Evaluation of the Riksbank's forecasts

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Foreword

The Riksbank is an authority under the Riksdag, the Swedish Parliament, with responsibility for monetary policy in Sweden. The monetary policy to be conducted is normally determined six times a year by the Executive Board of the Riksbank. As monetary policy affects the economy with a time lag, forecasts of economic developments in general, and of inflation in particular, form an important part of the material on which monetary policy decisions are based. This study evaluates the Riksbank's forecasts for a number of central economic variables. The Riksbank's forecasting performance is also compared to the accuracy of other forecasters. The study is a complement to the report Account of Monetary Policy, 2017. This evaluation covers the period from 2007 to 2017, with a particular focus on the forecasts made in 2017. The report has been produced by the Monetary Policy Department. The main work on this study has been carried out by Vesna Corbo, Paola Di Casola, Marika Hegg, Jesper Johansson, Karin Lindell, Mårten Löf and Ard Den Reijer.

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Introduction

Monetary policy acts with a time lag this means that it will take time before a change in monetary policy affects the real economy and inflation. Monetary policy therefore needs to be forward-looking and based on forecasts. As the forecasts comprise an important part of the decision-making process, they should also be evaluated systematically. This type of continuous evaluation can contribute to a gradual improvement in accuracy. But the accuracy of the forecasts varies from year to year, as the economy is affected by events that can sometimes be very difficult to predict. In this study, we analyse and evaluate the Riksbank's forecasts for a number of central economic variables.

The study begins with a general description of economic developments in 2017 and a more in-depth analysis of the development of inflation. This shows that economic activity abroad continued to strengthen in 2017. Swedish growth was in line with historical averages, however employment rose faster than normal and unemployment fell. Indicators of resource utilisation in the Swedish economy implied that it was higher than normal last year. Despite the tighter labour market and the high level of domestic resource utilisation, the rate of wage increase remained subdued compared with the historical average. This is probably due to several different factors, including the rate of wage increase abroad being subdued and growth in labour productivity being relatively low. Although wage increases were relatively low, the upturn in CPIF inflation continued, amounting to 2 per cent in 2017. A descriptive analysis of the rate of price increase for various sub-indices shows that it was primarily prices for services and energy that increased rapidly last year.

The second section interprets the recent upturn in inflation with the aid of two macroeconomic models. Here we study what shocks explain the recent upturn in inflation. The weak krona has contributed to the rise in inflation. Economic developments abroad have not weighed down inflation, either, in the same way as they did in 2014 and 2015. However, it is not as evident, according to the models that domestic factors have driven up inflation. But, according to one of the models domestic cost pressures do not dampen inflation to the same extent as before.

The following section compares the Riksbank's forecasts with those made by other forecasters. Firstly, the forecasts are analysed over a longer period of time, from 2007 to 2017, and after that the forecasts for 2017 are studied.[1] Over the past ten years, the after-effects of the financial crisis and the sovereign debt crisis in Europe have affected economic developments. Growth and inflation have been unusually low in many parts of the world. The evaluation shows that the forecasters included in the analysis have on average overestimated GDP growth in Sweden during the period 2007-2017, while unemployment has been lower than expected. The forecasters have also overestimated inflation and the level of the repo rate. GDP growth in the euro area and the United States was also overestimated by all analysts. With a few exceptions, the same also applies to inflation in the euro area. As regards inflation in the United States, on the other hand, there is no clear systematic in the forecasting errors.

Compared with other forecasters, the Riksbank has had a relatively high accuracy in its forecasts for GDP growth and unemployment in Sweden since 2007, and a somewhat lower level of accuracy in forecasts for CPIF inflation. The Riksbank has been below the average of all forecasters with regard to CPI inflation and the repo rate. The CPI includes households' mortgage interest expenditure. This is large governed by the development of the repo rate. If the Riksbank tends to overestimate the level of the repo rate, this also affects the assessment of CPI inflation. It explains why the accuracy for CPI inflation has been poorer than for CPIF inflation. The Riksbank's accuracy for GDP growth in the United States and the euro area has been poorer than the average. With regard to forecasts of inflation in the United States and the euro area, however, the Riksbank has had an accuracy close to the average.

When only the forecasts for 2017 are analysed, it is clear that both CPI and CPIF inflation were higher than the forecasters were expecting. Most also believed that GDP growth would be somewhat stronger and unemployment somewhat lower than was the case. All analysts also expected the repo rate to be higher than it actually was. The Riksbank also made somewhat larger forecasting errors than average for GDP growth and the repo rate. However, just as with the longer period, the Riksbank

[1] 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. After this, the forecasts were based on the market's expectations of the development of the repo rate, in the form of forward rates, until 2007. For a description of the problems involved in evaluating the Riksbank's forecasts prior to 2007, see Andersson and Palmqvist (2013).

produced accurate forecasts of unemployment. The Riksbank also succeeded better than average for CPI and CPIF inflation.

The evaluation also shows that the Riksbank's very short-term inflation forecasts, for the months immediately ahead, are just as good as or slightly better than the average for other forecasters.

1. Economic developments 2017

In recent years, the Swedish economy has been characterised by relatively high growth, rising employment and falling unemployment. At the same time, inflation and inflation expectations have risen from very low levels. To structure the analysis of economic developments in 2017, a comparison is made between the outcomes and the forecasts published by the Riksbank in the Monetary Policy Reports from February 2016 to December 2017. The forecast figures used in comparison is an average of these twelve forecasts (see Table 1 below). The first part of this section focuses on the variables that usually explain the development of inflation. After that, the development of the different sub-indices of the consumer price index (CPI) with a fixed mortgage rate (CPIF) is studied in relation to the historical average.

Table 1. The Riksbank's forecasts for 2017 published from February 2016 to December 2017 plus outcomes
Annual percentage change, unless otherwise specified

	Forecast			Outcome
	Min	Max	Mean	
GDP, euro area	1,4	2,4	**1,8**	2,5
GDP, USA	2,0	2,6	**2,3**	2,3
GDP abroad, KIX-weighted	2,1	2,8	**2,4**	2,9*
Inflation, euro area (HIKP)	1,2	1,7	**1,4**	1,5
Inflation, USA (CPI)	1,7	2,6	**2,2**	2,1
Inflation abroad, KIX-weighted	1,8	2,2	**2,0**	1,9
Policy rate abroad, KIX4-weighted, per cent	–0,2	0,0	**–0,1**	–0,1
Crude oil price, USD/barrel Brent	40,3	56,4	**51,8**	54,8
GDP	2,0	3,2	**2,5**	2,4
Number of hours worked, calendar-adjusted	1,0	1,6	**1,3**	1,9
Employed, aged 15–74	1,0	2,3	**1,6**	2,3
Labour force, aged 15–74	0,8	2,0	**1,3**	2,0
Unemployment, Per cent of the labour force	6,6	6,7	**6,7**	6,7
Hourly wage, NMO	2,7	3,5	**3,0**	2,5**
Hourly labour cost, NA	3,1	3,7	**3,5**	2,8
Productivity	0,8	2,0	**1,5**	0,8
Unit labour cost	1,4	2,5	**2,0**	2,1
CPIF	1,6	2,1	**1,9**	2,0
CPIF excluding energy	1,3	1,9	**1,6**	1,7
CPI	1,4	2,1	**1,7**	1,8
Exchange rate, KIX, 18 November 1992 = 100	106,9	114,5	**111,1**	112,9
Repo rate, per cent	–0,6	–0,4	**–0,5**	–0,5

Note. * refers to preliminary outcomes. ** refers to forecasts of definitive outcomes. NMO is the National Mediation Office's short-term wage statistics (forecast for 2017) and NA is the National Accounts. Labour costs per hour are defined as the sum of wages, social-security charges and wage taxes (total labour cost) divided by the total number of hours worked for employees, seasonally-adjusted data. Unit labour costs are defined as labour costs divided by the seasonally adjusted value added in fixed prices. The policy rate abroad is an aggregate of 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

Higher GDP growth but continuing subdued underlying inflation abroad

The economic upturn abroad continued to strengthen during 2017. It was a broad upturn in terms of both countries and sectors. Employment has risen rapidly in the United States, and the low unemployment indicates that there is little spare capacity on the labour market. The outcome for GDP growth in the United States was in line with the forecasts the Riksbank has published over the past two years. In the euro area, on the other hand, growth was much higher than expected in 2017. Resource utilisation in the euro area also increased rapidly, but is still assessed to be lower than in the United States. Aggregate GDP growth in the countries included in the krona index (KIX) was also higher than expected (see Table 1 above).[2]

International inflationary pressures are still low, despite the improvement in developments in the real economy. Inflation was very subdued in both the United States and the euro area up to the beginning of 2017, when inflation rose relatively quickly. The upturn was primarily due to energy prices having risen and thus making a positive contribution to inflation. In autumn 2017, an upturn in the oil price was again contributed to raising inflation somewhat. All in all, inflation in the euro area was somewhat higher than expected, while inflation in the United States and the aggregate international inflation were marginally lower than expected. The forecast for inflation in the United States has been revised more than that for the euro area over the past two years.[3]

In the United States underlying inflation, measured as the rate of increase in the CPI excluding energy and food, was 1.8 per cent on average in 2017. This was somewhat lower than in the previous year, when it amounted to just over 2 per cent. Underlying inflation in the euro area, measured as the rate of increase in the HICP excluding energy and foods, has been relatively unchanged since 2014 and amounted to 1.0 per cent on average in 2017.

The normalisation of monetary policy continued in the United States and was begun cautiously during the year in some other countries, such as the United Kingdom and Canada. The ECB, on the other hand, announced it was extending its asset purchases. Compared with the forecasts the Riksbank has made, the average policy rate abroad developed as expected.

High resource utilisation but low wage increases in Sweden

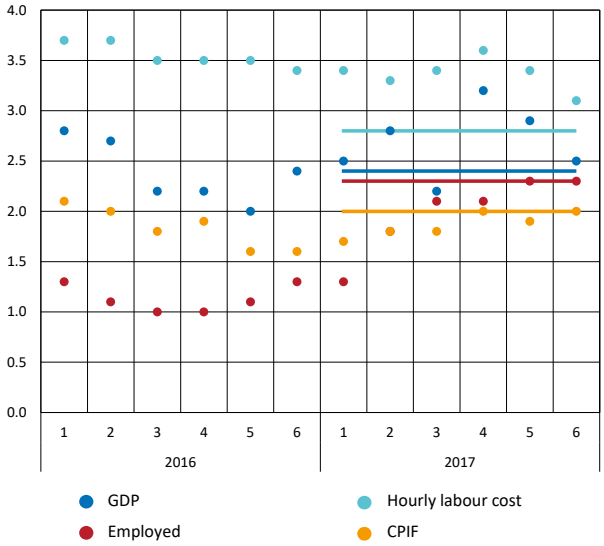
It can be noted that GDP growth in 2017 was in line with an average of the assessments made by the Riksbank over the past two years (see Table 1). The Riksbank's forecasts for the GDP growth in Sweden in 2017 have varied somewhat, however. In Figure 1 below the Riksbank's assessments for a number of domestic variables are plotted from the twelve forecasting rounds in 2016 and 2017. At the lowest point GDP growth was expected to be 2.0 per cent in 2017 (Monetary Policy Report, October 2016) and at the highest, to 3.2 per cent (Monetary Policy Report, September 2017).

Unemployment was roughly as expected, but the number of persons employed and the number of persons in the labour force increased much faster than expected. It can also be noted in Figure 1 that the forecast for employment growth has been revised up constantly. The same applies to the forecast for the number of people in the labour force. The various indicators of resource utilisation analysed by the Riksbank indicated on aggregate over the year that resource utilisation was higher than normal. Companies experienced difficulty finding the labour they were seeking. The number of companies that reported labour shortages was at a high level, as was the vacancy rate in the business sector, at the same time as the average recruitment time in the business sector was long. Capacity utilisation in the manufacturing sector also continued to rise and was close to the level that prevailed prior to the financial crisis. The Riksbank's RU indicator, which is an aggregate measure of the amount of spare capacity in the economy, attained historically high levels.

[2] GDP abroad is aggregated with the weights in the krona index (KIX).

[3] At the lowest point, CPI inflation in the United States was expected to be 1.7 per cent in 2017 (Monetary Policy Report, December 2016) and at the highest, to 2.6 per cent (Monetary Policy Report, February 2017).

Figure 1. The Riksbank's forecasts (dots) and outcomes (lines) for 2017
Annual percentage change, quarterly data



Note. There were six forecast rounds in both 2016 and 2017.
Sources: Statistics Sweden and the Riksbank

Despite the strained situation on the labour market and the high level of domestic resource utilisation, wage increased remained moderate. It can be noted in Figure 1 that the forecasts for the broader wage measure, labour costs per house according to the National Accounts, overestimated developments 2017. The same applies to wages according to the short-term wage statistics. The subdued wage increases are probably due to several different factors, including the rate of wage increase abroad and growth in labour productivity being relatively low.[4] Although wages did not increase at the pace the Riksbank was assuming in 2017, the domestic cost pressures, measured in terms of unit labour costs, turned out as forecast, as productivity also increased more slowly than expected (see Table 1).

Higher rate of increase in services prices than in earlier years

CPIF inflation amounted on average to 2.0 per cent last year. Compared with the average of the Riksbank's forecasts from 2016 and 2017, this was somewhat higher than expected. Measured as CPIF excluding energy, the rate of inflation was 1.7 per cent in 2017, which was somewhat higher than the average of the Riksbank's forecasts from 2016 and 2017. The same applies to CPI inflation (see Table 1).

Table 2 shows the average rate of price increase in 2017 for various sub-indices of CPIF in relation to the period 2000 to 2016.

[4] See the article "Strong economic activity but subdued wage increases" in the Monetary Policy Report, July 2017. This also names other factors that can have affected the wage rate, such as structural changes to the labour market and the possible adjustment of wage and inflation expectations to the long period of low inflation.

Table 2. Sub-indices of CPIF (weight and annual percentage change, annual average)

	Weight 2017	2000–2016	2017
Services	44,5	1,8	2,4
Rent	9,8	2,0	0,8
Property tax	0,7	−0,1	2,4
Foreign Travel	2,1	1,0	3,0
Other Services:	31,9	1,9	2,7
Health care, domestic travel and administrative prices[5]	9,2	2,6	3,5
Restaurant, lodging, entertainment, recreation[6]	13,1	2,5	2,6
Repair, cars and household appliances[7]	2,2	2,9	2,0
Banking, Insurance, etc.[8]	4,9	3,6	3,5
Telephony[9]	2,5	−3,7	−1,3
Goods excluding food	26,9	−0,5	−0,7
Food	18,0	1,8	2,1
Capital stock index	3,4	4,9	9,4
CPIF excluding energy	93,0	1,3	1,7
Energy	7,0	3,4	5,8
CPIF	100	1,5	2,0

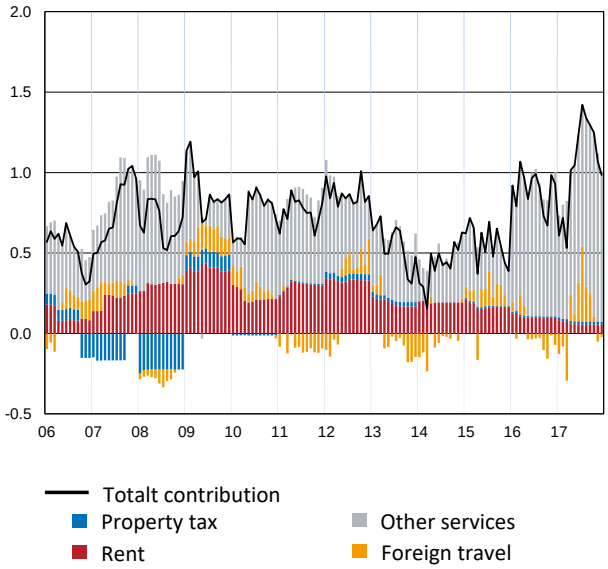
Note. Weight refers to the weight in CPI 2017.
Sources: Statistics Sweden and the Riksbank

Prices for goods increased faster than the average rate during the second half of 2015 and the first half of 2016. This is primarily assessed to be due to the exchange rate weakening during 2015, which affected goods prices with some time lag. The positive effect from the exchange rate diminished during 2017, as goods prices developed roughly in line with the historical average rate of development. Food prices, which increased slowly in 2016, rose somewhat faster than their historical average in 2017. After contributing to lower inflation until the second half of 2016, energy prices also increased faster than their historical average in 2017.

Service prices also increased faster in 2017. A more detailed breakdown of them is therefore given in Table 2 above. Figure 2 shows how various sub-indices within aggregate service prices have contributed to CPIF inflation in recent years. The contributions show, put simply, the annual rate of increase in each price group multiplied by the group's weight in CPIF. Bars above zero indicate a positive contribution to CPIF inflation, while bars below zero indicate a negative contribution.

[5] Includes costs for water, sewage, cleaning, sweeping, depreciation, TV license, postal services, medical treatment, dental fees, domestic travel such as local traffic, rail travel and taxi.
[6] This includes accommodation, food and drinks outside the home, entertainment and recreation, personal hygiene and gaming services.
[7] Includes repair and maintenance of cars, boats, dry cleaning, cleaning and other domestic services.
[8] This includes banking services, home and sickness insurance, accident insurance, legal fees, real estate agents and more.
[9] The figures in the two periods are not completely comparable for this sub index. It included cost of phones in the earlier period but not in the later.

Figure 2. Contribution to the CPIF inflation from subindices within service prices.
Percentage points, monthly data



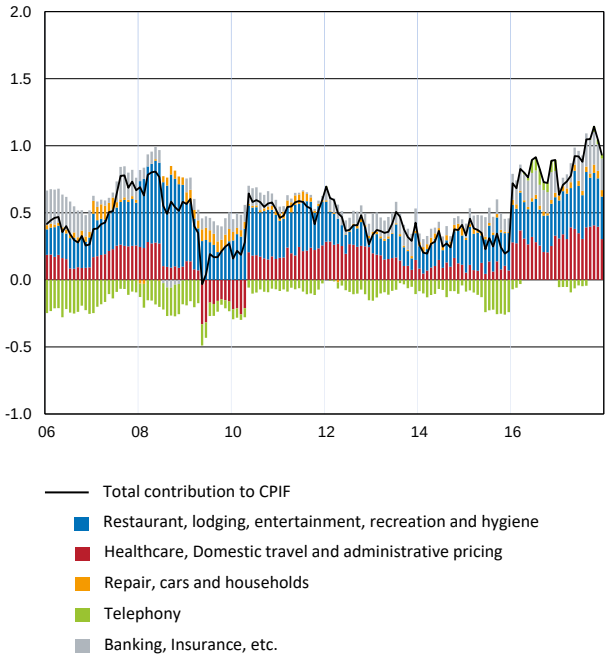
Note. The bars illustrate each sub-index's contribution to the rate of increase in CPIF over the past twelve months. The contributions can be interpreted as the annual rate of increase in each group multiplied by the group's weight in CPIF.
Sources: Statistics Sweden and the Riksbank

Rents, which comprise just over 20 per cent of the services aggregate, increased much more slowly than their average and the contribution to CPIF inflation was low in 2017 (see Table 2 and Figure 2).[10] The new measurement method for prices of package holidays has contributed to a new seasonal pattern in the sub-index for foreign travel. Despite the weight being relatively small, the fluctuations in this sub-index made it more difficult to predict and interpret inflation in 2017.[11] Seen across last year as a whole, however, the contribution from prices of foreign travel to CPIF inflation was small. The heterogeneous sub-aggregate in prices for services termed "other services" in Table 2 and Figure 2 increased faster in 2017 than on average during the years 2000 to 2016. The contribution to CPIF inflation was also considerable in 2017, as in 2016.

Figure 3 below shows contributions from various sub-indices within other services. The grey bars shown in Figure 2 have thus been broken down one stage further here. The bars in Figure 3 should once again be interpreted as the respective sub-index's contribution to the rate of increase in CPIF. There has been a relatively broad upturn in service prices since CPIF inflation was at its lowest in 2014. In January 2016 one can see a very clear change in the contribution from the group called telephony. This is explained by Statistics Sweden then removing the product group telephones from telephony in the sub-aggregate services and moving it to home electronics, in goods prices. The reclassification entailed an ostensible lift for prices in this group. The contribution from the group named "Healthcare, domestic travel and administratively priced services" also increased then. This upturn can to some extent be explained by changes in taxation.

[10] The reason that rents increased unusually slowly may be due to the low interest rates.
[11] Foreign travel is normally a volatile item in CPIF. In 2017 Statistics Sweden changed its method for calculating prices of package travel (weight 1.3 per cent in CPIF 2017). The new method follows recommendations from Eurostat and mainly means that prices of trips not sold during certain period of the year will not have an impact on the index. Prior to 2017, the most recently noted prices for a trip was instead noted in the index calculations even during the months that this trip could not be made. Last year the new seasonal pattern affected the annual change in CPIF. In coming years, the annual rate of change will not be affected by the new seasonal pattern, as the twelve-month comparisons will then be based on the same method.

Figure 3. Contribution to the CPIF inflation from subindices within "other services"
Percentage points, monthly data



Note. The bars illustrate each sub-index's contribution to the rate of increase in CPIF over the past twelve months. The contributions can be interpreted as the annual rate of increase in each group multiplied by the group's weight in CPIF.
Sources: Statistics Sweden and the Riksbank

To summarise, the descriptive analysis shows that higher energy and service prices contributed to the upturn in CPIF inflation in 2017. Within service prices, which were to a large extent affected by domestic economic activity and domestic costs, it was primarily the sub-index called "other services" that increased faster than the average for the years 2000 to 2016.

2. Interpretations of the upturn in inflation

This section analyses the development of inflation in 2017 with the help of two macroeconomic models used at the Riksbank. Ramses, a so-called dynamic stochastic general equilibrium (DSGE) model is used in the first part and a vector autoregressive (VAR) model is used in the second part.[12] As they are two different types of model, a short description is given first of their respective properties and interpretations of developments in 2017. Thereafter, the results are compared and some conclusions are presented.

According to Ramses, the rising inflation is due to less squeezed margins and a relatively weak exchange rate.
Ramses is the DSGE model used at the Riksbank for forecasts and policy analyses. Since 2017, a version of Ramses is used with a time-varying trend component in the internationally determined real interest rate, and hence also in the repo rate. The model's interpretation of historical monetary policy shocks is different to the earlier version of the model, in which the trend component was instead assumed to be constant. The fact that the model is stochastic means that the correlations between different variables can shift over time depending on which underlying factors affect economic developments. These factors can be domestic or come from abroad. By studying them, it is possible to provide an

[12] A previous version of the DSGE model is described in Adolfson et al. (2013). (2013). As regards BVAR, see Adolfson et al. (2007) for a description of this type of model used at the Riksbank and Villani (2009) for a description of the underlying methodology.

explanation for why the economy has developed in the way it has. It also gives us an idea of how important an individual explanatory factor is compared with others, as all factors are studied within the same model. In the current version, Ramses contains 18 shocks that affect the economy in different ways.[13] To simplify the discussion, we have sorted these into six main factors: [14]

- Domestic demand
- Domestic cost pressures
- Price mark-ups
- Monetary policy
- International
- Exchange rate

Figure 4 shows how different factors according to Ramses have contributed to the deviation of CPIF inflation from the target of 2 per cent. In 2017, inflation was close to target, while several other input variables were close to their long-term equilibrium levels. Policy rates in Sweden and abroad were also close to levels that follow from the historical behaviour of central banks. The deviations in inflation and other variables to be explained by the model are therefore minor.

The factor making the main contribution to holding back inflation in 2017 is weak domestic cost pressures (red bar in Figure 4). This corresponds well with the relatively low wage growth in recent years.[15] The relatively weak exchange rate seems to have contributed to higher inflation from 2014 and onwards (blue bars). Another factor contributing to the rise in inflation is stronger developments abroad (yellow bars), even though these contributions are minor. It should be noted, however, that this type of model for open economy finds it difficult to capture effects from economic fluctuations abroad.[16] This probably means that the significance of international developments is underestimated.

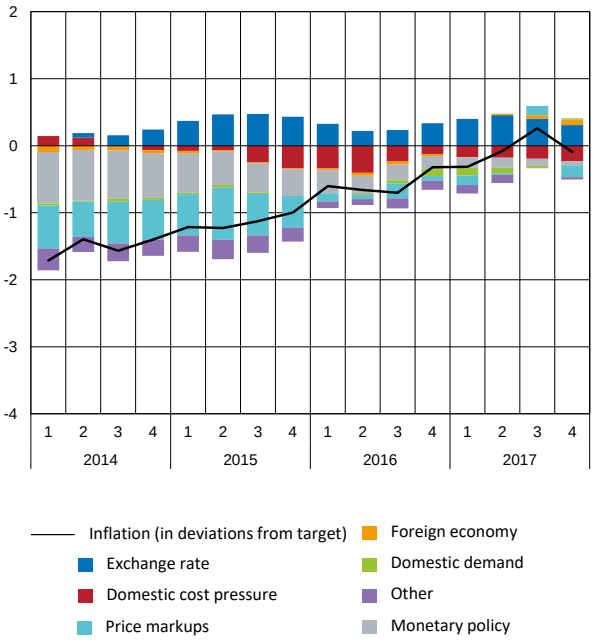
[13] In addition, the model contains a number of measurement errors for different variables, which represent observed variations that are difficult for the model to combine with developments in other model variables. Their contribution is normally very small.

[14] In the domestic demand group, the shocks include those to private consumption and investment. Domestic cost pressures include shocks to technological developments in Sweden and certain labour market factors. The temporary changes in price mark-ups that deviate in some way from the historical pattern will be interpreted as a shock to mark-ups. Changes in the repo rate that deviate from an estimated policy rule are interpreted as a monetary policy shock. Monetary policy in the model is determined by a policy rule for the repo rate based in how inflation and resource utilisation develop. How much monetary policy reacts to changes in inflation and resource utilisation reflects how the Riksbank has actually reacted historically. The international group includes shocks to technological developments abroad and shocks to inflation abroad.

[15] However, there are signs that domestic cost pressures do not dampen inflation to the same extent as 2016.

[16] For a discussion on this, see, for instance, Justiniano and Preston (2010).

Figure 4. The contributions of different shocks to the deviation of CPIF inflation from 2 per cent, according to Ramses
Percentage points, quarterly data



Source: The Riksbank

The most important explanation for why inflation rose and was close to target in 2017, however, is the gradual subsidence and subsequent low level of factors that had contributed to low inflation for several years beforehand. One of these shocks is call price mark-ups (purple bars in Figure 4). The fact that the negative contribution from such shocks was greatest in 2014 and 2015 is in line with the business surveys performed by the Riksbank during the same period. In these, companies replied that their margins were lower than normal. This in turn was thought to be due to weak demand and uncertainty about the future. But companies also said that competition had increased significantly in recent years. In this environment, companies have been less able to pass on their cost increases to consumers by raising their prices, and their margins have therefore shrunk. This is thus something which the model also seems to capture.

Another shock that contributed to the low inflation in years before 2017 is monetary policy (grey bars). In the model, monetary policy is illustrated by a simple policy rule, by which the central bank allows the repo rate to respond to movements in inflation and resource utilisation around the repo rate's trend level, which in turn is determined by the real interest rate's trend level and the inflation target. How much monetary policy reacts to changes in these variables reflects how the Riksbank has actually reacted historically. Changes in the repo rate that deviate from the policy rule are interpreted as monetary policy shocks. According to the model, the repo rate was higher than implied by the policy rule between 201 and 2014, which had a dampening effect on inflation for a long time.[17] It should be noted that the model does not consider monetary policy measures over and above repo rate adjustments, as the interest rate is the only monetary policy instrument in the model.[18] The effect of other monetary policy measures is therefore interpreted as other shocks in the model.

[17]Several shocks have relatively long-term effects on the economy in this type of model. There is also inertia in the monetary policy rule, which contributes to a monetary policy shock tending to have long-lasting effects.
[18]Apart from reducing the repo rate to a historically low level, the Riksbank has also purchased government bonds to make monetary policy more expansionary. Communication of monetary policy has also been a tool used to a great extent to emphasise the determination to achieve the inflation target and to affect inflation and interest rate expectations.

The negative contribution from foreign shocks has declined and hence contributed to the upturn in inflation according to the VAR model

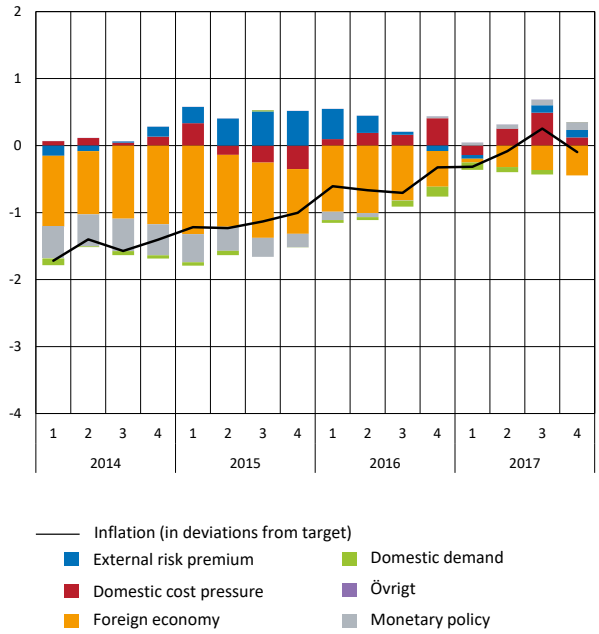
Another macroeconomic model used in the Riksbank's analyses is a so-called vector autoregressive (VAR) model that includes seven variables: real exchange rate, repo rate, CPIF inflation and GDP growth in Sweden, and the trade-weighted (KIX-weighted) international variables: policy rate, inflation and GDP growth.[19] As in Ramses, the international variables are assumed to be capable of influencing developments in the Swedish economy but not vice versa, as Sweden is a small, open economy. The model assumes a number of long-term relationships between the variables. GDP growth in Sweden and abroad is equal to potential growth in the long term.[20] The real repo rate and the real KIX-weighted policy rate are also assumed to move towards the same global real neutral rate in the long run.[21] The BVAR model identifies seven shocks. These are sorted into five major factors that can explain economic developments:

- International (3 shocks)
- Domestic demand
- Domestic coast pressures
- Monetary policy
- Exchange rate

Figure 5 shows the contributions to CPIF inflation from these factors according to the BVAR model. The upturn in inflation is mainly explained by a reduction in the negative contribution from international shocks. Thus, this model gives international factors a significantly greater role than in Ramses. According to the model, higher domestic cost pressures have also contributed to the rise in inflation in 2017 (red bars). Compared with Ramses, contributions from shocks to the exchange rate are smaller, but the weak exchange rate has contributed to higher inflation in recent years (blue bars). Monetary policy shocks have contributed to higher inflation in most recent times, even if the contributions are small (grey bars). As in Ramses, these contributions were negative in 2014 and 2015. It should once again be noted that this only captures the effect of changes in the repo rate, not the effects of other expansionary monetary policy measures.

[19] The model is estimated using Bayesian methods.
[20] Potential growth is the same in Sweden and abroad.
[21] Furthermore, inflation moves towards inflation targets in the long run.

Figure 5. The contributions of different shocks to the deviation of CPIF inflation from 2 per cent, according to the VAR model
Percentage points, quarterly data



Source: The Riksbank

Summary of model results

The weak krona has contributed to higher inflation, but the size of this contribution varies between the models. As in previous upturns in inflation, stronger economic developments abroad play an important role. This is most evident in the VAR model, where the major negative contributions from abroad in 2014 and 2015 have subsided. According to the models, it is not as obvious that domestic factors have contributed to the upturn in inflation. According to Ramses, however, higher price mark-ups and margins, both on domestic and imported products, have contributed to the upturn in inflation. Monetary policy has also contributed to the rise in inflation, but it is uncertain by how much. It is clear, however, that the negative effects on previous monetary policy shocks have abated. As mentioned earlier, it should be noted that the models cannot capture the effects of all expansionary monetary policy measures.

3. Forecast evaluation

This section compares the Riksbank's assessments with those performed by other forecasters. The evaluation focuses on the period 2007–2017, but also looks at 2017 separately.[22] When a slightly longer period is analysed, the results are less sensitive to random differences among various analysts. It must be remembered, however, that the period is to a great extent characterised by the financial crisis of 2008–2009 and the consequences thereof.

For each year, forecasts of developments up to two years ahead are studied. The accuracy for the whole of 2017 therefore refers to forecasts published in both 2016 and 2017.

Measures of forecasting performance

There are different ways of assessing how accurate forecasts are. A common assessment measurement is average forecasting error, or mean error. This describes how far the outcomes have on average deviated from the forecasts and shows whether there is a systematic over- or under-estimation. A negative mean error indicates that the forecasts have on average overestimated the outcomes, while a positive value indicates that the outcomes have been underestimated. The forecasts may have been

[22] It is difficult to evaluate the Riksbank's forecasts for the period before 2007. See footnote 1.

inaccurate even if the mean error is close to zero. Major positive and negative forecasting errors can cancel each other out and give the impression that accuracy has been good despite it not having being so. We therefore also report the mean absolute error, i.e. the average of the absolute value of the forecasting errors.[23]

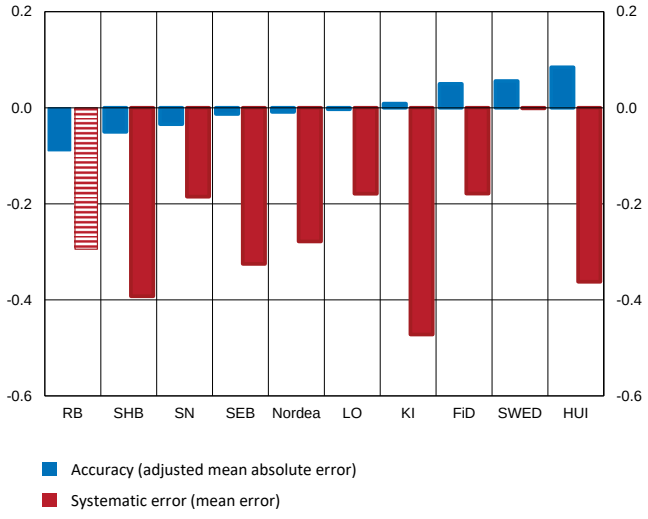
Forecasters often don't have access to the same information when they make their forecasts as the forecasts are performed at different frequencies and on different occasions. This makes it difficult to compare their accuracy. A forecaster who bases the analysis on a larger amount of information should have better accuracy. It is hence important to consider differences in access to information when evaluating forecasting performance. This is why an adjusted absolute average error is reported that takes this into account.[24]

An evaluation of the Riksbank's forecasts for 2007-2017

Figure 6–10 show average forecasting errors (mean errors) and adjusted mean absolute errors for five different variables: GDP growth, unemployment, CPI and CPIF inflation and the repo rate. The forecasts have been performed by Swedish forecasters during the period 2007–2017.[25] In the figures, forecasters are sorted by adjusted mean absolute error (blue bars) which on average is equal to zero. The red bars, which show the average forecasting error (outcome − forecast), are virtually all negative. This means that basically all forecasters on average have overestimated the outcomes for all variables. For GDP, it means that economic growth has on average been lower than expected, and the negative bars in Figure 7 indicate that unemployment has on average been lower than expected. The Riksbank has, together with other forecasters, also on average overestimated inflation and the level of the repo rate during this period.

Figure 6. GDP growth, accuracy and systematic error in forecasts from various analysts, 2007–2017

Percentage points



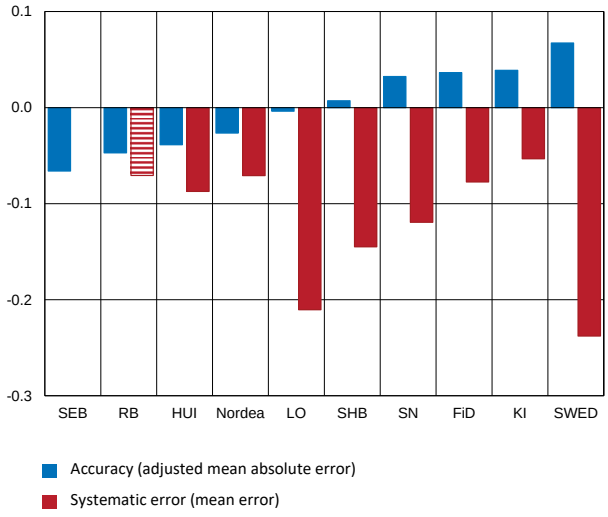
Sources: Respective analysts and the Riksbank

[23] The absolute value refers to a number's distance to zero. Both 1 and -1 have the absolute value of 1.

[24] The method has been developed at the Riksbank, see Andersson and Aranki (2009) and Andersson, Aranki and Reslow (2016). A brief description of the method is given in the Appendix.

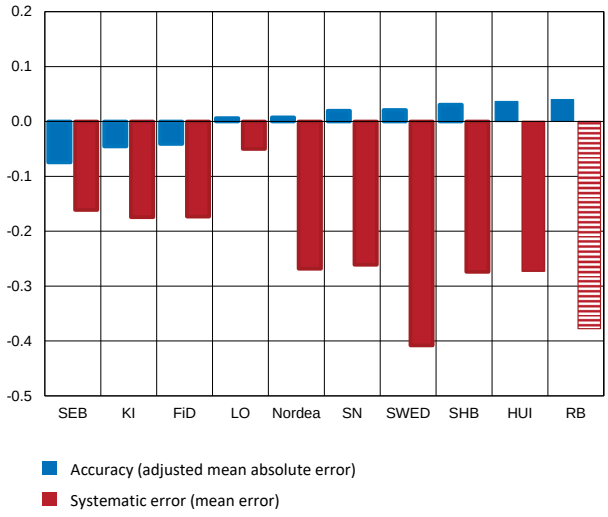
[25] For GDP growth, unemployment and CPIF inflation, the evaluation is based on forecasts from 10 forecasters: The Riksbank (RB), the Ministry of Finance (FD), The Retail and Wholesale Research Institute (HUI), the National Institute of Economic Research (KI), the Swedish Trade Union Confederation (LO), 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 the Retail and Wholesale Research Institute, 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) and adjusted for credit risk premiums.

Figure 7. Unemployment, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



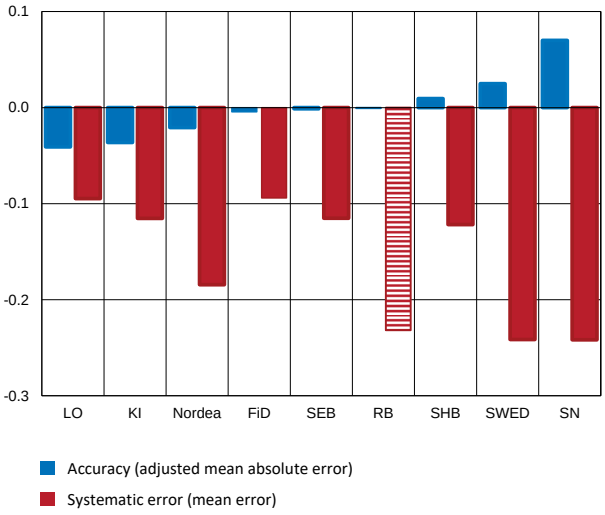
Sources: Respective analysts and the Riksbank

Figure 8. CPI inflation, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



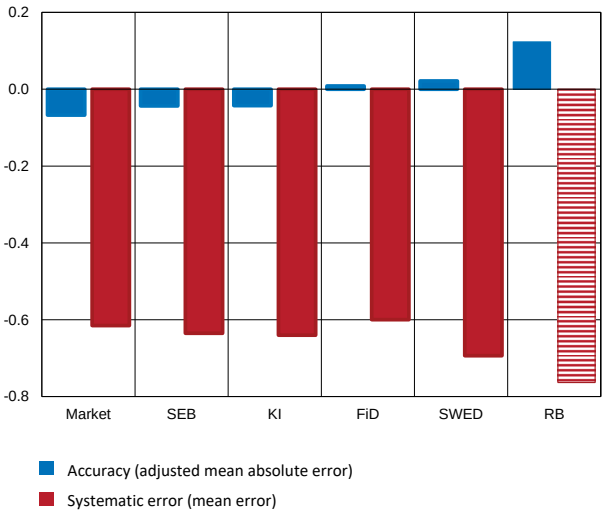
Sources: Respective analysts and the Riksbank

Figure 9. CPIF inflation, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



Sources: Respective analysts and the Riksbank

Figure 10. Repo rate, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



Sources: Respective analysts and the Riksbank

The blue bars in Figure 6–10 show the adjusted mean absolute error for forecasts made in 2007–2017. The adjusted mean absolute error is reported as a deviation from the mean value for all forecasters. A negative value is to be interpreted as accuracy being better than average and a positive value as it being worse. There are some differences in accuracy among the various analysts, but they are small. The difference between the best and worst forecaster, for example for both inflation measures, is only just over 0.1 percentage points (see Figure 8 and 9).

During the period 2007–2017, the Riksbank has made the least accurate forecasts for the repo rate and CPI inflation, measured according to the mean absolute error. The Riksbank is about as good as average regarding forecasts for CPIF inflation.[26] The Riksbank had the least forecasting error for GDP growth and has also been better than the average for unemployment. The ranking in Figure 6–10 is based on forecasts for all years from 2007 to 2017, but it varies when forecasting performance is

[26] The repo rate plays a crucial role for the difference between CPI and CPIF inflation. Poorer forecasts for the repo rate tend to directly affect the forecasts for CPI inflation. This is because the repo rate forecast steers the forecasts for mortgage rates. The CPI is directly affected when mortgage rates change while these are held constant when calculating CPIF.

compared for individual years. Table 3 shows the Riksbank's ranking for different years. For example, the Riksbank has made good forecasts for CPIF inflation in certain years (2010, 2011 and 2017) compared to other forecasters, but made relatively large forecast errors in other years (2007, 2015 and 2016). For unemployment, the Riksbank has made accurate forecasts compared with other analysts for most years.

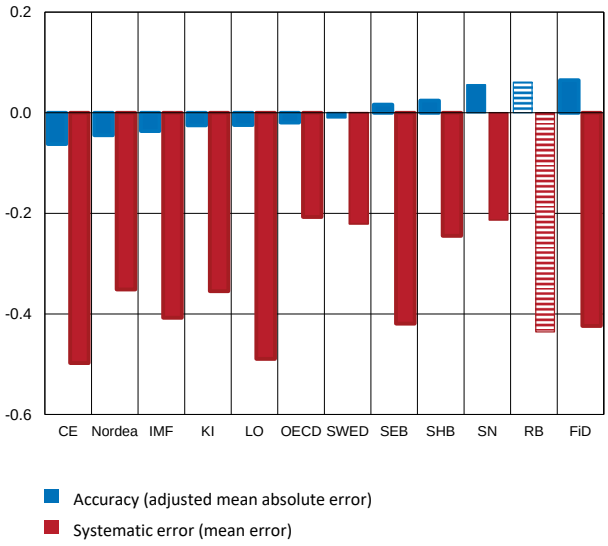
Table 3. Annual ranking of the Riksbank's forecasts for the Swedish economy 2007-2017

	GDP	Unemployment	CPI	CPIF	Repo rate
2007	1	5	4	9	4
2008	5	2	3	4	4
2009	5	7	10	7	6
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
2017	6	1	2	2	4
Average 2007-2017	**1**	**2**	**10**	**6**	**6**
Of no. institutions:	10	10	10	9	6

Note. The figures in the table give the Riksbank's ranking, based on estimated accuracy according to the adjusted mean absolute error. The highest ranking is 1. 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

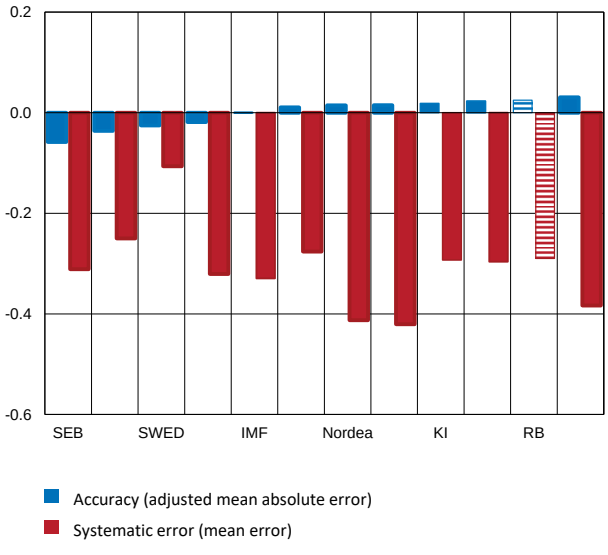
Figure 11-14 show the corresponding result for GDP growth and inflation in the United States and the euro area. The red columns show that, on average, all analysts have overestimated GDP growth in both the euro area and the United States over the period 2007–2017. With a few exceptions, the same also applies to inflation in the euro area (see Figure 14). As regards inflation in the United States, there is no clear systematic in the mean errors (see Figure 13). The blue columns in Figure 11 and 12 show that the Riksbank's accuracy for GDP growth in the United States and in the euro area has been worse than average. In contrast, as regards forecasts for inflation in both the United States and the euro area, the Riksbank has been close to the average. However, in all cases, the differences between the forecasters are very small.

Figure 11. GDP growth in the United States, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



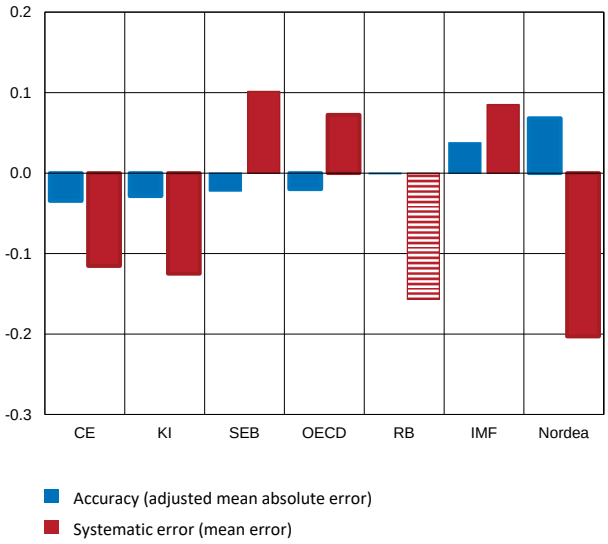
Sources: Respective analysts and the Riksbank

Figure 12. GDP growth in the euro area, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



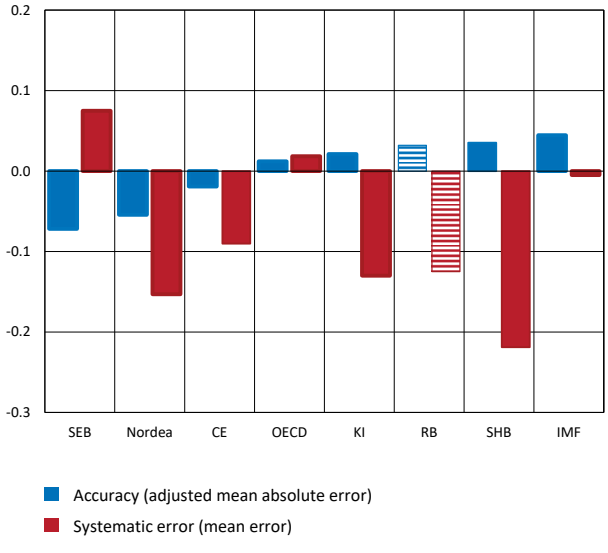
Sources: Respective analysts and the Riksbank

Figure 13. CPI inflation in the United States, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



Sources: Respective analysts and the Riksbank

Figure 14. HICP inflation in the euro area, accuracy and systematic error in forecasts from various analysts, 2007–2017
Percentage points



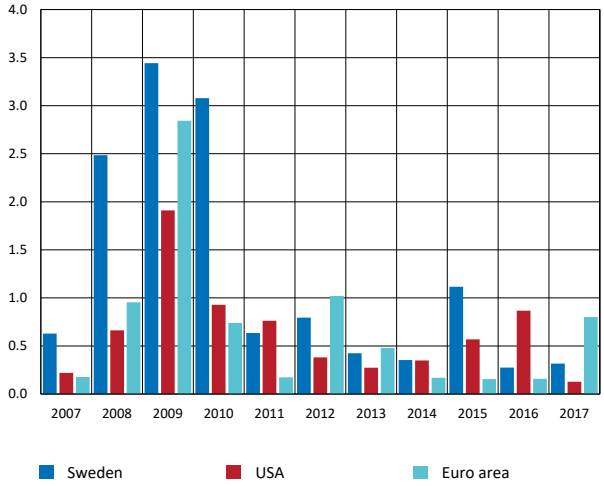
Sources: Respective analysts and the Riksbank

An evaluation of the Riksbank's forecasts for 2017

By calculating an average of the different analysts' mean absolute errors year by year, a measurement can be obtained of how difficult it been for the analysts to forecast different variables over time. Here, such average mean absolute errors have been calculated for GDP growth and inflation in Sweden, the United States and the euro area. Figure 15 below plots the average mean absolute error for GDP growth. The high mean absolute errors during the financial crisis are the first things to be noted. The forecasting errors for GDP growth in Sweden are highest in 2008–2010. In 2017, the mean absolute error was relatively minor. The mean absolute error for GDP growth in the United States 2017 is the lowest since 2007. However, the average forecast error is slightly larger for GDP growth in the euro area 2017. Figure 16 plots corresponding figures for inflation. In this case too, the average mean absolute errors were low in 2017. The results thus indicate that 2017 was a relatively easy year to forecast.

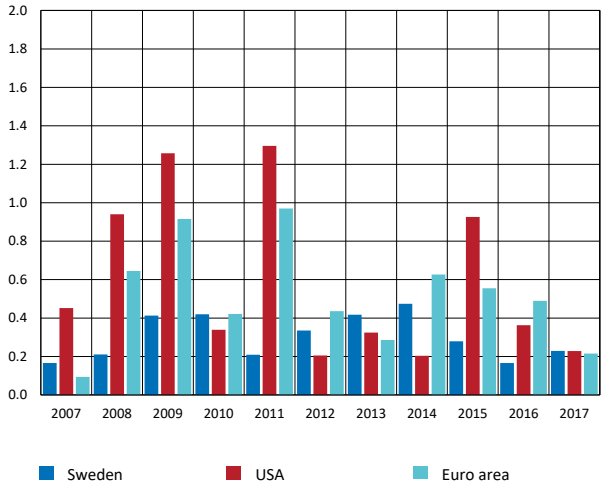
After having compared the various analysts' forecasts for the entire period 2007–2017 in the preceding section, the forecasts for 2017 are now examined in more detail.[27] The results are shown in Figure 17–21. Most analysts had expected lower unemployment than was actually the case. Both CPI and CPIF inflation were higher than the forecasters as a whole had expected. All analysts also expected the repo rate to be higher than it actually was.

Figure 15. Average mean absolute errors for GDP growth 2007–2017



Sources: Respective analysts and the Riksbank

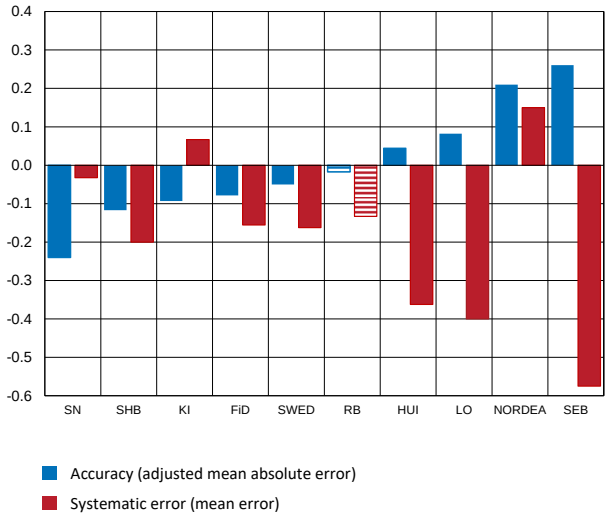
Figure 16. Average mean absolute errors for inflation 2007–2017



Sources: Respective analysts and the Riksbank

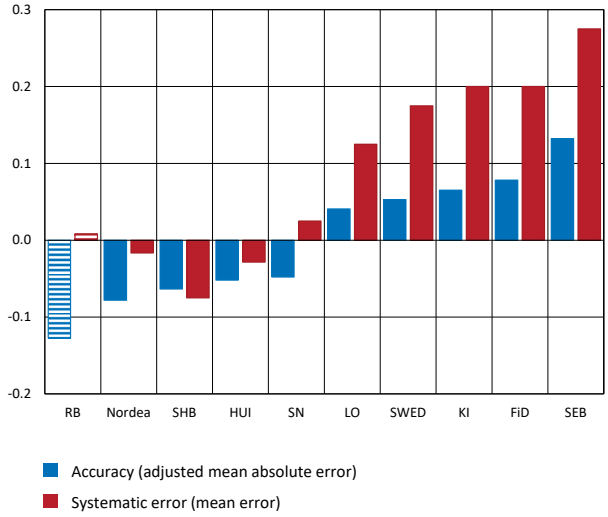
[27] The forecasts for 2017 were made over the period 2016 to 2017.

Figure 17. GDP growth, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



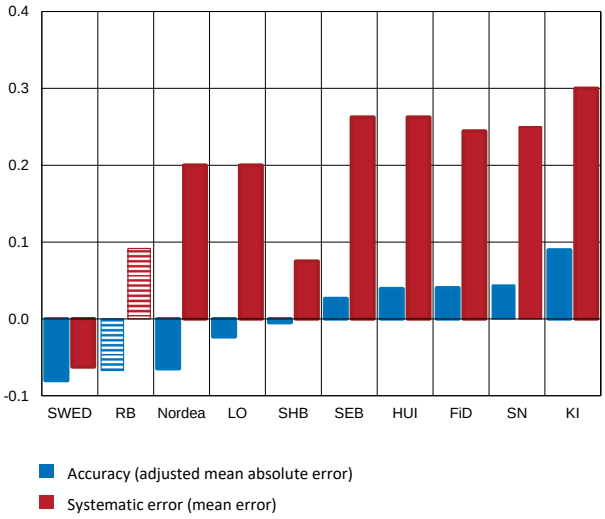
Sources: Respective analysts and the Riksbank

Figure 18. Unemployment, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



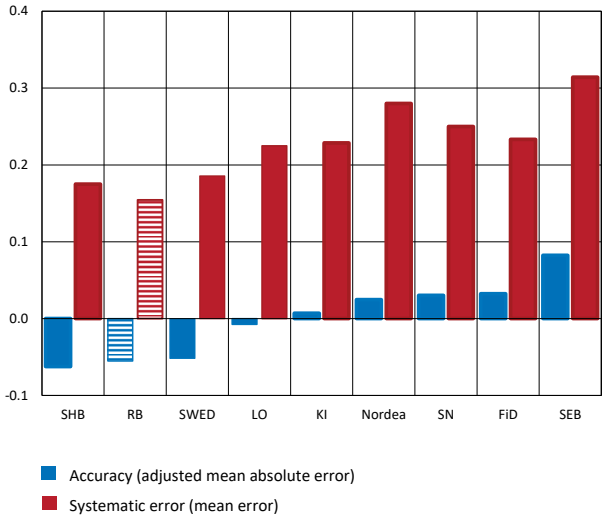
Sources: Respective analysts and the Riksbank

Figure 19. CPI inflation, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



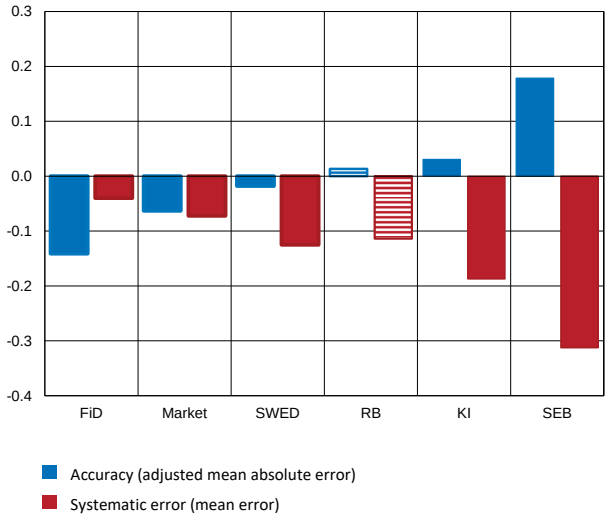
Sources: Respective analysts and the Riksbank

Figure 20. CPIF inflation, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



Sources: Respective analysts and the Riksbank

Figure 21. Repo rate, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points

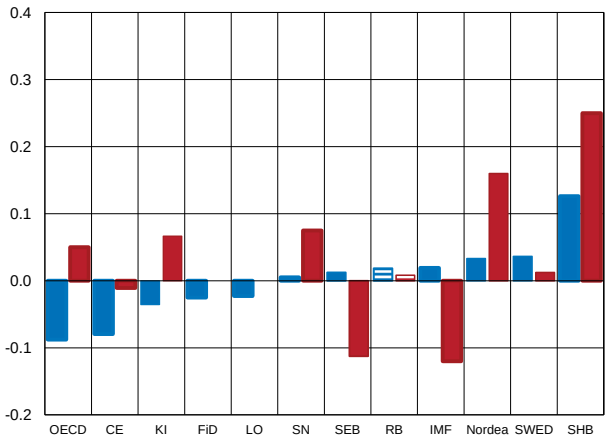


Sources: Respective analysts and the Riksbank

The difference in accuracy between forecasters is greatest for GDP growth and unemployment according to the blue columns in Figure 17–21. However, the differences are small for inflation. For example, the difference between the best and worst forecaster of CPIF is only just over 0.1 percentage points. However, just as with the longer period, the Riksbank has produced good forecasts of unemployment. Compared with the most recent years, the Riksbank has also succeeded better with the forecasts for CPI and CPIF inflation.

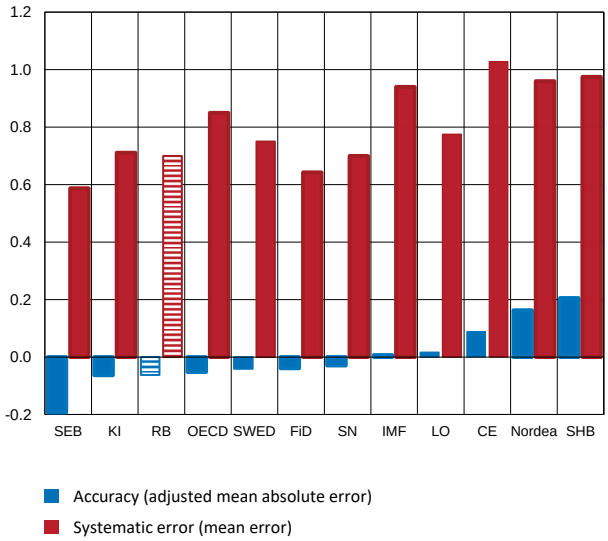
The red columns in Figure 22–25 show no clear systematic in the errors for GDOP growth in the United States, but growth in the euro area is heavily underestimated. Neither is there any clear systematic for inflation in the United States. On the other hand, all forecasters have forecast lower inflation in the euro area than was actually the case. The blue columns in Figure 22–25 show that the Riksbank's accuracy for international variables has been close to average or better.

Figure 22. GDP growth in the United States, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



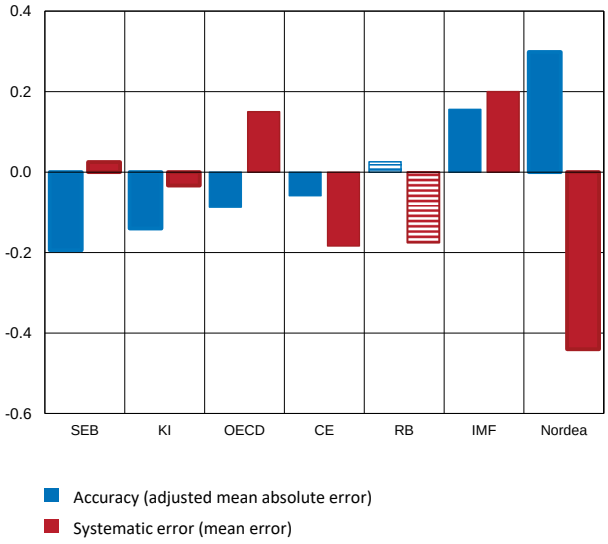
Sources: Respective analysts and the Riksbank

Figure 23. GDP growth in the euro area, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



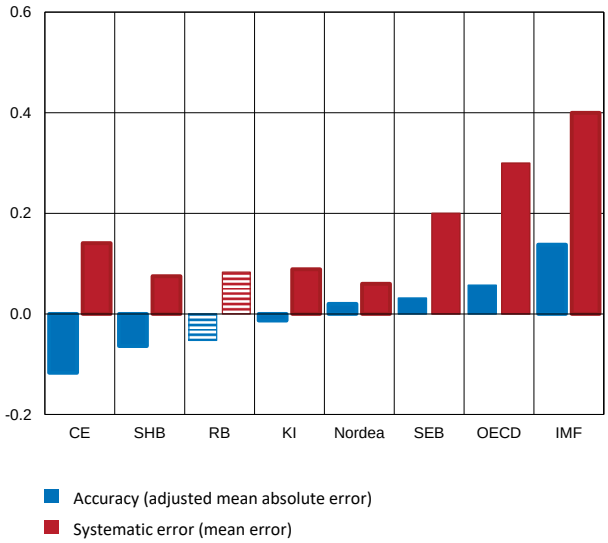
Sources: Respective analysts and the Riksbank

Figure 24. CPI inflation in the United States, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



Sources: Respective analysts and the Riksbank

Figure 25. HICP inflation in the euro area, accuracy and systematic errors in forecasts for 2017 from various analysts, 2016–2017
Percentage points



Sources: Respective analysts and the Riksbank

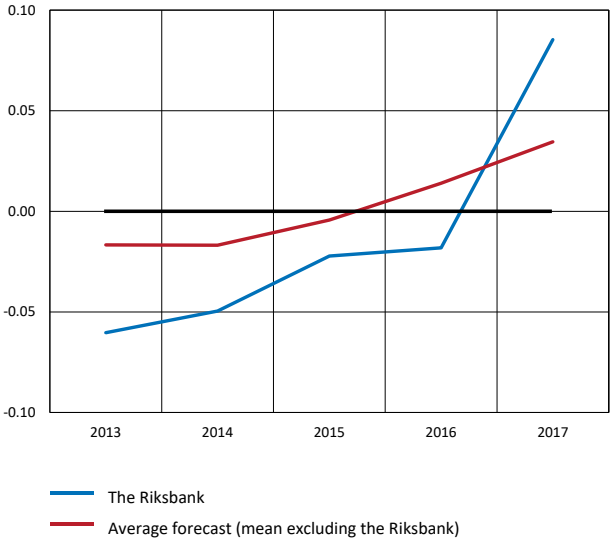
An evaluation of the Riksbank's inflation forecasts in the short term

Finally, we study the accuracy of inflation forecasts in the shorter run, i.e. one to three months ahead. The analysis above, which was based on forecasts up to two years ahead, showed that all forecasters overestimated inflation during the period 2007–2017. For 2017, CPI and CPIF inflation was instead higher than most forecasters expected. A similar pattern emerges when only short-term forecasts are analysed. The results are reported both for the Riksbank, and for a number of other forecasters who report their forecasts on a regular basis.[28]

As the Riksbank published new forecasts six times a year, two, or sometimes three, CPI outcomes may often have been published before a new forecast from the Riksbank is available. As far as the Riksbank is concerned, therefore, forecasts one to three months ahead are included. The Riksbank's mixed forecast horizons are compared with assessments from other forecasters, which are often made only one or a few days before new inflation outcomes are published. In most cases, therefore, the forecasts of other forecasters are based on more information than the Riksbank's forecasts.[29] Figure 26 shows the annual average of monthly forecast error for CPIF inflation. The results indicate that the Riksbank has overestimated short-term inflation during the period 2013–2016. In 2017, however, the Riksbank has underestimated the short-term development of inflation. The red line, labelled "Mean value forecast", shows average forecasting errors when a mean value of all forecasts (excluding the Riksbank) has been calculated as a first step. According to the academic literature, such a mean value forecast is considered very reliable and, over longer periods, it is usually very difficult to make better forecasts.[30] The mean value forecast also overestimated inflation in 2013 and 2014. As for the Riksbank, inflation has on average been overestimated in 2017.

[28] Bloomberg publishes one-step forecasts (forecasts one month ahead) every month from a number of forecasters. The number of forecasters, excluding the Riksbank, is eighteen during the studied period 2013–2017. They include the major Swedish banks and other private financial agents.
[29] Forecasts from other forecasters are usually one-step ahead forecasts and should in most cases be more accurate than the Riksbank's most recently published forecast. Even when the Riksbank's forecast is for inflation one month ahead, other forecasters have a certain advantage, as their forecasts are often made just a few days before the CPI outcome. It can sometimes be decisive how the amount of information held on the development of factors such as fuel prices, electricity prices and exchange rates in recent days can sometimes be the decisive factor.
[30] See, for instance, Stock and Watson (2004).

Figure 26. Annual average of monthly forecasting errors for CPIF inflation, 2013-2017
Percentage points



Sources: Bloomberg and the Riksbank

Figure 27 shows forecasting errors for CPIF inflation for January to December 2017. Inflation outcomes were higher than expected six out of twelve months. The forecasting errors were relatively small in most months but somewhat larger in April, July and November. Inflation was underestimated for these months.

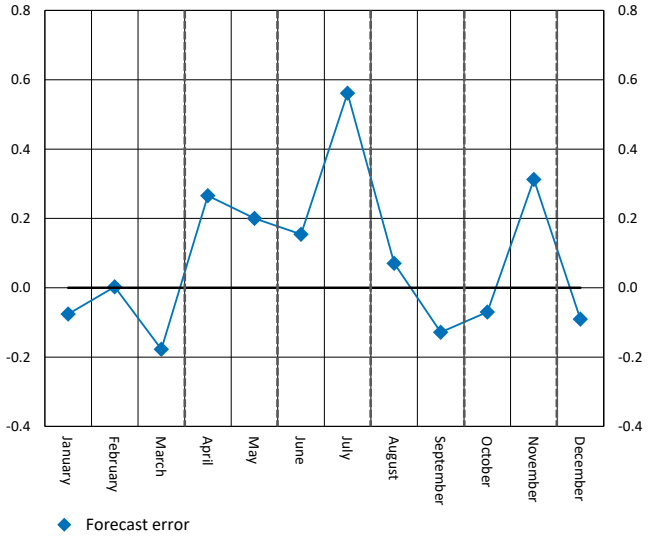
In January and February, the errors were small, but in March inflation was about 0.2 percentage points lower than expected. The forecast on which the errors are based was published in the Monetary Policy Report in February 2017. The January forecast was a one-step forecast (one month ahead) and the March forecast was a three-step forecast. It was primarily food and services prices that increased slowly.

In April, the inflation outcome was almost 0.3 percentage points higher than expected. The forecast had been published in April 2017 and was based on outcomes up to and including March. Prices for services increased rapidly as did prices for goods. A more refined analysis of the development of services prices shows that foreign air travel increased more rapidly than expected. At the same time, the price of charter travel fell slightly more than expected.[31] Within the goods sub-index, prices of several exchange rate-dependent products rose unusually rapidly (furniture, household textiles, vehicles, sports equipment, and toys). There was also a rapid positive rebound in book prices, which had fallen in March.

The forecasting error was slightly less in May. There was insufficient time for Riksbank to publish a new forecast, which meant that it was a two-step forecast. Most sub-indices contributed to reducing the forecasting error compared with April. An exception is prices for services, which once again rose quickly. It was mostly prices for services in accommodation, telecommunications and personal hygiene that rose more than usual in May.

[31] As from 2017, there is a new seasonal pattern in this component (charter travel), see footnote 9.

Figure 27. The Riksbank's forecasting error for CPIF inflation in 2017
Percentage points



Source: The Riksbank

In June, the forecasting error amounted to almost 0.2 percentage points. In the forecast, which was published in the Monetary Policy Report on 4 July, the Riksbank had access to CPI information for May, which means that it was a one-step forecast. Prices for services were once again high, while prices for goods were slightly lower. No new forecast was made prior to publication of the July outcome, when CPIF inflation was almost 0.6 percentage points higher than expected. Within the services aggregate, it was prices for bank services that increased rapidly, along with prices for air and charter travel. Increased electricity grid charges also contributed to the forecasting error.

In August, the forecasting error was still positive, albeit only slightly so. Inflation was lower than expected as prices for goods in particular rose slowly. Higher electricity and fuel prices moved in the opposite direction, however.

In October, inflation was once again lower than expected and the forecasting error could again be explained by lower prices of goods, primarily clothes and shoes. When the CPI figures for November were published, no new forecast had been published, which means that it was a two-step forecast. The forecasting error was now positive. Prices of both clothes and shoes and of other goods rose more rapidly than in October. Energy prices also increased, primarily as a result of higher fuel prices. The outcome in December was slightly lower than the Riksbank's forecast in the December Monetary Policy Report. This was due to prices for services falling slightly more rapidly than expected.

All in all, prices for services have often increased more rapidly than expected and thus contributed to short-term inflation being underestimated during 2017. This was most evident during the first half of the year. During the second half of the year, higher energy prices also contributed to positive forecasting errors.

Table 4 compares various forecasters' accuracy in the short term, both in terms of average forecast error (mean error) and mean absolute error (MAE), over the period January 2013 to December 2017. Including the Riksbank, eleven forecasters are included in the comparison. Over this period, the most accurate analyst has a mean absolute error of 0.12. The row marked "Mean value forecast" shows the result when an average of all forecasts (excluding the Riksbank) has been calculated as a first step. In this analysis, the mean value forecast takes third place in the ranking. The Riksbank, with a mean absolute error of 0.16, takes seventh place. Four individual forecasters have on average made more accurate forecasts than the Riksbank, but the differences are small. The Riksbank has been about as good as 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 4. Evaluation of short-term forecasts for CPIF inflation on a one- to three-month horizon, 2013–2017

Ranking	Forecaster	Average error	MAE	# Forecasts
1	Forecaster with lowest MAE	–0.02	0.12	57
3	Mean value forecast	0.01	0.13	60
6	Average MAE	0.01	0.16	60
7	**The Riksbank**	**–0.01**	**0.16**	**60**
13	Forecaster with highest MAE	0.02	0.18	46

Note. Forecasts with a one- to three-month horizon for the Riksbank. The forecasting error is calculated as outcome – forecast.
Sources: Bloomberg and the Riksbank

Table 5 again compares the forecasting performance of the various forecasters, but here the Riksbank's two- and three-step forecasts have been omitted. Comparability among forecasters is enhanced but there are fewer forecasts and the results are more uncertain. Eleven forecasters including the Riksbank are also analysed here. The most accurate forecast is now the Mean value forecast. The Riksbank takes sixth place with a mean absolute error of 0.14, but four forecasters have once again on average made more accurate forecasts. It can also be seen here that the Riksbank, on average, has forecast slightly too high inflation.

Table 5. Evaluation of short-term forecasts for CPIF inflation on a one-month horizon, 2013–2017

Ranking	Forecaster	Average error	MAE	# Forecasts
1	Mean value forecast	–0.01	0.12	30
2	Forecaster with lowest MAE	–0.01	0.13	27
6	**The Riksbank**	**–0.04**	**0.14**	**30**
10	Average MAE	–0.01	0.16	30
13	Forecaster with highest MAE	–0.09	0.19	17

Note. Forecasts with a one- to three-month horizon for the Riksbank. The forecasting error is calculated as outcome – forecast.
Sources: Bloomberg and the Riksbank

Sammantaget visar denna analys att Riksbankens inflationsprognoser på mycket kort sikt, de närmaste månaderna, är lika bra som eller något bättre än många andra prognosmakare.

Summary

The economic upturn abroad continued to strengthen during 2017. In Sweden, growth was relatively good and the labour market improved. Despite the tighter labour market and higher domestic resource utilisation, wage increases was subdued. Even though wage growth was relatively low, inflation measured as CPIF amounted to 2 per cent on average in 2017. A descriptive analysis of the rate of price increases for various sub-indices of CPIF in 2017 compared with the average rate of increase during the period 2000–2016 shows that it was above all prices for services and energy prices that rose rapidly last year.

The most recent development of inflation is analysed with the help of two macroeconomic models used at the Riksbank. The shocks that primarily explain the recent upturn are studied here. The results suggest that the weak krona has contributed to the rise in inflation. Economic developments abroad have not weighed down inflation as much as in previous years. However, it is not as evident, according to the models that domestic factors have driven up inflation.

In this study, the Riksbank's forecasts are studied for the period 2007–2017 as well as specifically for 2017. The evaluation of the longer period, 2007–2017, shows that the forecasters included in the study have overestimated GDP growth in Sweden. At the same time, the Riksbank and other forecasters have systematically overestimated inflationary pressures in the Swedish economy. There are some differences in accuracy among the various analysts, but they are small. Growth abroad has also been overestimated by all analysts during the period. With a few exceptions, the same also applies to inflation in the euro area.

Just as with the longer period, the Riksbank has produced good forecasts of unemployment in Sweden in 2017. The Riksbank has also succeeded better with the forecasts for CPI and CPIF inflation in 2017, compared with the longer time period. The evaluation also shows that the Riksbank's very short-term inflation forecasts, for the months immediately ahead, are just as good as or slightly better than many other forecasters.

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Appendix: Measuring accuracy

Let x_t be an outcome for 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 forecasting error $\varepsilon_{it,h}$ is then given by

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

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

$$MAF_t = \frac{\sum \varepsilon_i}{n_i}, \quad (2)$$

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 performance, or how accurate various forecasters have been.

In practice, forecasters publish their forecasts at different points in time. If forecast horizon *h* differs among forecasters, it also means that the forecasters have access to different volumes of information when drafting 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, has a low *h* on average, and should therefore 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 forecasting 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

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

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 performance when individual years ,*c*, are evaluated. 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 forecasting error that the equation is not able to capture. It is assumed to be randomly allocated, with the mean value of zero and constant variance.

The annual growth rate 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 also have different weights in terms of annual growth.[32] Det här viktschemat används för att konstruera $M_{it,h}$ in equation (3). The volume of information possessed by forecaster *i* in the publication month is here approximated by the accumulated weight up to a certain month, $W_{it,h}$. The weight increases, the closer one is in time to the definitive outcome. 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 in equation (3) captures the marginal effect on the forecasting error of having access to less information, and the effect is allowed to vary over time.

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

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

$$\mu^*_{i,t=c} = \hat{\mu}_{i,t=c} + \hat{\mu}_i - \frac{1}{n}\sum_j \left(\hat{\mu}_{j,t=c} + \hat{\mu}_j\right). \qquad (5)$$

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.

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