Box 6

The Central Bank of Iceland forecasting record

Economic developments often diverge in some respect from forecasts. The macroeconomic 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 others 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, the data may be subject to measurement errors, and there are always unforeseen developments that are impossible to forecast. Studying errors in previous forecasts helps to identify the uncertainties in new forecasts and 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

Four times a year, the Central Bank prepares forecasts for the real economy and inflation covering a forecast horizon of three years. The forecasts are 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, institutional directors, and labour market institutes; and statistical analysis of developments in 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 DSGE model is also used in the forecasting exercise, not least as a cross-check on the baseline forecast (see Box 3).

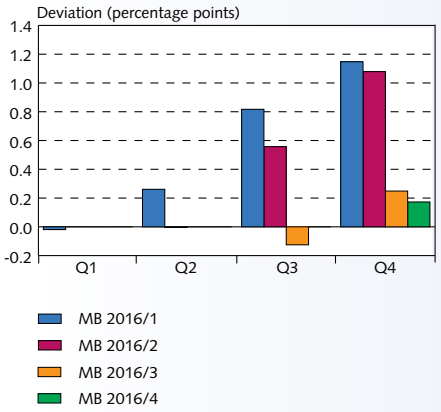
Monetary policy performance during the forecast horizon is a key factor in the preparation of each forecast. In QMM, monetary policy is set with a forward-looking monetary policy rule wherein Central Bank interest rates are determined by the expected deviation of inflation from the inflation target and 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 2016

Inflation rose slightly year-on-year in 2016, averaging 1.7% for the year, up from 1.6% in 2015. This was the third year of below-target inflation. Inflation excluding indirect tax effects also measured 1.7%. As has been discussed in previous issues of *Monetary Bulletin*, year-2016 inflation was driven mainly by rising house

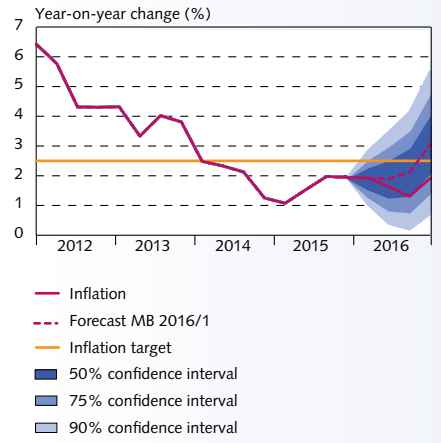
1. See Daníelsson, Á., B. G. Einarsson, M. F. Gudmundsson, S. J. Haraldsdóttir, T. G. Pétursson, S. Sigmundardóttir, J. Sigurdsson, and R. Sveinsdóttir (2015), "QMM: A quarterly macroeconomic model of the Icelandic economy – Version 3.0", Central Bank of Iceland, *Working Paper* no. 71. The most recent version of the handbook for the model can be found here: http://www.sedlabanki.is/library/Skraarsafn---EN/Working-Papers/WP_71_net_nytt.pdf.

Chart 1
Inflation forecasting errors in *Monetary Bulletin* in 2016



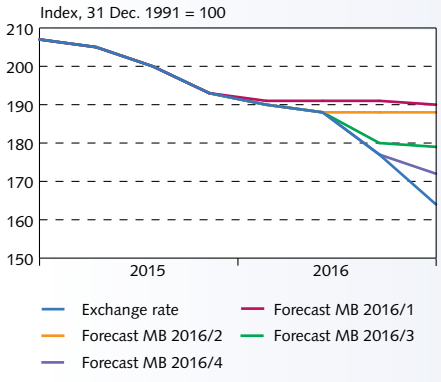
Source: Central Bank of Iceland.

Chart 2
Inflation forecast and confidence intervals, *Monetary Bulletin* 2016/1
Q1/2012 - Q4/2016



Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3
Exchange rate forecasts in *Monetary Bulletin* 2016[1]



1. Narrow trade basket.
Source: Central Bank of Iceland.

prices, with the appreciation of the króna and low global inflation pulling in the opposite direction.

Chart 1 illustrates the forecasting record for the inflation forecasts within the year. The forecast in *Monetary Bulletin* in the first half of the year assumed that inflation would be higher in 2016 than proved to be the case. That forecast assumed that when the effects of the steep decline in import prices tapered off, inflation would rise concurrent with a widening output gap and large wage rises. As the year progressed, however, it became clear that the effects of imported deflation would be more persistent than previously thought; furthermore, the króna appreciated much more than previous forecasts had assumed. This can also be seen in Table 1, which shows that average inflation for the year was overpredicted at the beginning of the year, whereas the forecast in *Monetary Bulletin* 2016/3 proved accurate. Part of the forecasting error for 2016 was due to Statistics Iceland's error in calculating the CPI. Because of this, the rise in imputed rent in March was not included in the CPI calculation for that month but was included in the April calculation instead. The imputed rent component was therefore included in the CPI with a one-month time lag. Statistics Iceland discovered the error in September and corrected it by basing the September CPI calculation on the rise in imputed rent in both August and September. Inflation was therefore underestimated by 0.1-0.3 percentage points for the period from March through August, affecting Q3 figures the most. The Bank's overestimation of 2016 inflation would have been smaller had Statistics Iceland's error not occurred.

Table 1 Inflation forecast for 2016

	Monetary Bulletin				*Final*
Year-on-year change (%)	*2016/1*	*2016/2*	*2016/3*	*2016/4*	*result*
Inflation	2.3	2.1	1.7	1.7	1.7
Underlying inflation (excluding indirect tax effects)	2.2	2.1	1.7	1.7	1.7

Chart 2 shows the confidence interval for the inflation forecast in *Monetary Bulletin* 2016/1, together with actual inflation. At that time, the risks to the forecast were considered skewed to the upside, owing to recently finalised wage settlements and stimulative Government measures that could potentially have stronger demand-side effects than was assumed in the baseline forecast. However, it was also considered possible that inflation could be overestimated and could turn out lower than in the baseline forecast if the global economic outlook were to deteriorate still further, for instance, or if the króna should appreciate and firms' capacity to absorb cost increases were greater. This indeed turned out to be the case: the króna appreciated more than the forecast in *Monetary Bulletin* had assumed (Chart 3), offsetting the factors that could have led to an underprediction. As can be seen, inflation was within the 50% probability distribution of the forecast for most of the period. In other words, the developments in inflation over the course of 2016 had been deemed relatively likely at the beginning of the year.

Errors in inflation forecasts over longer periods

Chart 4 shows developments in errors in Central Bank inflation forecasts one, four, and eight quarters ahead, from Q1/2001 through Q3/2017. Forecasts two years ahead have been published since March 2001, when the inflation target was adopted. Inflation forecasts for the first quarter of the forecast horizon showed no tendency towards either over- or underpredicting. Forecasting errors can generally be expected to increase as forecasts extend further

ahead in time. One- and two-year forecasts tend to be underestimated rather than overestimated. 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. Inflation forecasts during the period 2001-2013 underestimated inflation more often than they overestimated it. A change occurred in 2014, when overprediction became more common, partly due to lower oil prices, global deflation, and the appreciation of the króna.

Table 2 shows the mean deviation (which gives an indication of whether inflation is being systematically over- or underpredicted) and the root mean square error (RSME, which shows the uncertainty in the forecast) since the Bank began publishing inflation forecasts two years ahead. In March 2007, the Bank began publishing forecasts three years ahead. As is discussed above, the error was greatest for 2008 and 2009. Table 2 omits the forecasts carried out for those two years. According to the table, inflation was still underestimated three to twelve quarters ahead during this period. The underestimation in the forecasts three quarters ahead is too small to be statistically significant, but for the forecasts four and eight quarters ahead it is statistically significant and measures nearly 1 percentage point in the forecasts eight quarters ahead. There was no significant bias in the three-year forecasts, however.

Table 2 Central Bank of Iceland inflation forecast errors since Q2/2001

	One quarter	*Two quarters*	*Three quarters*	*Four quarters*	*Eight quarters*	*Twelve quarters*
No. of measurements	59	59	58	56	53	29
Mean forecast error (%)	0.0	0.0	-0.1	-0.5	-0.9	-0.3
RMSE (%)	0.3	1.1	1.7	2.0	2.1	1.7

It should also 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.[2] From the introduction of the capital controls and up to the *Monetary Bulletin* 2016/4 forecast, the Bank's macroeconomic and inflation forecasts had also been 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 5), as the correlation between the forecast errors for inflation and the exchange rate is 0.73. The chart shows that inflation was 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 financial crisis. In the instances when the króna proved stronger than the forecast had assumed, inflation was usually overpredicted. This applies in particular to 2016, when a large portion of the inflation forecasting errors can be traced to underestimation of the exchange rate, as is discussed above.

Central Bank GDP growth forecasts for 2016

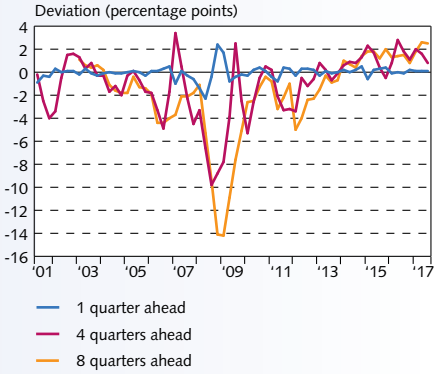
In order to obtain a clearer view of the Central Bank's success in inflation forecasting, it is necessary to examine its success in fore-

2. 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.

Chart 4

Inflation forecasting errors in *Monetary Bulletin*[1]

Q2/2001 - Q3/2017



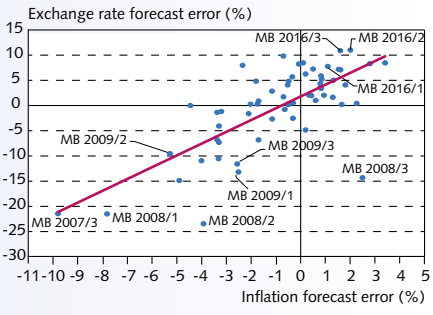
1. The first quarter is the quarter in which the report is published or the first quarter forecasted; 4 quarters ahead is three quarters after the report has been published; 8 quarters ahead is seven quarters after the report has been published.

Source: Central Bank of Iceland.

Chart 5

Inflation forecasting errors in *Monetary Bulletin* and deviation of average exchange rate from forecast 2001-2016

Forecast one year ahead



Source: Central Bank of Iceland.

casting developments in the real economy. It is likely that inflation will be underpredicted during periods when demand pressures or growth in demand is also underestimated.

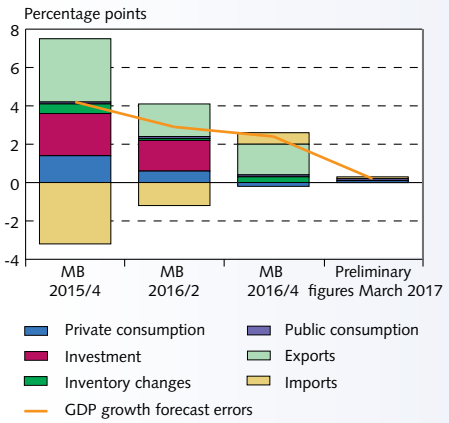
Statistics Iceland publishes preliminary national accounts figures for each quarter about two months after each quarter-end. The first estimates for Q4/2016 and the full year 2016 were published in March 2017, and revised figures were published in September. The *Monetary Bulletin* forecasts and Statistics Iceland's estimates of changes in key macroeconomic variables from the previous year can be seen in Table 3. In February 2016, when *Monetary Bulletin* 2016/1 was published, Statistics Iceland's preliminary national accounts figures were available only for Q3/2015. As a result, the Bank had to base its forecast for 2016 on the forecast for Q4/2015.

Statistics Iceland's figures for 2016 changed between the publication of the preliminary numbers in March 2017 and the revision in September. Domestic demand was underestimated in the preliminary figures; in particular, private consumption was underestimated by 0.2 percentage points, and the annual growth rate is at its highest since 2005. Alongside the release of the national accounts in September, the methodology used to calculate private consumption was revised, which generally entailed an increase in previous private consumption figures. Exports and imports were overestimated but tended to offset one another and therefore had little impact on the GDP growth figure for the year. GDP growth, according to Statistics Iceland's September figures, was therefore 7.4%, or 0.2 percentage points more than in the March figures.

Table 3 *Monetary Bulletin* macroeconomic forecasts and Statistics Iceland data for 2016

Forecast horizon from: *% change from prior year*	*2015/4* *MB 2016/1*	*2016/1* *MB 2016/2*	*2016/2* *MB 2016/3*	*2016/3* *MB 2016/4*	*2016/4* *MB 2017/1*	*Preliminary figures (March 2017)*	*Revised figures (Sept. 2017)*
Private consumption	5.3	6.0	6.7	7.6	6.2	6.9	7.1
Public consumption	1.4	1.5	1.4	1.6	1.2	1.5	1.9
Investment	12.4	14.1	18.2	22.5	23.2	22.7	22.8
Domestic demand	5.2	6.3	7.7	8.7	8.4	8.7	8.9
Exports	6.4	7.6	8.6	7.8	10.2	11.1	10.9
Imports	8.7	11.7	14.6	15.7	15.5	14.7	14.5
GDP growth	4.2	4.5	4.9	5.0	6.0	7.2	7.4

Chart 6
Contribution of expenditure items to forecast errors in GDP growth 2016[1]



1. Based on real figures in September 2017.
Sources: Statistics Iceland, Central Bank of Iceland.

GDP growth for the year turned out much stronger than had been forecast, as the GDP growth forecast was revised upwards in each *Monetary Bulletin* published in 2016. This substantial underestimation is due for the most part to exports, as the number of tourists visiting Iceland turned out far greater than previously projected. Pulling in the other direction were imports, which were underpredicted in the February and May 2016 issues of *Monetary Bulletin*. The GDP growth forecast in *Monetary Bulletin* 2016/1 was 3.2 percentage points below the actual outcome. This underprediction grew smaller as the year progressed: GDP growth was underestimated by 1.4 percentage points in *Monetary Bulletin* 2017/1, which was based on preliminary data for Q3/2016. Chart 6 illustrates how errors in forecasts of expenditure items explain the errors in the GDP growth forecasts for the year.

Private consumption growth, which was especially strong in 2016, was underestimated except in *Monetary Bulletin* 2016/4. The public consumption growth forecast in *Monetary Bulletin* was broadly in line with Statistics Iceland's preliminary figures, but when

the national accounts were revised in September, public consumption was revised upwards by 0.4 percentage points. It is unsurprising that the forecast error for investment was largest among the national accounts items. Investment is the most volatile national accounts component and the one that changes most upon revision.

Apart from investment, the largest error was in the forecast of external trade. In *Monetary Bulletin* 2015/4, both exports and imports were underpredicted. The errors were similar in size, however, and therefore had limited overall impact on the GDP growth forecast error. In *Monetary Bulletin* 2016/2, the underprediction of exports was larger than that of imports. This led to an underestimation in the GDP growth forecast over and above that attributable to domestic demand. In *Monetary Bulletin* 2016/4, however, exports were underpredicted, while the forecast for imports proved too optimistic. This explains nearly the entire error in that GDP growth forecast, as the forecast of domestic demand was quite accurate.

Central Bank forecasts over longer periods in comparison with other forecasters' projections

Chart 7 gives a comparison of the Central Bank's output growth forecasts for 2016 and the average of projections from others that publish regular forecasts concerning the Icelandic economy. The Bank's forecasts were all prepared in the fourth quarter of the year during the period 2013-2016, and the mean is calculated from each year's last forecast as prepared by the International Monetary Fund (IMF), Icelandic Federation of Labour, the three large commercial banks, Statistics Iceland, and the European Commission.[3] 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 period covered by the forecast approaches and more information becomes available.

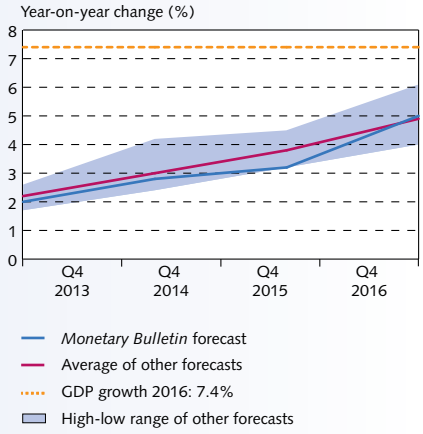
The forecasts in *Monetary Bulletin* accord well with the average from other forecasters, as all of them underpredicted GDP growth for the year. The errors in the Bank's forecasts were close to the average for the other forecasters, and the progression in the forecasts is broadly similar as well. However, the average for the other forecasters at the end of 2016 was 2.5 percentage points below actual GDP growth for the year.

Chart 8 gives the same comparison of inflation forecasts. The Central Bank's long-term inflation forecasts have a tendency to outperform other forecasters' projections. This has been the case in recent years, and 2016 was no exception: the Bank's forecasts are closer to the actual outcome than other forecasters' projections for the entire period.

The Central Bank's 2016 forecasts in international comparison

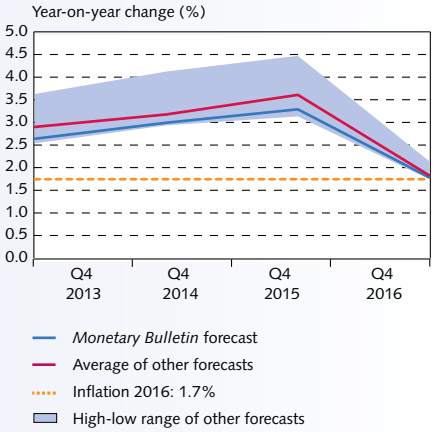
It can be useful to examine the Bank's forecasts in international context. Inflation has been very low for a long time in advanced economies, and it has remained so even though the global economic recovery has gained momentum. Overpredicting inflation has therefore had forecasters in a quandary for some time.[4] As

Chart 7
GDP growth forecast for 2016



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

Chart 8
Inflation forecast for 2016



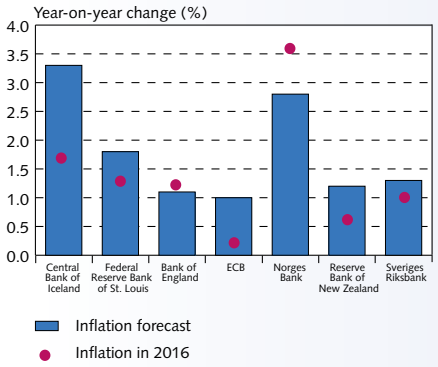
Sources: Arion Bank, European Commission, Icelandic Confederation of Labour, IMF, Íslandsbanki, Landsbankinn, Statistics Iceland, Central Bank of Iceland.

3. Not all of these forecasters prepare forecasts over a horizon of three years; therefore, the 2013 value in Chart 7 is based only on the forecasts from the IMF, Statistics Iceland, and Landsbankinn. This explains in part why the high-low range is smaller in 2013 than in 2014.

4. See, for example, International Monetary Fund, *World Economic Outlook*: "The dog that didn't bark: has inflation been muzzled or was it just sleeping" (April 2013, Chapter 3) and "Global disinflation in an era of constrained monetary policy" (October 2016, Chapter 3).

Chart 9

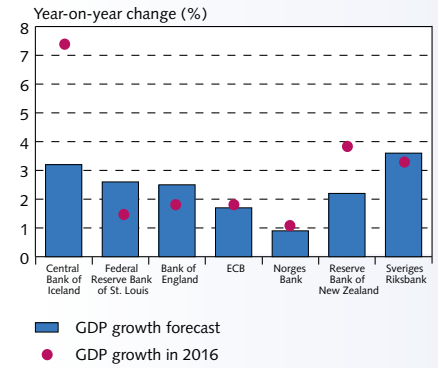
Inflation forecasts for 2016 in selected advanced economies[1]



1. Forecasts prepared at the end of 2015, apart from the Federal Reserve Bank forecast, which was prepared in July 2015. Bank of England forecast of year-on-year inflation in Q4.
Sources: Bank of England, ECB, Federal Reserve Bank of St. Louis, Norges Bank, Reserve Bank of New Zealand, Sveriges Riksbank, Thomson Reuters, Central Bank of Iceland.

Chart 10

2016 GDP growth forecasts for selected advanced economies[1]



1. Forecasts prepared at the end of 2015, apart from the Federal Reserve Bank forecast, which was prepared in July 2015.
Sources: Bank of England, ECB, Federal Reserve Bank of St. Louis, Norges Bank, Reserve Bank of New Zealand, Sveriges Riksbank, Thomson Reuters, Central Bank of Iceland.

Chart 9 indicates, year-2016 inflation turned out lower than had been forecast in most developed countries at the end of 2015. In the UK and Norway, it turned out higher, but this was due in part to a depreciation of both currencies. The Central Bank's overprediction was larger than that in other countries, mainly because of the unforeseen strong appreciation of the króna during the period, as is discussed above.

Chart 10 gives the same type of comparison of GDP growth forecasts. Year-2016 GDP growth was overestimated in the US, Sweden, and the UK but underpredicted in the other countries. The underestimation in Iceland was much greater than in the comparison countries, owing to the unusually strong positive shocks that affected the economy; i.e., the marked improvement in terms of trade and the enormous growth of the tourism sector.