

## Appendix 2

### Errors in Central Bank forecasts

Errors in economic forecasts typically stem from incomplete information about the economic data on which the forecasts are based, misinterpretation of the state of the economy, unforeseen events and imperfect forecasting models. Some errors are unavoidable, while others are not. Examining errors in the Central Bank's forecasts can indicate mistakes in the preparation of the forecasts or can point to possible structural changes in the economy. Both can be used for further development of the Bank's models and their utilisation in forecasting.

#### Central Bank inflation forecasts

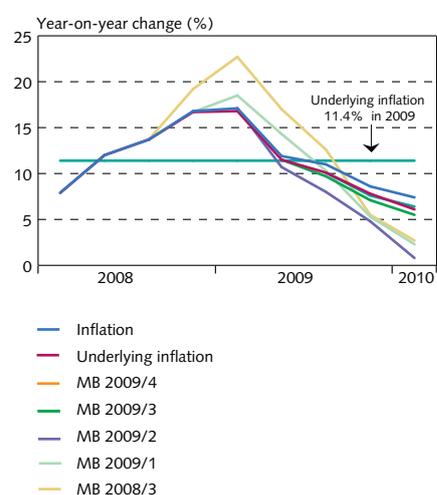
Four times a year, the Central Bank prepares an inflation forecast covering a forecast horizon of three years. The forecasts are set up so as to allow monetary policy in the forecast to respond to future deviations in inflation from the Bank's inflation target, as well as the output gap. This technical assumption implies that the Central Bank's interest rate adjusts such that inflation will converge towards the Bank's target in accordance with the time lags in the monetary policy transmission mechanism, while minimising the output cost during the adjustment phase. This characteristic of the forecast ensures that inflation is always at or near the inflation target by the end of the forecast horizon.

#### Inflation in 2009

Twelve-month inflation peaked at 18.6% in January 2009. It took a sharp turn during the year, declining rather rapidly and measuring 7.5% by year-end, the lowest measured inflation rate since February 2008. Twelve-month inflation averaged 12% in 2009, while underlying inflation (inflation excluding the direct effects of increases in indirect taxes) measured 11.4%.

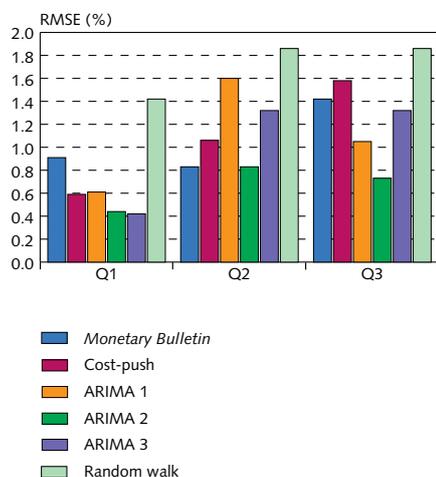
Chart 1 illustrates the inflation forecast from November 2008 through year-end 2009. In August 2009, the Central Bank began to prepare a separate forecast of the direct inflationary effects of hikes in consumption taxes. The forecasts published in *Monetary Bulletin* 2009/3 and 2009/4 therefore show underlying inflation. When the forecast in the November 2008 *Monetary Bulletin* was published, shortly after the collapse of Iceland's banking system, there seemed to be no limit to possible depreciation of the króna, and inflation looked set to exceed 20%. At the time, there was great uncertainty about the monetary policy framework. At the end of November, however, capital account restrictions were imposed so as to prevent the exchange rate from plunging still further. By January 2009, the króna had strengthened somewhat after a sharp decline during the autumn, and was 14% stronger than it had been in November, when *Monetary Bulletin* was published. In January, the Bank forecast 11.9% inflation for the year 2009. The forecast published in early May 2009, however, assumed much weaker economic activity than the previous

Chart 1  
Inflation forecasts MB 2008/3 - MB 2009/4  
and underlying inflation



Sources: Statistics Iceland, Central Bank of Iceland.

Chart 2  
Forecast error for inflation in *Monetary Bulletin* and from simple models in 2009<sup>1</sup>



1. Q1 is the quarter in which the report is published or the first quarter forecasted; Q2 is the quarter after the report has been published; Q3 is the following quarter.

Source: Central Bank of Iceland.

forecast, and projected that inflation would subside much more rapidly, falling to 9.9% in 2009.

In the forecast that appeared in *Monetary Bulletin* 2009/3, inflation was projected at 11.8% for 2009, with underlying inflation estimated at 11.1%. The November issue of *Monetary Bulletin* forecast 12% inflation and 11.3% underlying inflation.

### Assessment of forecasting errors over a longer period

In assessing inflation forecasts, it is important to consider the average deviation (bias) and the root mean square error (RMSE) of the forecasts concerned. The bias shows the forecasts' average deviation from actual inflation and thus whether inflation is being systematically over- or underforecast. A negative sign indicates that inflation has been systematically underforecast. The RMSE, on the other hand, measures how large the deviations are on average.

Table 1 Central Bank of Iceland inflation forecast errors since Q1/1994

(%)	Q1	Q2	Q3	Q4
Mean forecast error	0.0	-0.3	-0.8	-1.2
RMSE	0.6	1.7	2.5	2.9

In order for it to be possible to draw conclusions from such measures, the forecast errors must be independent and sufficiently large in number. As forecasts extend farther ahead in time, it can also be expected that the forecast errors will increase. Table 1 shows the bias and RMSE in the Bank's inflation forecasts up to four quarters ahead from 1994 through the January 2010 forecast. By this criterion, inflation has been underforecast two to four quarters ahead, to an increasing degree along the horizon. In all cases, except those involving forecasting errors one and two quarters ahead, the bias proved to be statistically significant at the 5% critical level.

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

	Number of measurements	Mean forecast error (%)	RMSE (%)
Four quarters ahead	30	-1.7	3.3
Eight quarters ahead	26	-3.1	5.0

Since adopting an inflation target in March 2001, the Central Bank has also published inflation forecasts two years ahead. Table 2 shows the bias and the RMSE for the period since the Bank introduced inflation targeting. A comparison of Tables 1 and 2 shows that the standard deviation for the one-year forecast has been greater since the Bank adopted the inflation target (3.3%) than it was for the entire period (2.9%). It should be noted, however, that no forecasts of developments in the exchange rate or the policy interest rate were made until the latter half of 2006, as previous forecasts simply used the technical assumption of unchanged interest rate and exchange rate. Therefore, these forecasts did not make full use of Bank staff's assessments of likely developments in these variables, and it is indeed

clear that forecasting errors appear closely linked to fluctuations in the exchange rate of the króna for the majority of the forecast period.

### Success in short-term inflation forecasting

For the past 1½ years, the Central Bank has also used a cost-push model, wherein inflation is determined by historical developments in wage costs and exchange rate, and a simple ARIMA time-series model, which uses only past inflation for short-term inflation forecasting. These models do not use any indicators of economic activity or measures of inflation expectations, as the Bank's macroeconomic model does. It can prove useful to compare the accuracy of these models to forecasts using the macroeconomic model, which were published in *Monetary Bulletin* for 2009.

Chart 2 compares the Central Bank's inflation forecasts one to three quarters ahead for the year 2009. The standard deviation of the forecasts published in *Monetary Bulletin* in that year is compared with the cost-push model and three different ARIMA models.<sup>1</sup> Also shown, for comparison, are forecasting errors based on a simple random walk, which forecasts that inflation in a given quarter will be the same as in the previous quarter throughout the forecast horizon.

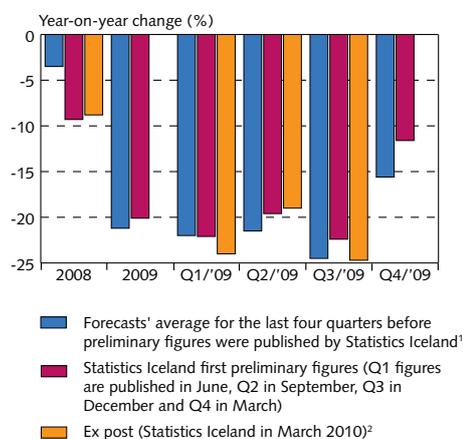
The simple time series models all generate better results (smaller forecast errors) than the *Monetary Bulletin* forecasts one quarter ahead. The forecasts obtained with the ARIMA 2 model and *Monetary Bulletin* are similar, however, when the forecast extends two quarters ahead in time. The ARIMA 2 model performs best for forecasts three quarters ahead. The *Monetary Bulletin* forecasts three quarters ahead are somewhat less accurate, however, than the forecasts from the ARIMA models. In all cases, the random walk forecasts were least accurate. It should be borne in mind that the short-term inflation forecasts published in *Monetary Bulletin* in 2009 were based to some extent on results from ARIMA models. Comparing the standard deviation of forecasts published in *Monetary Bulletin* 2009 with that of forecasts published in 2008 (see the discussion in *Monetary Bulletin* 2009/2) reveals that the deviation for 2009 declined significantly, irrespective of whether the forecast extends one, two, or three quarters ahead. As in *Monetary Bulletin* 2009/2, these results indicate that the Central Bank could further improve its short-term inflation forecasting by using these simple time-series models.

### Forecasts of macroeconomic developments in 2009

In order to gain a more accurate view of inflation forecast quality, it is also necessary to analyse the forecasts for key determinants of inflation, such as output growth, labour market conditions, and asset prices. Table 3 shows a comparison of *Monetary Bulletin* forecasts of

1. The first ARIMA model draws on forecasts for the main subcomponents of the consumer price index and weights them together to create a single overall index. The second, ARIMA 2, directly forecasts the overall consumer price index. Both of these models were discussed in Appendix 2 in *Monetary Bulletin* 2009/2. In addition to these, the Bank has now estimated an ARIMA model that forecasts the overall CPI excluding indirect tax effects (ARIMA 3). The twelve subcomponents of the consumer price index are as follows: agricultural products less vegetables, vegetables, other domestic food and beverages, other domestic goods, imported food and beverages, cars and spare parts, petrol, other imported goods, alcohol and tobacco, housing, public services, and other services.

Chart 3  
National expenditure



1. Average of quarterly forecasts does not extend further back than MB 2008/3. 2. The first preliminary figures for Q4 2009 were published in March 2010. Therefore, first preliminary figures have not been revised. Sources: Statistics Iceland, Central Bank of Iceland.

developments in major macroeconomic variables for the year 2009. Any assessment of economic forecasts for 2009 must take into account, however, that it was an extraordinary year in Icelandic economic history. For example, the contraction in domestic demand and GDP was the largest in the history of Iceland's national accounts, unemployment was at an all-time high, and changes in relative factor price and prices of a number of expenditure items were unprecedented.

A common characteristic of all of the forecasts is that they assumed that a larger share of the adjustment to the financial crisis would be channelled through real variables rather than relative price changes. Thus they assumed too sharp a contraction in GDP and therefore a more pronounced negative output gap and higher unemployment. Forecasts of domestic demand are not far from accurate, however. Statistics Iceland revises national accounts figures up to four times over a two-year period if necessary. If preliminary and revised figures differ greatly, it can strongly affect forecasts. Chart 3 shows the average of the forecasts for national expenditure the year before Statistics Iceland's first preliminary figures are published, compared with the first preliminary figures and the most recent revised figures. It can be seen that the quarterly forecasts for Q2-Q4/2009 all assumed a stronger contraction in national expenditure. The most recent national accounts figures from March indicate that the contraction in national expenditure was more pronounced in Q1 and Q3 than the first figures indicated.

Table 3 Forecasts and assumptions concerning developments in major macroeconomic variables for the year 2009 from *Monetary Bulletin* 2008/3 through 2010/1

(%)	MB 2008/3	MB 2009/1	MB 2009/2	MB 2009/3	MB 2009/4	MB 2010/1	Preliminary accounts <sup>1</sup>
Private consumption	-24.8	-25.2	-23.5	-19.7	-16.2	-16.0	-14.6
Public consumption	2.9	1.5	-2.7	-2.3	-1.2	-0.4	-3.0
Investment	-20.2	-28.9	-44.8	-48.4	-48.0	-48.3	-49.9
National expenditure	-17.6	-20.3	-23.5	-21.5	-19.7	-19.4	-20.1
Exports	-0.5	0.4	-3.0	-1.8	1.3	1.6	6.2
Imports	-24.5	-26.9	-35.6	-33.0	-25.7	-25.4	-24.0
GDP	-8.3	-9.9	-11.0	-9.1	-8.5	-7.7	-6.5
Inflation	14.1	11.9	9.9	11.8	12.0	12.0	12.0
Underlying inflation	14.1	11.8	9.6	11.1	11.3	11.4	11.4
EURISK exchange rate	141.1	146.6	158.2	169.2	171.7	172.0	172.0
Output gap	-4.7	-5.8	-8.3	-6.8	-4.2	-3.9	-3.4
Unemployment	6.3	9.4	9.3	8.9	8.2	8.0	8.0
Wage growth <sup>2</sup>	6.4	4.2	4.2	4.4	4.4	4.7	0.6
Real disposable income	-13.7	-17.1	-15.6	-19.9	-19.2	-17.6	-18.0 <sup>3</sup>
Trade	5.2	5.4	-14.1	-11.4	-11.4	-10.3	-8.2
Price of aluminium in USD	-3.4	-39.2	-41.8	-38.7	-36.1	-35.4	-35.8
Price of marine products in foreign currency	-2.9	-9.0	-12.0	-12.6	-8.5	-10.4	-12.8
Export of aluminium	4.5	7.9	3.0	3.5	4.7	6.0	3.8
Export of marine products	-2.9	2.0	0.0	-1.0	-2.0	4.0	3.4

1. Preliminary figures are used as a basis for the Central Bank of Iceland baseline forecast as published in this issue of *Monetary Bulletin*.

2. The first figures for wage growth in 2009 were published in March 2010. They turned out to be different from the previous forecast for the year, but they were based primarily on the Statistics Iceland wage index.

3. 2009 figures for disposable income will be published in September 2010. The -18% figure is the Central Bank's forecast.

### **Contraction in private consumption proved smaller than forecast**

As regards individual sub-components of national expenditure, forecasts of developments in investment have been quite accurate, but it has proven more difficult to project developments in private consumption in 2009. Originally, a contraction of more than 20% in private consumption was assumed, but that estimate declined as the year passed, especially after national accounts figures for Q1 and Q2 were published in June and September 2009. Private consumption depends on variables such as disposable household income, unemployment, and exchange rate. The exchange rate forecast for 2009 has been broadly unchanged since the summer of 2009. Forecasts of disposable income have been more variable, however. It has been difficult to project developments in disposable income, and the final figures for 2009 will not be available until September 2010. In September 2009, for example, it was revealed that disposable income for 2008 had risen by 0.5%, while earlier estimates had assumed a 7.5% contraction.

### **Revised figures for public consumption in 2008 changed forecasts for 2009**

The assumptions concerning developments in public consumption are obtained from Government estimates and data from Statistics Iceland. Public consumption growth in 2009 has changed somewhat in the Central Bank's forecasts due to the considerable uncertainty about public consumption in 2008. In *Monetary Bulletin* 2009/3, it was estimated that public consumption for 2008 had risen by 2.8%, but when national accounts figures were released in September 2009, the increase proved to be 4.6%. The national accounts figures published in September 2009 indicated that public consumption had grown by 0.4% in the first half of 2009; therefore, it was decided to assume a much smaller contraction in the forecasts for 2009. As a result, a contraction of only 1.2% was forecast in November. Preliminary figures from March indicate that public consumption contracted by 3%, which is close to the Bank's forecast prior to the publication of those figures.

### **Exports rose by over 4 percentage points in 2009 due to ships and aircraft**

Forecasts of developments in trade in goods and services have not been fully borne out, in part due to large transactions involving irregular and unpredictable items such as ships and aircraft, for which information is often received after a long time lag. Exports of ships and aircraft totalled 32 b.kr. fob value in 2009, while imports of these items totalled 16.6 b.kr. Only one-third of the imports and just over one-fifth of the exports had been included in national accounts figures by the time the January forecast was prepared. This explains the dramatic difference in export figures between the January forecast and Statistics Iceland's preliminary figures from March. If these irregular items had not been included, the 2009 rise in exports would have measured 2.9%, while imports would have declined by over 25%. It should be noted that they made no impact on GDP growth, as investment was scaled down by a corresponding amount.

### Chain-volume effect influences 2009 forecasts

An unusually strong chain-volume effect in the 2009 national accounts also led to errors in GDP growth forecasts. Until this issue of *Monetary Bulletin*, the Central Bank's forecasts of volume changes in national accounts variables have been based on data that are adjusted to year-2000 price levels using the chain-volume approach. In preparing GDP forecasts, however, it has been assumed that the constant-price expenditure items of the national account identity will sum up to GDP. According to the chain-volume approach, however, instead of adjusting all amounts to a fixed price level according to a specified base year, volume changes are calculated so that amounts at the price level of a specific year are adjusted to the price level of the preceding calendar year, and the volume change is calculated from this. Annual chain-volume linking means that the expenditure sum does not equal GDP except in the reference year for price indices (currently 2000) and the year thereafter. This was not a problem until last year, when relative prices changed unusually dramatically, particularly the relative price of imports and exports. Table 4 reveals some difference between the Central Bank's GDP growth forecasts with and without the chain-volume approach, while forecasts of national expenditure are virtually identical.

Table 4 Central Bank of Iceland forecasts with and without chain-volume index

Forecast	Year	GDP		National expenditure	
		Forecast without chain-volume index	Forecast with chain-volume index	Forecast without chain-volume index	Forecast with chain-volume index
MB 2009/4	2009	-8.5%	-7.8%	-19.7%	-20.0%
MB 2009/3	2009	-9.1%	-7.2%	-21.5%	-21.5%
MB 2009/2	2009	-11.0%	-9.0%	-23.5%	-23.9%
MB 2009/1	2009	-9.9%	-8.1%	-20.4%	-20.8%
MB 2008/3	2009	-8.3%	-6.4%	-17.6%	-17.5%