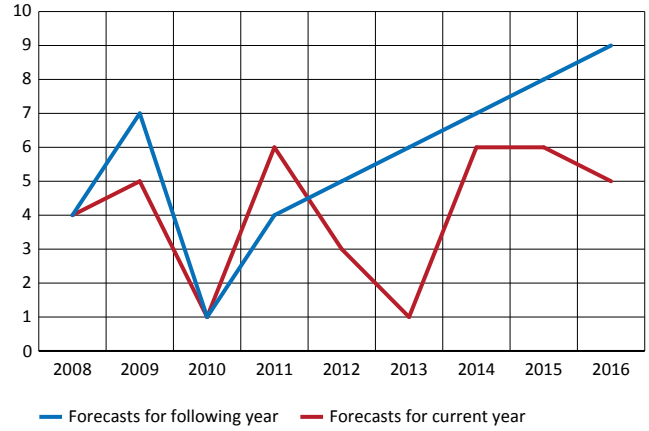
Sources: Respective analysts and the Riksbank

3.3 An evaluation of the Riksbank's inflation forecasts in the short term

The analysis above is based on forecasts for many different horizons, from one to 24 months ahead. But forecasters normally use different methods for forecasts over different horizons. Here, we look more closely at the Riksbank's inflation forecasts in the short term, up to a one-year horizon, and compare them with forecasts a little further ahead.

Figure 22 shows the Riksbank's annual ranking for forecasts of CPIF inflation for the current year (the red line) and the following year (the blue line). For the following year, the Riksbank made the most accurate forecasts for 2010, but since then the Riksbank's ranking has gradually worsened. For the current year, the Riksbank ranking has varied over time, but without any clear trend. Compared with other analysts' forecasts, the Riksbank's forecasts in the short term have held up well, while those for the longer term have deteriorated since 2010.

Figure 22. The Riksbank's ranking for forecasts for CPIF inflation, 2007-2016



Sources: Respective analysts and the Riksbank

Figure 23 shows the average forecast error (or bias) for the Riksbank's CPIF forecasts for two different periods, 2007-2011 and 2012-2016, for forecast horizons up to and including 24 months ahead. Over 2007-2011, the Riksbank's forecasts have no clear bias up to one year, but, for longer horizons, the Riksbank has, to a certain extent, systematically overestimated inflation. But over 2012-2016, the Riksbank's forecasts have a clear negative bias for all horizons, which increases the longer the horizon becomes.

Figure 23. Average forecast error for the Riksbank's forecasts for CPIF inflation, up to 24 months horizon
Percentage points

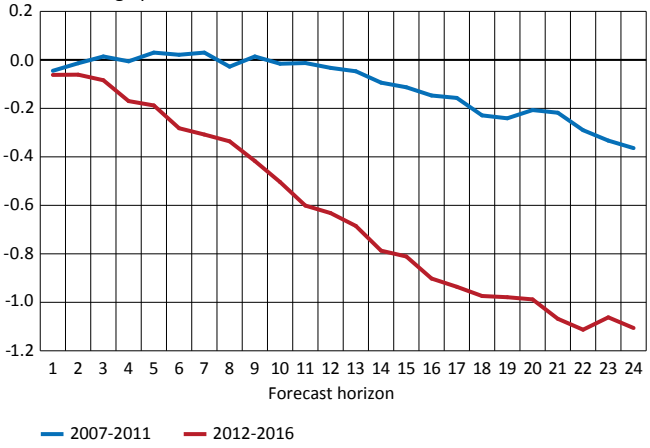
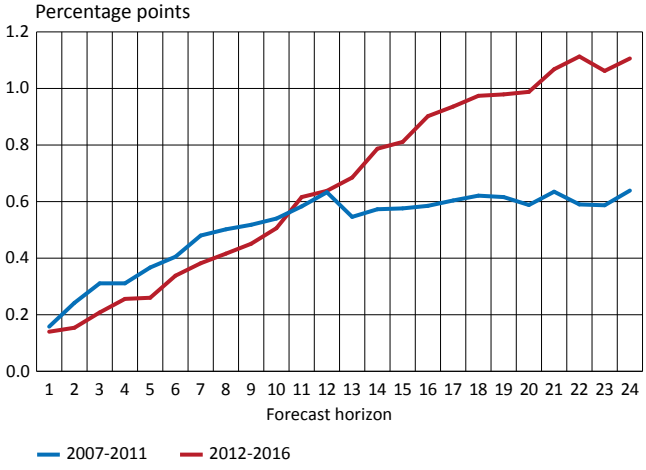


Figure 24 shows the mean absolute error for CPIF forecasts over different horizons. Even if the mean error has become more negative over time, as shown in Figure 23, the short-term forecasts are slightly better over the later period than in 2007-2011, measured in terms of the mean absolute error. This concerns two periods that differ in many ways, and too far-reaching conclusions should not be drawn from it, but longer-term forecasts seem to have worsened at the same time as short-term forecasting ability has not deteriorated, but may even have improved.

Figure 24. Average absolute error for the Riksbank's forecasts for CPIF inflation, up to 24 months horizon
Percentage points



Tables 5 and 6 present the accuracy of the Riksbank's inflation forecasts over the very short term, i.e. one month ahead, compared with a larger number of other forecasters.[26] The Riksbank publishes new forecasts six times per year. Consequently, one, two or sometimes even three CPI outcomes can often be published before a completely new forecast from the Riksbank becomes available for comparison. As far as the Riksbank is concerned, forecasts one to three months ahead are therefore used.[27] The Riksbank's mixed forecast horizons can be compared with assessments from other forecasters, which are often made only one or a few days before the inflation outcome is published. In most cases, their forecasts are thus based on more information than the Riksbank's forecasts.[28]

26 In this comparison, other forecasts come from Bloomberg. The number of forecasters, excluding the Riksbank, is 14 for 2013, 15 for 2014, 13 for 2015 and 15 for 2016.

27 Consequently, when every monthly outcome over the period is matched with assessments from the Riksbank, twenty-four forecasts with horizons of one month, twenty forecasts with horizons of two months and four forecasts with horizons of three months are used.

28 An average of the forecasts from a number of forecasters should thus in most cases be more accurate than the Riksbank's most recently-published forecast. Even in cases in which the Riksbank's forecast refers to inflation one month ahead, other forecasters have a certain informational advantage, as their forecasts are often made only a couple of days ahead of the CPI outcome. The amount of information available on the development of factors such as fuel prices, electricity prices and exchange rates in recent days can sometimes be entirely decisive.

Table 5. Evaluation of short-term forecasts for CPIF inflation at 1-3 months horizon, 2013-2016

Ranking	Forecaster	Mean error	Mean absolute error	Number of forecasts
1	Forecaster with lowest mean absolute error	−0.02	0.12	45
3	Mean forecast	−0.01	0.14	48
6	**Riksbank**	**−0.04**	**0.15**	**48**
7	Average forecaster	−0.01	0.16	48
17	Forecast with highest mean absolute error	−0.10	0.22	39

Note. The forecasting error is calculated as the outcome minus the forecast.
Sources: Bloomberg and the Riksbank

Table 5 compares the various actors' forecasting ability, both with an average forecast error (bias) and mean absolute error, over the period January 2013 to December 2016. Including the Riksbank, 15 forecasters are included in the comparison. Over this period, the most accurate analyst has a mean absolute error of 0.12 percentage points. The row marked "Mean forecast" shows the result when a mean of all forecasts has been calculated as a first step. According to the academic literature, such a mean forecast is considered to be highly effective and, over longer periods, it is usually very difficult to make a better forecast.[29] In this analysis, the mean forecast takes third place in the ranking. The Riksbank, with a mean absolute error of 0.15 percentage points, takes sixth place. Four individual forecasters of a total of 15, plus the mean forecast, have thus made more accurate forecasts than the Riksbank, but the differences in the mean absolute error are quite small. The Riksbank has been consistently better than the average forecaster. It can also be noted that the Riksbank, on average, has forecast a slightly too high level of inflation in the short term (the mean error is negative).

Table 6 again compares the various actors' forecasting ability, but only with those of the Riksbank's forecasts with a one-month horizon. Comparability among forecasters is thereby increased, at the same time as the number of forecasts decreases and results become more uncertain. For example, the best forecaster has only half as many forecasts as the Riksbank. Even so, the ranking becomes about the same as in Table 5, but the Riksbank's mean absolute error is now as low as the mean forecast. The Riksbank has, on average, also in this case forecast slightly too high inflation.

Table 6. Evaluation of short-term forecasts for CPIF inflation at 1-month horizon, 2013-2016

Ranking	Forecaster	Mean error	Mean absolute error	Number of forecasts
1	Forecaster with lowest mean absolute error	0.02	0.16	12
5	Mean forecast	−0.03	0.18	24
6	**Riksbank**	**−0.07**	**0.18**	**24**
11	Average forecaster	−0.03	0.21	24
17	Forecast with highest mean absolute error	−0.14	0.28	20

Note. The forecasting error is calculated as the outcome minus the forecast.
Sources: Bloomberg and the Riksbank

29 See, for instance, Stock and Watson (2004).

This analysis shows that the Riksbank's inflation forecasts in the short term (horizons of up to one year) are just as good or slightly better than the average for other forecasters. This applies not least to forecasts in the very short term, i.e. the next few months ahead. On the other hand, the Riksbank's forecasts in the longer term are worse than those of other analysts. In addition, inflation forecasts in the longer term seem to have deteriorated relative to those of other forecasters in recent years, while the forecasts in the short term do not show such a trend.

3.4 The Riksbank's inflation forecasts normally move towards 2 per cent in the long run

Most forecasters probably use approximately the same methods to make forecasts in the short term. But methods for making forecasts over the longer term presumably differ more from forecaster to forecaster. The Riksbank's inflation target means that inflation should normally be close to 2 per cent a couple of years ahead.[30] The Riksbank therefore needs to employ methods in its forecasting work that allow it to make an assessment of which monetary policy is needed to bring inflation closer to target at an appropriate pace. Other forecasters may be freer to make forecasts that deviate from 2 per cent in the longer run and, for example, use methods that assume, to a greater extent, that inflation will move towards a historical average.[31]

Table 7 summarises the Riksbank's and eight other forecasters' forecasts for CPIF inflation during 2008-2016 for the current and following year.[32] For the current year the Riksbank's forecasts are on average just marginally higher than those of other forecasters, but for the following year the Riksbank's forecasts are clearly higher, and closer to 2 percent. When inflation has been close to 2 per cent, the Riksbank's forecast error in the longer run has often been relatively smaller, while the forecast error has become greater when inflation has been below target, as has been the case in recent years.

Table 7. Average forecasts for CPIF inflation under current and following year, 2008-2016
Annual percentage change

	Current year	Following year
The Riksbank	1.47	1.77
Average of other forecasters	1.39	1.48

Sources: Respective forecasters and the Riksbank

The Riksbank has several different models to help it make assessments of how a change of monetary policy affects economic developments and inflation. Historical correlations suggest that an unexpected cut of the repo rate by 0.25 percentage points will lead to just under one-tenth of a percentage point higher inflation in the following year.[33] But in recent years, monetary policy has been unusual in the sense that the repo rate has been cut below zero and the Riksbank has purchased large volumes of government bonds. It has been significantly more difficult to assess the effects on the economy and inflation of measures of this type as they have never previously been used in Sweden. In addition, monetary policy has been conducted in an environment in which global interest rates have shown a falling trend for many years, which could have influenced the effects of monetary policy on the economy.

30 See Sveriges Riksbank (2010) and Nyman and Söderström (2016).
31 As inflation, on average, has been lower than the inflation target of 2 per cent, these methods will normally result in lower forecasts in the longer term.
32 The forecasters included in this analysis are the same as in sections 3.1-2.3, see footnote 24.
33 See, for instance, Hopkins et al. (2009).

Figure 25. CPIF, outcomes and Riksbank forecasts
Annual percentage change

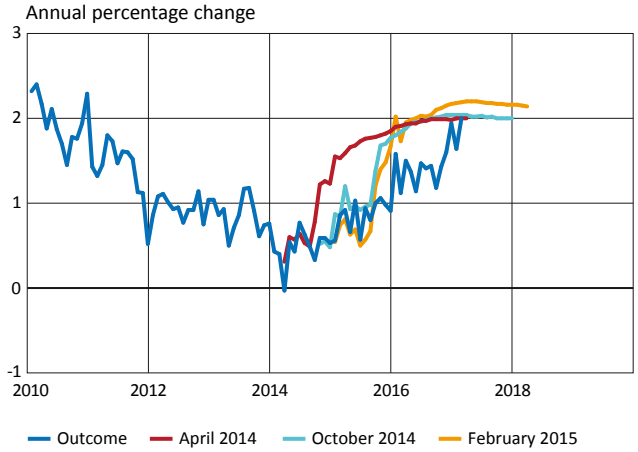
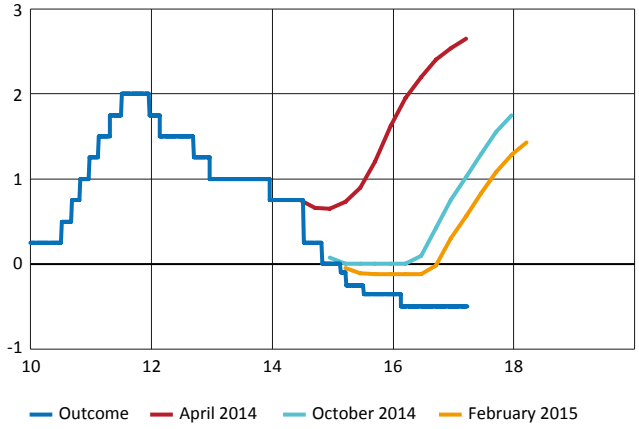


Figure 26. Repo rate, outcomes and Riksbank forecasts
Per cent



To illustrate how the Riksbank works with forecasts of inflation a few years ahead, Figure 25-26 describe the forecasts and forecast revisions made for the repo rate and inflation on a few occasions since 2014.[34]

- In *April 2014*, the Riksbank deemed that it would take slightly less than two years for CPIF inflation to approach 2 per cent (see Figure 25). The forecast was that the repo rate would remain at 0.75 per cent, or slightly lower, for about a year, thereafter rising relatively quickly (see Figure 26).
- When inflation then failed to rise as expected, the Riksbank cut the repo rate substantially so that inflation would rise to 2 per cent. In Figure 25-26, it can be seen that the assessment in *October 2014* was that a significantly lower repo rate was needed, both in the short and longer terms, so that inflation would approach 2 per cent at about the same point in time as in earlier forecasts.
- In *February 2015*, the repo rate and the repo rate path had been cut further, at the same time as the Riksbank started to purchase government bonds to make monetary policy more expansionary. There was great concern that confidence in the inflation target was under threat and the Executive Board therefore communicated that inflation needed to rise rapidly and that it was prepared to do more to make this happen. The large change that was made to monetary policy in an expansionary direction was

34 We do not discuss the reasoning behind the monetary policy decisions, only how the revisions of monetary policy are connected to the revisions of the inflation forecast.

expected to contribute towards making inflation approach 2 per cent about one year ahead. The inflation forecast was also revised upwards slightly two years ahead.

- Since February 2015, the Riksbank has continued to make monetary policy more expansionary, cut the repo rate to −0.50 per cent and adjusted the forecast for the repo rate heavily downwards. In addition, until December 2016 the Riksbank has made and announced purchases of government bonds in a total amount of SEK 275 billion. Even if this monetary policy has contributed towards inflation having risen and become higher in 2016 than in previous years, and inflation expectations having increased towards 2 per cent, the Riksbank's forecasts overestimated inflation in 2016 to a relatively great degree.

This short review illustrates how the Riksbank, in recent years, has successively lowered its assessment of the inflationary pressure and then made new assessments of which monetary policy would be required to affect the economy in such a way as to bring inflation close to the target of 2 per cent. One way of expressing this would be to say that monetary policy has been adjusted more than inflation forecasts a couple of years ahead.

Resource utilisation has risen and is deemed to have been about normal in 2016 and inflation has risen to a level close to the historical average, but did not reach the inflation target of 2 per cent, despite the highly expansionary monetary policy. Against this background, it is natural to ask whether the way in which monetary policy affects the economy and inflation has changed, or whether other structural changes that are hard to predict have pushed down inflation more permanently.

In light of this, the Riksbank has worked in recent years with various issues to do with the impact of monetary policy and different relationships in the economy. For example, the Riksbank has analysed in more detail the correlation between inflation and both resource utilisation and the exchange rate,[35] as well as how changes abroad affect the Swedish economy. The Riksbank has also analysed the downward trend in global interest rates, and come to the conclusion that the long-term level of the repo rate is probably lower than it has been historically.[36] On several occasions, the Riksbank has also utilised its business survey to pose more detailed questions about companies' pricing behaviour, most recently in May 2016. Companies said then that competition had increased, pushing down their margins.

Currently, the Riksbank is working on, for example, in-depth analyses of how changes in the labour market affect wage formation and pricing. For some time, the Riksbank has also been adapting existing models, and developing new models to take into account how the expansiveness of monetary policy is affected by trends in underlying interest rates, and to capture the effect of complementary monetary policy measures, such as purchases of government bonds.

In its forecasting work, the Riksbank has been influenced by the analysis conducted. For example, the most recently published forecasts imply that it takes longer before domestic resource utilisation affects inflation enough so that it stabilises around 2 per cent, given that international inflation is relatively low and companies' margins are low. In addition, the forecasts are based on a lower repo rate and more extensive purchases of government bonds than previously assumed.

35 See the articles "The relationship between resource utilisation and inflation" in the Monetary Policy Report of October 2016 and "The impact of the exchange rate on inflation" in the Monetary Policy Report of December 2016.

36 See, for instance, the article "Does the Riksbank sufficiently take into account Sweden's international dependence in its forecasts?" in the report Account of Monetary Policy 2015, and Aranki and Reslow (2015).

3.5 Summary of the forecast evaluation

The Riksbank and other analysts have systematically overestimated GDP growth during the period 2007-2016 while unemployment has been lower than expected. All forecasters included in the comparison have overestimated inflation in Sweden after the financial crisis.

There are some differences in accuracy between the different analysts, but these differences are small, on the whole. Compared with other analysts, the Riksbank has had minor forecast errors for GDP growth and has also been better than average at forecasting unemployment in the period 2007-2016. However, at the same time, the Riksbank has had the least accurate forecasts of the repo rate and CPI inflation, and has been about as good as average regarding forecasts of CPIF inflation.

If we only study forecasts for 2016, the Riksbank has made relatively minor forecast errors for GDP growth and unemployment. But compared with other analysts, the Riksbank has made the least accurate forecasts for the repo rate and CPIF inflation. If we look at forecasts of international variables, we find a pattern in which all forecasters have overestimated inflation in the euro area, and we find that the Riksbank's accuracy for GDP growth and inflation in both the euro area and the United States has been close to the average.

A more detailed analysis of the Riksbank's forecasting ability for CPIF inflation on different horizons shows that the Riksbank has made poorer forecasts than other analysts in the longer term. There is no significant difference for forecasts up to one year ahead. An analysis of Riksbank forecasts over time also shows that longer-term forecasts have deteriorated during the last five-year period, but short-term forecasts have not demonstrated such a trend. The accuracy of the Riksbank's very short-term inflation forecasts, i.e. one month ahead, also hold up well compared with other analysts. The Riksbank's poorer accuracy as regards longer-term forecasts may be related to the Riksbank's inflation forecasts being based on a monetary policy that normally ensures that inflation approaches the target of 2 per cent within a couple of years. When inflation has been close to 2 per cent, the Riksbank's longer-term forecasts have been relatively accurate, but during periods when inflation has deviated from 2 per cent for a long time, as has been the case recently, the Riksbank's inflation forecasts demonstrate greater forecast errors. The Riksbank has in recent years conducted in-depth analysis of issues to do with the impact of monetary policy and various relationships in the economy, with the aim to improve the forecasts and the basis for monetary policy decisions.

References

Adolfson, Malin, Stefan Laséen, Lawrence Christiano, Mathias Trabandt and Karl Walentin (2013), "Ramses II – Model description", Occasional Paper No. 12, Sveriges Riksbank.

Andersson, Björn, Vesna Corbo and Mårten Löf (2015), "Why has inflation been so low?", Economic Review 2015:3, Sveriges Riksbank.

Andersson, Mikael K. and Ted Aranki (2009), "Forecasters' performance – what do we usually assess and what would we like to assess?", *Economic Review* 2009:3, Sveriges Riksbank.

Andersson, Mikael K. and Stefan Palmqvist (2013), "A fairer picture of the Riksbank's inflation forecasts", *Economic Commentaries* No. 7, 2013, Sveriges Riksbank.

Andersson, Mikael K., Ted Aranki and André Reslow (2016), "Adjusting for information content when comparing forecast performance", Working Paper Series No. 328, Sveriges Riksbank. Forthcoming in *Journal of Forecasting*.

Aranki, Ted and André Reslow (2015), "An assessment of the Riksbank's international forecasts", *Economic Commentaries* No. 14, 2015, Sveriges Riksbank.

European Central Bank (2017), "Low inflation in the euro area: Causes and consequences", Occasional Paper Series No. 181.

Hopkins, Elisabeth, Jesper Lindé and Ulf Söderström (2009), "The monetary transmission mechanism", *Economic Review* 2009:2, Sveriges Riksbank.

International Monetary Fund (IMF) (2016), "Global disinflation in an era of constrained monetary policy", Chapter 3 in *World Economic Outlook*.

National Institute of Economic Research (2017), "Utvärdering av makroekonomiska prognoser" ("Evaluation of macroeconomic forecasts"), Specialstudier No. 56.

Nyman, Christina and Ulf Söderström (2016), "Forecasts and monetary policy", *Economic Commentaries* No. 6, 2016, Sveriges Riksbank.

Stock, James H. and Mark W. Watson (2004), "Combination forecasts of output growth in a seven-country data set", *Journal of Forecasting* 23 (6), 405-430.

Sveriges Riksbank, (2010), *Monetary Policy in Sweden*.

Appendix: Measuring accuracy

Let x_t be the outcome for an economic variable x, for instance the rate of inflation or GDP growth for a certain period t. Assume also that $x_{it,h}$ is a forecast for x_t, made by forecaster i a certain number of months h before the outcome is published. The absolute forecast error $\varepsilon_{it,h}$ is then given by

$$(1) \qquad \varepsilon_{it,h} = |x_t - x_{it,h}|.$$

In this study, x_t refers to yearly averages, e.g. GDP growth in 2008, and the forecasts evaluated here refer to the current or next year. This means that $h \leq 24$ months. If we wish to summarise the accuracy of forecaster i, we can calculate its mean absolute error (*MAE*) as

$$(2) \qquad MAE_t = \sum \varepsilon_i / n_i,$$

where n_i is the number of forecasts made by forecaster i. The measure shows how much the forecasts have deviated from the outcome on average and it can be used to compare forecasting ability, or how accurate various forecasters have been.

In practice, forecasters publish their forecasts at different points in time. If the forecast horizon h differs among forecasters, it also means that the forecasters have access to different volumes of information when making their forecasts. It is therefore not entirely fair to directly compare the mean absolute error of different forecasters. A forecaster i that often publishes its forecasts late will have a low h on average, and therefore should on average have a better accuracy than other forecasters.

In order to correct the measure of accuracy because forecasters have access to different amounts of information when they make their forecasts, Andersson et al. (2016) propose dividing the absolute forecast error into different components. The results from this decomposition are then used to calculate accuracy or forecasting ability in a fairer way. The decomposition is done by estimating the equation

$$(3) \qquad \varepsilon_{it,h} = \delta_t M_{it,h} + \mu_i + \mu_{i,t=c} + \lambda_t + e_{it,h}.$$

The first component in the equation, $M_{it,h}$, depends on the volume of information available at point in time h, when forecaster i publishes its forecast. The two components thereafter reflect the forecasters' general forecasting ability. The average accuracy of forecaster i is described by μ_i whereas the term $\mu_{i,t=c}$ captures the forecasting ability when evaluating individual years (c). The fourth term, λ_t, takes into account the fact that some years are more difficult to forecast than others. Finally, the residual $e_{it,h}$ is the part of the forecast error that the equation is not able to capture. It is assumed to be randomly distributed, with mean zero and constant variance.

The annual rate of growth for a specific year, T, is a function of all quarterly or monthly growth rates during years $T - 1$ and T. Andersson et al. (2016) show that the growth rates at the higher frequencies have different weights in terms of annual growth.[37] This weighting scheme is used to construct the functional form $M_{it,h}$ in equation (3). The volume of information possessed by forecaster in the publication month is here approximated by the accumulated weight up to a certain month, $W_{it,h}$. The weight increases, the more one approaches the final outcome.

37 See the discussion on Table 1 in Andersson et al. (2016), which describes the weighting scheme for quarterly data. This study uses monthly weights.

The time effect in equation (3) is defined as

$$M_{it,h} = 1 - W_{it,h}. \quad (4)$$

When $W_{it,h}$ increases, $M_{it,h}$ decreases and equation (4) can be seen as an approximation of the information that is missing when the forecast is published. The coefficient δ_t in equation (3) captures the marginal effect on the forecast error of having access to less information, and the effect is allowed to vary over time.

Equation (3) is estimates over all n forecasters and horizons. Based on the estimates of μ_i and $\mu_{i,t=c}$, the adjusted mean absolute error is defined for a certain year as

$$\mu^*_{i,t=c} = \hat{\mu}_{i,t=c} + \hat{\mu}_i - \tfrac{1}{n}\textstyle\sum_j (\hat{\mu}_{j,t=c} + \hat{\mu}_j). \quad (5)$$

The adjusted mean absolute error is therefore defined as the deviation from an average of all forecasters. A negative value means that forecaster i makes better forecasts than the average while a positive value means that the forecaster has made poorer forecasts than the average.

SVERIGES RIKSBANK
SE-103 37 Stockholm
(Brunkebergstorg 11)

Tel +46 8 787 00 00
Fax +46 8 21 05 31
registratorn@riksbank.se
www.riksbank.se