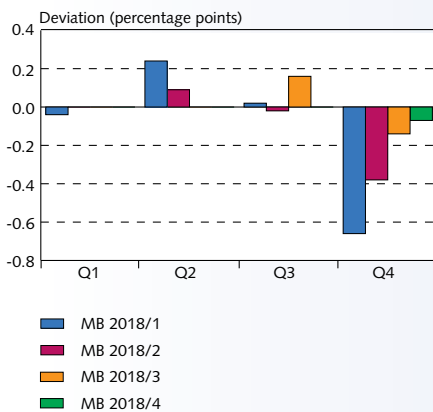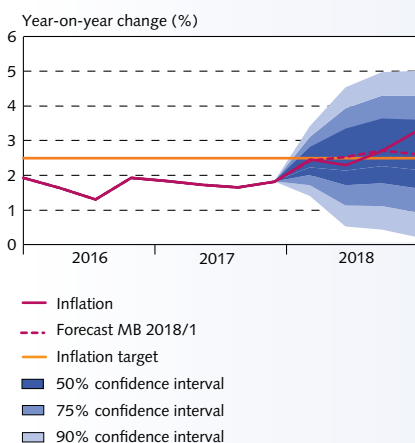Box 4

The Central Bank of Iceland forecasting record

Chart 1

Inflation forecasting errors in *Monetary Bulletin* 2018

Source: Central Bank of Iceland.

Chart 2

Inflation forecast and confidence intervals
Monetary Bulletin 2018/1
Q1/2016 - Q4/2018

Sources: Statistics Iceland, Central Bank of Iceland.

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*. The forecasts are based on models that present a simplified view of the economy: the equations of the models describe the economic relationships that are most important, while those less significant are inevitably omitted.

Underlying each forecast is an in-depth analysis of the current state of the economy. National accounts and other official statistics provide the primary basis for the analysis, but in addition, experts from the Bank's Economics and Monetary Policy Department prepare an independent assessment of economic developments and prospects based on surveys and discussions with corporate executives, directors of institutes, and labour market partners, as well as other sources. The assumptions concerning global economic developments are based primarily on forecasts from international institutions and the information implied by commodity futures. The Central Bank's quarterly macroeconomic model (QMM) is the tool used to manage this information and ensure that the forecast does not neglect to take into account the interactions between various types of information. The Bank's dynamic stochastic general equilibrium (DSGE) model, DYNIMO, also plays an important role in forecast preparation, not least as a cross-check of the baseline forecast (see Box 3 in *Monetary Bulletin* 2017/4). Monetary policy performance over 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 inflation will be close to target by the end of the forecast horizon.[1]

Economic developments often diverge from forecasts. The simplified view of the economy presented by models can give rise to forecasting errors, although errors can occur for other reasons. For example, forecasts are based in part on preliminary figures and estimates that may change upon review. In addition, unforeseeable events that strongly affect economic variables – such as oil price shocks – could take place. Because studying past forecast errors helps to identify uncertainties in the new forecast and possible structural changes in the economy, the Bank evaluates its forecasting record once a year. This evaluation is also useful in further developing the Bank's macroeconomic models.

The Bank's inflation forecasts for 2018

Inflation increased to an average of 2.7% in 2018, up from 1.8% in the previous year. The 2018 average was therefore marginally above the Bank's inflation target after four years of below-target inflation. Inflation excluding indirect tax effects was slightly lower, at 2.6%. As has been discussed in previous issues of *Monetary Bulletin*, the main driver of inflation in 2018 was the rise in house prices, as had been the case in previous years, although higher imported goods prices played a role as well. Inflation measured 2.4% in January 2018 and then rose over the course of the year, to 3.7% by December. The rise in inflation primarily reflected the depreciation of the króna by more than 10% that autumn, itself a result of mounting concerns about the position of airline WOW Air and substantial uncertainty about upcoming wage negotiations and the state of the economy more generally.

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1. See Daníelsson, Á., L. Elíasson, M. F. Gudmundsson, S. J. Haraldsdóttir, L. S. Kro, T. G. Pétursson, and T. S. Sveinsson (2019), "QMM: A quarterly macroeconomic model of the Icelandic economy – Version 4.0", Central Bank of Iceland *Working Paper*, forthcoming.

The Bank's forecasts of average inflation in 2018 were well in line with the final outcome for the year (Table 1). As Chart 1 shows, the Bank's baseline forecast assumed that inflation would be lower than the actual outcome early in the year – particularly the first forecast of the year, published in February. However, the aforementioned depreciation of the króna strongly affected Q4/2018 inflation. In spite of this, inflation for the year was well within the 50% confidence band for the February forecast (Chart 2).

Table 1 Inflation forecast for 2018

	Monetary Bulletin				Final
Year-on-year change (%)	2018/1	2018/2	2018/3	2018/4	result
Inflation	2.6	2.6	2.7	2.7	2.7
Inflation excl. indirect tax effects	2.5	2.5	2.6	2.6	2.6

Sources: Statistics Iceland, Central Bank of Iceland.

Inflation forecast errors over the past decade

Chart 3 shows errors in Central Bank inflation forecasts one, four, and eight quarters ahead, from Q1/2009 through Q3/2019 (forecasts prepared in 2007-2019). Inflation one quarter ahead was overestimated more often than underestimated, and actual inflation averaged 0.1 percentage points below the Bank's forecasts. In the first half of the period, the Bank's forecasts underestimated inflation four and eight quarters ahead more often than they overestimated it. This reversed in 2014, when overforecasts became more common, partly due to an unexpected decline in oil prices, global deflation, and the appreciation of the króna. As can be seen in Chart 3, errors in the Bank's inflation forecasts in the past two years have been negligible at all horizons: one, four, and eight quarters ahead.

Table 2 shows the mean deviation (which gives an indication of whether inflation is being systematically over- or underforecast) and the root mean square error (RMSE, which shows the uncertainty in the forecast) in forecasts from Q1/2009 onwards. As is stated above, the mean deviation is usually positive, and it is greatest in forecasts two quarters ahead, when inflation was overforecast by an average of 0.2 percentage points, and four quarters ahead, when inflation was underforecast – again, by an average of 0.2 percentage points. The mean deviation is not statistically significant, however, indicating that inflation was not systematically under- or overforecast during this period.

From the time the capital controls were imposed in autumn 2008 until the forecast published in *Monetary Bulletin* 2016/4, the Bank's macroeconomic and inflation forecasts were 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 fluctuations (Chart 4), as the correlation between the numerical errors in inflation and exchange rate fore-

Table 2 Forecast errors in Central Bank of Iceland inflation forecasts[1]

%	One quarter	Two quarters	Three quarters	Four quarters	Eight quarters	Twelve quarters
No. of observations	43	42	41	40	36	32
Mean forecast error (%)	0.1	0.2	0.1	-0.2	0.1	0.0
RMSE (%)	0.4	0.9	1.2	1.7	1.9	1.4

1. Forecast errors from Q1/2009 through Q3/2019.
Source: Central Bank of Iceland.

Chart 3

Inflation forecasting errors in *Monetary Bulletin*[1]
Q1/2009 - Q3/2019
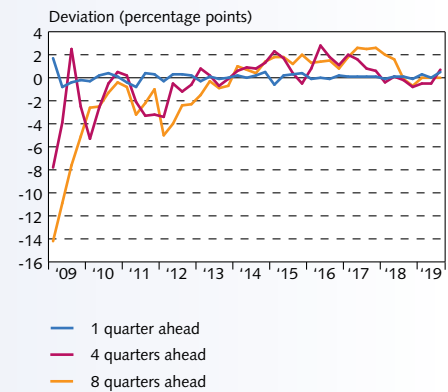
Deviation (percentage points)

- 1 quarter ahead
- 4 quarters ahead
- 8 quarters ahead

1. The 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 2009-2018

Forecast one year ahead

Exchange rate forecast error (%)
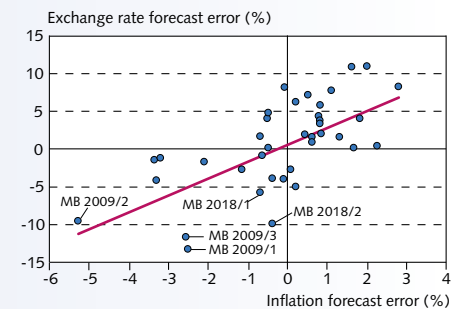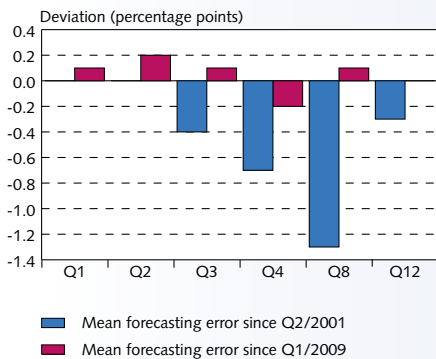
Inflation forecast error (%)
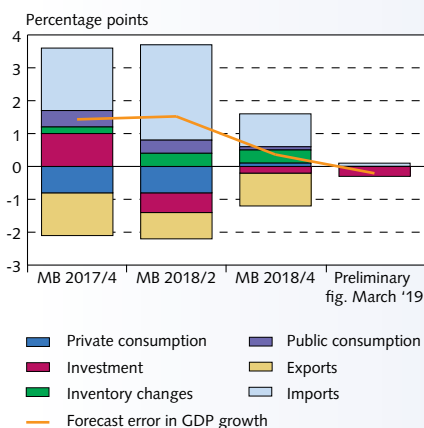
Source: Central Bank of Iceland.

Chart 5

Mean inflation forecasting errors
in *Monetary Bulletin*[1]

1. The first quarter is the quarter in which the report is published or the first quarter forecasted. Two quarters ahead is the quarter immediately thereafter, etc.
Source: Central Bank of Iceland.

Chart 6

Contribution of expenditure items to errors
in GDP growth forecasts 2018[1]

1. Based on real figures in August 2019.
Sources: Statistics Iceland, Central Bank of Iceland.

casts is 0.63. The chart also shows that inflation was usually under-forecast 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, but it also applies to forecasts prepared in early 2018. In instances when the exchange rate of the króna turned out higher than forecasts assumed, inflation was usually overestimated.

Comparison of inflation forecast errors since the adoption of the inflation target

Since the Bank adopted the inflation target in 2001 and began publishing inflation forecasts, it has made substantial changes to its forecast preparation methods. The Bank began using its quarterly macroeconomic model (QMM) at the beginning of 2006, and it did not prepare forecasts of the exchange rate or Central Bank interest rates until 2007.[2]

Chart 5 compares the mean error in Central Bank inflation forecasts from Q2/2001 onwards, on the one hand, and from Q1/2009 onwards, on the other. The forecast errors in inflation forecasts from 2001 onwards are not statistically significant one, two, and three quarters ahead. On the other hand, the errors in forecasts four and eight quarters ahead are large and statistically significant. This suggests that inflation was systematically under-forecast over that period. The mean error in inflation forecasts prepared in the last decade is generally smaller than in forecasts prepared since 2001. This indicates that forecasting performance has improved significantly, particularly over longer horizons.

Central Bank GDP growth forecasts for 2018

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 be generally underforecast during periods when growth in domestic demand is also underforecast and demand pressures in the economy are therefore underestimated as well.

Statistics Iceland publishes preliminary national accounts estimates for each quarter two months after each quarter-end. The first figures for Q4/2018 and for the year as a whole were published in March 2019 and then revised in August. The Bank's forecasts and Statistics Iceland's estimates of developments in key macroeconomic variables can be seen in Table 3. In February 2018, when *Monetary Bulletin* 2018/1 was published, Statistics Iceland's national accounts estimates for Q3/2017 were available. As a result, the Bank had to base its forecast for the full year 2018 on the forecast for Q4/2017, as well as on preliminary figures for the first three quarters of 2017 – figures that would subsequently change.

Statistics Iceland's figures for 2018 changed between the publication of the preliminary numbers in March 2019 and the revision in August. Growth in domestic demand was underestimated in the preliminary figures, particularly to include a 1.9 percentage point underestimation of investment growth, which is often the item that is subject to the largest revisions. Statistics Iceland's estimates of developments in net trade changed as well. Imports proved to have been underestimated more than exports, with the result that net trade contributed less to GDP growth than was initially assumed. Year-2018 GDP growth according to Statistics Iceland's August figures was therefore 4.8%, or 0.2 percentage points more than in the March figures.

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.

Output growth for the year turned out stronger than in the Bank's forecasts. The largest deviation, 1.6 percentage points, was in the *Monetary Bulletin* 2018/1 forecast, where the Bank projected GDP growth for the year at 3.2%. The deviation has narrowed with each of the Bank's forecasts, and since the November 2018 forecast it has been relatively small, as that forecast was based on Statistics Iceland's preliminary figures for the first half of the year. In the main, domestic demand has developed in line with the Bank's forecasts, and the deviation in GDP growth forecasts has stemmed mainly from errors in forecasts of external trade (see Table 3 and Chart 6). The forecast for export growth proved overly optimistic, although the deviation was smaller than in the import growth forecast. Because of the sizeable overestimation of import growth, the contribution of net trade to output growth was considerably larger than had been forecast early in the year, and output growth was therefore underestimated.

Table 3 *Monetary Bulletin* macroeconomic forecasts and Statistics Iceland data for 2018

% change from prior year	MB 18/1 (forecast from Q4/'17)	MB 18/2 (forecast from Q1/'18)	MB 18/3 (forecast from Q2/'18)	MB 18/4 (forecast from Q3/'18)	MB 19/1 (forecast from Q4/'18)	Preliminary figures (March 2019)	Revised figures (Aug. 2019)
Private consumption	6.4	6.3	5.6	4.6	4.5	4.8	4.7
Public consumption	2.3	1.9	2.5	2.9	3.6	3.3	3.5
Investment	3.8	6.5	5.2	5.0	2.9	2.1	4.0
Domestic demand	4.4	5.2	4.7	4.2	4.1	4.1	4.6
Exports	4.4	3.3	3.6	3.9	2.8	1.6	1.7
Imports	7.4	7.7	6.0	3.3	2.0	0.1	0.8
GDP growth	3.2	3.3	3.6	4.4	4.3	4.6	4.8

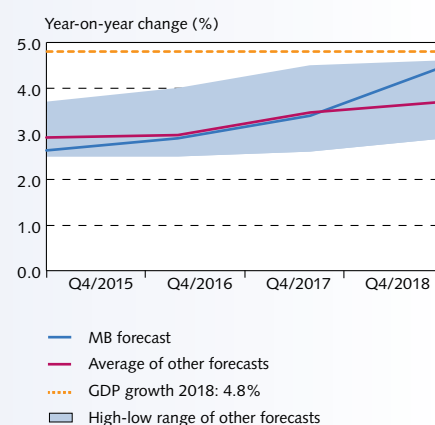*Sources*: Statistics Iceland, Central Bank of Iceland.

Central Bank forecasts in comparison with other forecasters' projections

Chart 7 gives a comparison of the Central Bank's output growth forecasts for 2018 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 years 2015-2018. The mean is calculated from each year's last forecast as prepared by eight forecasters: the International Monetary Fund (IMF), Icelandic Federation of Labour (ASÍ), the three large commercial banks, Statistics Iceland, Organisation for Economic Co-operation and Development (OECD), and the European Commission (EC). The range between the highest and lowest forecast values is indicated by the shaded area.[3] In general, it widens during periods of marked uncertainty. Other things being equal, economic forecasts should become more consistent with one another as the end of the forecast period approaches and more detailed information becomes available.

Overall, the Bank's forecasts accord well with the average from other forecasters. Towards the end of the year, the Bank's GDP growth forecasts were closer to the ultimate outcome for the year than the other forecasters' average. Chart 8 also shows that the Bank's inflation forecasts have generally been more accurate than

Chart 7

GDP growth forecast for 2018

Year-on-year change (%)

— MB forecast
— Average of other forecasts
····· GDP growth 2018: 4.8%
▢ High-low range of other forecasts

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

Chart 8

Inflation forecasts for 2018

Year-on-year change (%)

— MB forecast
— Average of other forecasts
····· Inflation 2018: 2.7%
▢ High-low range of other forecasts

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

Chart 9

Inflation forecasts for 2018, selected advanced economies[1]
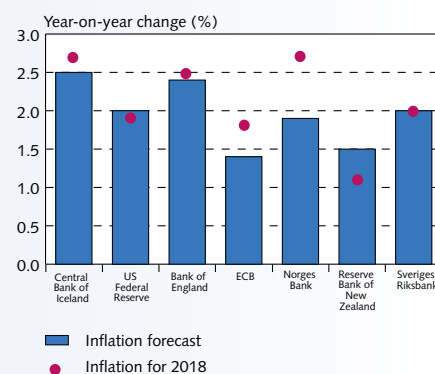
Year-on-year change (%)

■ Inflation forecast
● Inflation for 2018

1. Forecasts prepared at year-end 2017 except the US Federal Reserve, which was prepared in July 2017. The Bank of England projection is Q4 four-quarter CPI inflation.
Sources: Bank of England, ECB, Norges Bank, Reserve Bank of New Zealand, Sveriges Riksbank, Thomson Reuters, US Federal Reserve, Central Bank of Iceland.
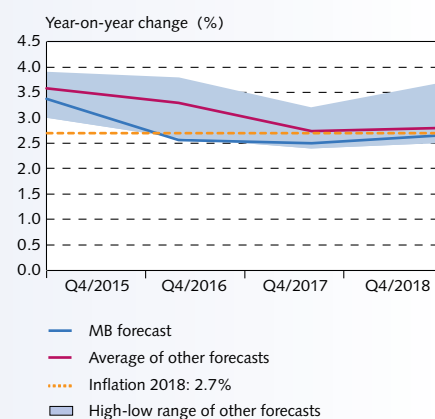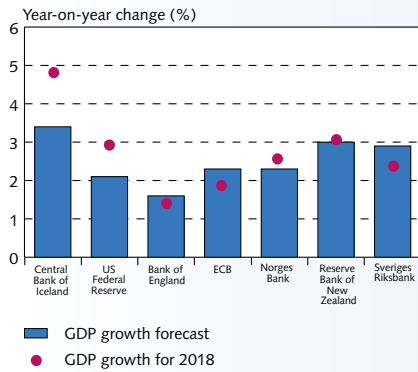
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3. Not all of these forecasters prepare forecasts over a horizon of three years; therefore, the 2015 value in Charts 7 and 8 is based only on the forecasts from the IMF, Arion Bank, Statistics Iceland, and Landsbankinn. This explains in part why the high-low range is smaller in 2015 than in 2016.

Chart 10

GDP growth forecasts for 2018, selected advanced economies[1]

Year-on-year change (%)

GDP growth forecast
GDP growth for 2018

1. Forecasts prepared at year-end 2017 except the US Federal Reserve, which was prepared in July 2017.
Sources: Bank of England, ECB, Norges Bank, Reserve Bank of New Zealand, Sveriges Riksbank, Thomson Reuters, US Federal Reserve, Central Bank of Iceland.

those from other forecasters. This is in line with experience from previous years.

International comparison

It can be useful to examine the Bank's forecasts in international context. As Chart 9 indicates, year-2018 inflation turned about higher in most advanced economies than was assumed in late-2017 forecasts prepared by the relevant central banks. This was particularly the case for Norges Bank and the European Central Bank (ECB). Inflation was also underestimated in Iceland, partly because of the steep depreciation of the króna in the latter half of the year. The size of the deviation does not stand out in international context, however.

Chart 10 gives the same type of comparison of GDP growth forecasts. In most countries, year-2018 GDP growth developed broadly in line with forecasts, whereas in Iceland it exceeded forecasts. The deviation in the Bank's GDP growth forecast was relatively large in international comparison, which probably reflects to some extent the relative difficulty of forecasting macroeconomic variables in small open economies like Iceland, where economic shocks can have a much stronger impact than they do in larger economies.