

Box 5

The Central Bank of Iceland forecasting record

Economic developments often diverge from forecasts. The forecasts in *Monetary Bulletin* are based on models that present a simplified view of the economy. The equations in the model describe the economic relationships that are most important; however, it is inevitable that they will omit many other less significant. When forecasts are prepared, they must be based on preliminary figures for the recent past, data that in some instances will not be available in their final form until several years later. Furthermore, forecasts are based to a degree on forecasters' assessments, which can also give rise to errors. Moreover, unforeseen developments that are impossible to forecast can always occur. Studying past forecast errors helps to identify the uncertainties in future forecasts and possible structural changes in the economy. In addition, it can be useful in further developing macroeconomic models, using them for forecast preparation, and improving the procedures used for analysis and forecast presentation.

Forecasts of the real economy and inflation

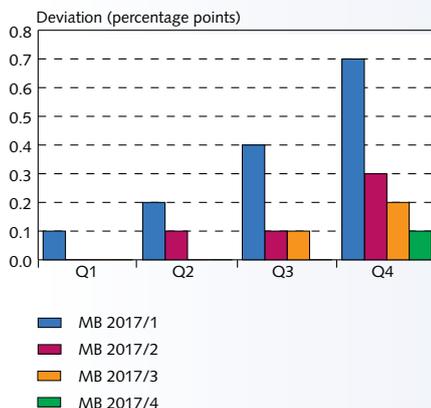
The Central Bank's macroeconomic and inflation forecasts are prepared four times a year over a horizon of three years and are published in its *Monetary Bulletin*. Each forecast is based on a detailed analysis of the current state of the economy. The assumptions concerning global economic developments are based, among other things, on forecasts from international institutions and the information implied by key commodity futures. The national accounts are the primary source of data on the domestic economy. In addition, Bank staff prepare an independent assessment of the state of the economy through surveys; discussions with corporate executives, directors of institutes, and labour market partners; and statistical analysis of data on key variables. The Central Bank's quarterly macroeconomic model (QMM) is the tool used to manage this information. Some of the equations in the model are accounting equations, while others are behavioural equations that are estimated using econometric methods. However, the Bank's forecast – particularly for the recent past and immediate future – is determined not least by staff assessments, various simple statistical models, and a variety of information not included in QMM. The Bank's dynamic stochastic general equilibrium (DSGE) model, DYNIMO, also plays an important role in forecast preparation, not least as a cross-check on the baseline forecast (see Box 3 in *Monetary Bulletin* 2017/4).

Monetary policy performance during the forecast horizon is a key factor in the preparation of each forecast. In QMM, monetary policy is set with a forward-looking monetary policy rule wherein Central Bank interest rates are determined by the expected deviation of inflation from the inflation target and the current output gap. This rule ensures that the Bank's interest rates bring inflation back to target by the end of the forecast horizon. The monetary policy rule in the model was selected so as to minimise the sacrifice cost in ensuring that inflation is at target.¹

Central Bank inflation forecasts for 2017

Inflation rose slightly year-on-year in 2017, averaging 1.8% for the year, up from 1.7% in 2016. It was the fourth year in a row with below-target inflation. Inflation excluding indirect tax effects was slightly lower, at 1.5%. Rising house prices were the main

Chart 1
Inflation forecasting errors in *Monetary Bulletin* in 2017



Source: Central Bank of Iceland.

1. See Ásgeir Daniélsson, Bjarni G. Einarsson, Magnús F. Guðmundsson, Svava J. Haraldsdóttir, Thórarinn G. Pétursson, Signý Sigmundardóttir, Jósef Sigurdsson, and Rósa Sveinsdóttir (2015), "QMM: A quarterly macroeconomic model of the Icelandic economy - version 3.0, Central Bank of Iceland, Working Paper no. 71, http://www.sedlabanki.is/library/Skraarsafn---EN/Working-Papers/WP_71_net_nytt.pdf.

driver of inflation during the year, albeit offset to a large degree by lower imported goods prices. Chart 1 and Table 1 illustrate the forecasting record for inflation forecasts within the year. The Bank's baseline forecast assumed that inflation would be higher in 2017 than proved to be the case, particularly the first forecast of the year. To some extent, this is attributable to stronger-than-expected pass-through from the appreciation of the króna to imported goods prices early in the year. The February forecast also assumed that oil prices would rise more than they ultimately did. As Chart 2 indicates, the Bank's forecasting errors at the beginning of 2017 were well within the 50% confidence interval of the forecast.

Table 1 Inflation forecast for 2017

Year-on-year change (%)	Monetary Bulletin				Final result
	2017/1	2017/2	2017/3	2017/4	
Inflation	2.1	1.9	1.8	1.8	1.8
Inflation excl. indirect tax effects	1.9	1.7	1.6	1.5	1.5

Errors in inflation forecasts over longer periods

Chart 3 shows developments in errors in Central Bank inflation forecasts one, four, and eight quarters ahead, from Q2/2001 through Q3/2018. Forecasts two years ahead have been published since March 2001, when the inflation target was adopted. Inflation forecasts one quarter ahead showed no tendency towards either over- or underestimating inflation. Forecasting errors can generally be expected to increase as forecasts extend further ahead in time, and one- and two-year forecasts tend to underestimate rather than overestimate the level of inflation. The errors were greatest for 2008 and 2009, when inflation was significantly underestimated, owing largely to the steep depreciation of the króna during the financial crisis. The chart also shows that forecasts during the period 2001-2013 had a tendency to underestimate inflation, whereas overestimation became more common in 2014 and thereafter.

Table 2 shows the mean deviation (which gives an indication of whether inflation is being systematically over- or underestimated) and the root mean square error (RMSE, which shows the uncertainty in the forecast) since the Bank began publishing inflation forecasts. Because the errors were greatest for 2008 and 2009, the table also reports the mean deviation and the RMSE of the forecasts, excluding those years.²

Table 2 Forecast errors in Central Bank of Iceland inflation forecasts¹

%	One quarter	Two quarters	Three quarters	Four quarters	Eight quarters	Twelve quarters
No. of measurements	67 (63)	66 (63)	65 (62)	64 (62)	60 (57)	34 (33)
Mean forecast error (%)	0.0 (0.0)	0.0 (0.0)	-0.4 (-0.1)	-0.8 (-0.5)	-1.3 (-0.7)	-0.4 (-0.2)
RMSE (%)	0.6 (0.3)	1.4 (1.0)	2.1 (1.6)	2.4 (2.0)	3.4 (2.2)	1.8 (1.6)

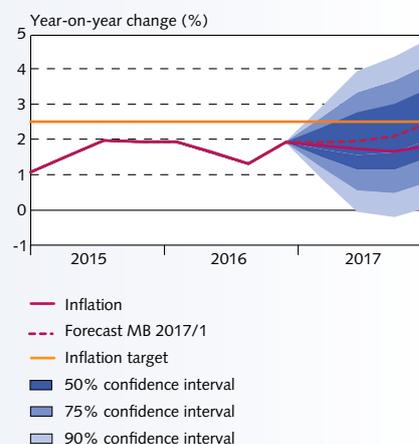
1. Forecast errors from Q2/2001 through Q3/2018. Figures in parentheses represent the same period, excluding 2008 and 2009.

Inflation was underestimated three to twelve quarters ahead during the period. The underestimation in forecasts up to three quarters ahead is minor and not statistically significant, but for the forecasts four and eight quarters ahead, it is statistically significant. For forecasts two years ahead, the underestimation totals 1.3

2. There are fewer measurements for inflation forecasts three years ahead because the Central Bank did not begin to publish forecasts with a three-year horizon until 2007.

Chart 2

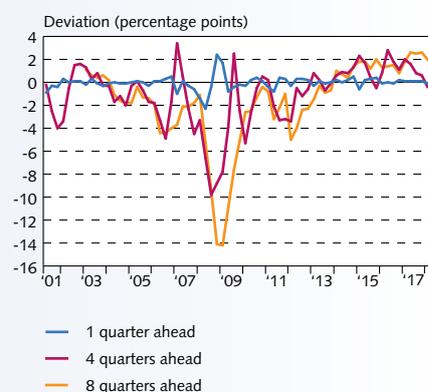
Inflation forecast and confidence intervals
Monetary Bulletin 2017/1
Q1/2015 - Q4/2017



Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3

Inflation forecasting errors in *Monetary Bulletin*¹
Q2/2001 - Q3/2018



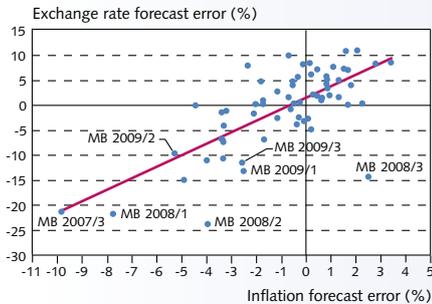
1. First quarter is the quarter in which the report is published or the first quarter forecasted; Four quarters ahead is three quarters after the report has been published; Eight quarters ahead is seven quarters after the report has been published.

Source: Central Bank of Iceland.

Chart 4

Inflation forecasting errors in *Monetary Bulletin* and deviation of average exchange rate from forecast 2001-2017

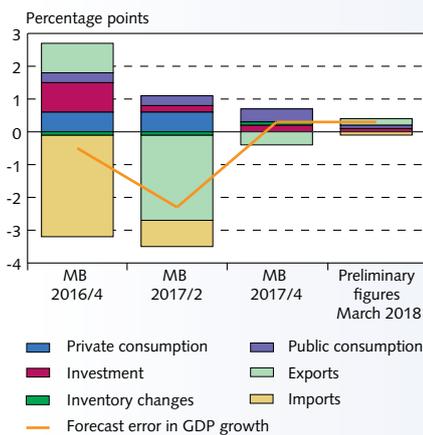
Forecast one year ahead



Source: Central Bank of Iceland.

Chart 5

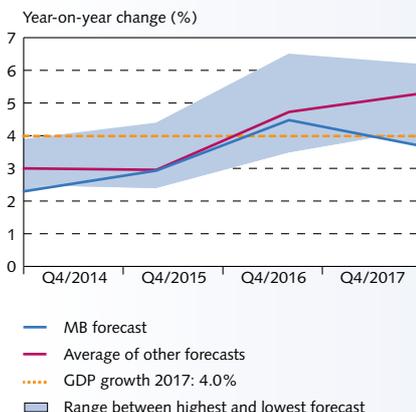
Contribution of expenditure items to forecast errors in GDP growth 2017¹



1. Based on real figures in September 2018.
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 6

GDP growth forecast for 2017



Sources: Arion Bank, European Commission, Icelandic Confederation of Labour, IMF, Íslandsbanki, Landsbankinn, Statistics Iceland, Central Bank of Iceland.

percentage points. There was no significant bias in the three-year forecasts, however.

It should be borne in mind that the Bank did not begin using its quarterly macroeconomic model (QMM) until the beginning of 2006, and it prepared no forecasts of the exchange rate or Central Bank interest rates before 2007.³ From the introduction of the capital controls through the forecast in *Monetary Bulletin* 2016/4, the Bank's macroeconomic and inflation forecasts were also based on the technical assumption that the exchange rate of the króna would remain unchanged throughout the forecast horizon. Experience shows that large errors in inflation forecasts in Iceland are usually related to exchange rate volatility (Chart 4), as the correlation between the numerical errors in inflation and exchange rate forecasts is 0.72. Chart 4 also shows that inflation was generally underestimated in those instances when the króna turned out weaker than the forecast had assumed. This is particularly the case for forecasts prepared during the wake of the financial crisis. However, in the instances when the króna proved stronger than the forecast had assumed, inflation was usually overestimated.

Central Bank GDP growth forecasts for 2017

In order to obtain a clearer view of the Central Bank's success in inflation forecasting, it is necessary to examine its success in forecasting developments in the real economy. It is likely that inflation will generally be underestimated during periods when demand pressures or growth in demand is also underestimated.

Statistics Iceland publishes preliminary national accounts figures for each quarter about two months after each quarter-end. The first estimates for Q4/2017 and the full year 2017 were published in March 2018, and revised figures were published in September. The *Monetary Bulletin* forecasts and Statistics Iceland's estimates of changes in key macroeconomic variables from the previous year can be seen in Table 3. In February 2017, when *Monetary Bulletin* 2017/1 was published, Statistics Iceland's preliminary national accounts figures were available only for Q3/2016. As a result, the Bank had to base its forecast for 2017 on the forecast for Q4/2016. In addition, the forecast was based on historical figures that would subsequently change.

Table 3 *Monetary Bulletin* macroeconomic forecasts and Statistics Iceland data for 2017

	MB 17/1 (forecast from Q4/'16)	MB 17/2 (forecast from Q1/'17)	MB 17/3 (forecast from Q2/'17)	MB 17/4 (forecast from Q3/'17)	MB 18/1 (forecast from Q4/'17)	Pre- liminary figures (March 2018)	Revised figures (Sept. 2018)
% change form prior year							
Private consumption	6.8	6.7	7.1	7.9	7.5	7.8	7.9
Public consumption	1.5	1.6	1.6	1.5	2.7	2.6	3.1
Investment	9.2	8.6	9.2	8.8	9.0	9.3	9.5
Domestic demand	5.8	5.9	6.5	6.3	7.0	6.8	7.0
Exports	6.2	10.5	8.7	6.1	3.2	4.8	5.5
Imports	7.4	10.2	11.9	12.2	11.0	11.9	12.5
GDP growth	5.3	6.3	5.2	3.7	3.4	3.6	4.0

Statistics Iceland's figures for 2017 changed between the publication of the preliminary numbers in March 2018 and the revision in September. Growth in domestic demand was underestimated in the preliminary figures, owing mainly to a 0.5-point underestima-

3. See Ólafsson, T. T. (2007), "Publication of its own policy rate path boosts the effectiveness of central bank monetary policy", *Monetary Bulletin* 2007/1, pp. 71-86.

tion of public consumption growth. Both import growth and export were underestimated by roughly the same amount, and therefore these underestimations had little impact on the GDP growth figure for the year. GDP growth according to Statistics Iceland's September figures was therefore 4.0%, or 0.4 percentage points more than in the March figures.

GDP growth for the year turned out weaker than had been projected earlier on. The forecast error amounted to 1.3 percentage points in the forecast in *Monetary Bulletin* 2017/1 and 1 percentage point more in *Monetary Bulletin* 2017/2, but beginning with the August issue, the deviation has been relatively small. As can be seen in Table 3 and Chart 5, the overestimation of GDP growth in *Monetary Bulletin* 2017/2 is due predominantly to an overestimation of the outlook for export growth, although it was offset to a degree by an underestimation of domestic demand growth. The underestimation of domestic demand was due to an underestimation of growth in consumption spending by households and the public sector. However, the deviation in the forecasts of investment growth were relatively small, which is unusual, as investment is the national accounts item that tends to be most volatile and changes the most upon revision.

Central Bank forecasts in comparison with other forecasters' projections

Chart 6 gives a comparison of the Central Bank's output growth forecasts for 2017 and the average of projections from others that publish regular forecasts concerning the Icelandic economy. All of the forecasts were prepared in the fourth quarter of the years 2014-2017, and the mean is calculated from each year's last forecast as prepared by seven forecasters: the International Monetary Fund (IMF), the Icelandic Federation of Labour (ASÍ), the three large commercial banks, Statistics Iceland, and the European Commission.⁴ The range between the highest and lowest forecast values is indicated by the shaded area. In general, it widens during periods of marked uncertainty. Other things being equal, economic forecasts should become more consistent with one another as the period covered by the forecast approaches and more detailed information becomes available.

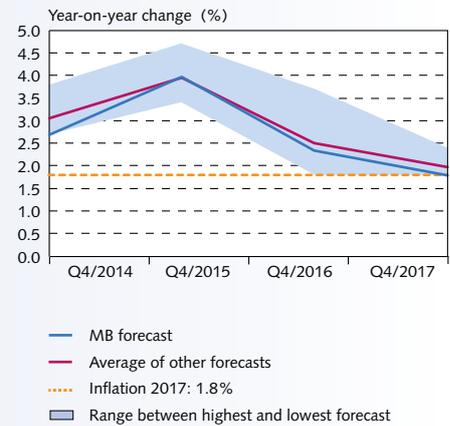
Overall, the forecasts in *Monetary Bulletin* accord well with the average from other forecasters, although the Bank's GDP growth forecasts were closer to the ultimate outcome for 2017 than the other forecasters' average. Chart 7 gives a comparison of the inflation forecasts for 2017, prepared by the Bank and the other forecasters. The Bank's inflation forecasts have generally been more accurate than those from other forecasters in recent years, and this applies to 2017 as well.

The Central Bank's 2017 forecasts in international comparison

It can be useful to examine the Bank's forecasts in international context. In recent years, the general tendency has been to overestimate inflation among advanced economies; however, this trend turned around in some economies, such as New Zealand and Sweden, in 2017 (Chart 8). In Iceland, however, inflation was overestimated, in part due to stronger-than-expected pass-through from the appreciation of the króna to imported goods prices, as is discussed above. The deviation was similar to that, for instance, in Norway.

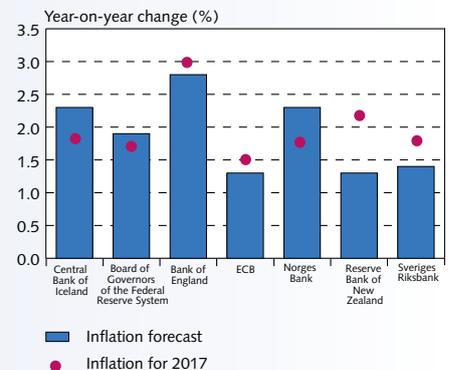
4. Not all of these forecasters prepare forecasts over a horizon of three years; therefore, the 2014 value in Chart 7 is based only on the forecasts from the IMF, Arion Bank, Statistics Iceland, and Landsbankinn. This explains in part why the high-low range is smaller in 2014 than in 2015.

Chart 7
Inflation forecasts for 2017



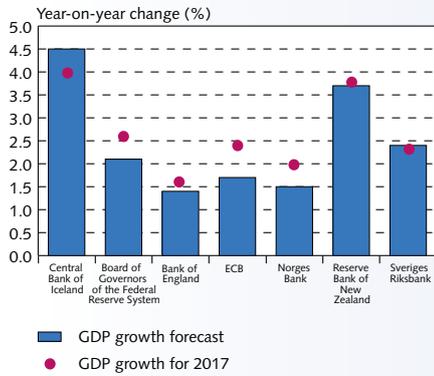
Sources: Arion Bank, European Commission, Icelandic Confederation of Labour, IMF, Islandsbanki, Landsbankinn, Statistics Iceland, Central Bank of Iceland.

Chart 8
Inflation forecasts for 2017 in advanced economies¹



1. Forecasts made in end of 2016 except the Fed's was made in June 2016. Bank of England's projection is Q4 four-quarter CPI inflation. Sources: Bank of England, Board of Governors of the Federal Reserve System, ECB, Norges Bank, Reserve Bank of New Zealand, Sveriges Riksbank, Thomson Reuters, Central Bank of Iceland.

Chart 9
GDP growth forecasts for 2017 in advanced economies¹



1. Forecasts made in end of 2016 except the Fed's, which was made in June 2016.

Sources: Bank of England, Board of Governors of the Federal Reserve System, ECB, Norges Bank, Reserve Bank of New Zealand, Sveriges Riksbank, Thomson Reuters, Central Bank of Iceland.

Chart 9 gives the same type of comparison of GDP growth forecasts. In most countries, GDP growth for 2017 turned out underestimated, whereas for Iceland it was overestimated, as is discussed above. The size of the deviation does not stand out in international context.