SPECIAL PUBLICATION

CENTRAL BANK OF ICELAND

No. 11

Monetary policy based on inflation targeting: Iceland's experience since 2001 and post-crisis changes

September 2017

Central Bank of Iceland

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Available on the Central Bank of Iceland website (http://www.sedlabanki.is)

ISSN 2298-2736, print
ISSN 2298-2744, online

Foreword

This report explores Iceland's experience of inflation-targeting monetary policy since March 2001, when a formal inflation target and floating exchange rate were adopted by agreement between the Government and the Central Bank. This assessment of monetary policy performance has been undertaken now because of recent signs that monetary policy has been more effective and that policy outcomes have improved. It is important to determine whether this increased success is due solely to favourable external conditions or whether it is a sign of a more durable turning point. Thanks are due to all of those who contributed to this report, particularly the Chief Economist, who bore the brunt of the preparation and writing. The contents and findings have been discussed by the Monetary Policy Committee, and many useful comments were received from Central Bank staff.

According to the Central Bank's 2012 report entitled *Iceland's currency and exchange rate policy options*, Iceland's experience of independent monetary policy had been mixed, as inflation had long been well above the inflation target and exchange rate fluctuations had to a significant extent been a source of shocks rather than a shock absorber. Admittedly, much of the period from the adoption of the inflation target was affected to some extent by the prelude to and aftermath of the worst global financial crisis since the 1930s – a crisis that hit Iceland particularly hard, partly as a result of domestic economic policy mistakes and weak financial system oversight. During the first years after the inflation target was adopted, the new monetary policy framework appeared to deliver good results, but as the decade progressed, severe imbalances developed and inflation rose above the target.

The experience of the run-up to the financial crisis had revealed certain weaknesses in monetary policy arrangements both in Iceland and abroad. Various reforms have therefore been made to monetary policy conduct in Iceland during the post-crisis period. The interest rate decision process was improved and transparency enhanced when a five-member Monetary Policy Committee was established by statutory amendment in February 2009. The Central Bank now applies a larger number of policy instruments than before, including foreign exchange market intervention, as it had signalled in its 2010 report entitled *Monetary policy in Iceland after capital controls*. Furthermore, monetary policy is now better supported by the financial regulatory framework, partly because the recommendations presented in the Bank's 2012 report *Prudential rules following capital controls* were implemented. With the establishment of the Financial Stability Council and the Systemic Risk Committee, of which the Bank is a member, monitoring of financial system risk has increased. The premises for an improved monetary-fiscal policy mix have strengthened as well since the pre-crisis period, with the establishment of the Macroeconomic Council, of which the Bank is also a member, and with an improved fiscal policy framework.

In the recent past, there have been signs of a turning point in the efficacy and success of monetary policy. This success can be seen, for instance, in long-term inflation expectations, which are now better aligned with the inflation target and appear less sensitive than before to short-term fluctuations in inflation and the exchange rate. The inflation target therefore seems to enjoy greater credibility, which is one of the main reasons that lower interest rates appear to be needed to keep inflation close to target. Moreover, a floating exchange rate appears to be much more effective than before in absorbing shocks. This report maps out these changes and assesses the degree to which they can be traced to the aforementioned post-crisis changes in monetary policy conduct. The results indicate strongly that the policy reforms play an important role in these improvements.

Monetary policy has been a frequent topic of discussion in the recent term, and the authorities are currently evaluating Iceland's monetary policy options based on an independent currency and free capital flows. It is important that discussion and policy formation in this area be based on the best available information and research. This report is intended as a contribution to that effort.

Monetary policy based on inflation targeting: Iceland's experience since 2001 and post-crisis changes[1]

This report examines Iceland's experience with the inflation-targeting monetary policy framework adopted in March 2001. Early on, the new policy was beset by economic imbalances that had accumulated before the inflation target was introduced. These imbalances were unwound relatively quickly after the new framework was adopted, and inflation was brought back to target in late 2002. It remained close to the target until the first half of 2004, and the economy was broadly balanced over that period. From then on, however, the situation deteriorated, and the years leading up to the financial crisis featured growing economic imbalances and inflation well above target. Inflation rose still further in the wake of the crisis and the collapse of the króna but has subsided again, and it appears that monetary policy has become more effective and is achieving better outcomes than before. Macroeconomic volatility has diminished in recent years, and the basis of the current economic recovery seems to be much more solid than during the pre-crisis upswing. Deviations of inflation from target have diminished markedly, as have fluctuations in inflation and inflation expectations. Uncertainty about future inflation appears to have tapered off as well, and inflation expectations seem more firmly anchored to the target. As price stability has increased, the inflation process appears to have changed as well. Furthermore, exchange rate movements seem to a greater degree than before to reflect changes in aggregate supply and demand conditions in the economy, suggesting improved ability of the exchange rate to act as a shock absorber rather than as a source of shocks. Although capital controls and increased foreign exchange market intervention by the Central Bank play some role in this, it is nevertheless likely that another important factor is at work: that fluctuations in real interest rates have diminished as inflation expectations have become more firmly anchored. Finally, monetary policy formulation seems to be better aligned with conventional monetary policy rules and now delivers a combination of fluctuations in inflation and output that is much closer to what can be achieved given the shocks that hit the economy. Monetary policy therefore appears to have grown more successful in recent years, which – together with favourable external conditions – has contributed to lower and more stable inflation and more securely anchored inflation expectations.

1 Introduction

On 27 March 2017, sixteen years had passed since fundamental changes were made to Iceland's monetary policy framework: the fixed exchange rate policy was abandoned and a formal inflation target based on a floating exchange rate adopted in its place. Major changes took place in the domestic financial markets during the years before the inflation target was introduced, chief among them the deregulation of interest rates in the late 1980s, the development of a domestic foreign exchange and money market at the beginning of the 1990s, and the removal of restrictions on movement of capital in the first half of the 1990s. The financial system underwent radical changes soon thereafter, not least because of the privatisation of financial institutions and increased competition in the mortgage lending market. It was a time of flux in the global environment as well. The eurozone

1. This report was prepared by Thórarinn G. Pétursson, Chief Economist at the Central Bank of Iceland and Director of the Bank's Economics and Monetary Policy Department. Ólafur Sindri Helgason and Stefán Thórarinsson assisted with the analysis of exchange rate fluctuations using the Bank's DSGE model in Chapter 5, and Stefán Thórarinsson assisted with the estimation of efficient monetary policy frontiers in Chapter 6. The author wishes to thank other colleagues who read the manuscript for useful comments.

had recently been established when Iceland adopted its inflation target, and global financial market integration continued apace. The international scene was also changing rapidly, with the increased integration of China into the global economy. The interactions between these factors led to unusually low global interest rates, extremely easy access to global liquidity, and rapidly rising debt levels worldwide. Then the global financial crisis struck, bringing with it the most severe economic recession since the Great Depression. Eventually, the global economy began to right itself, but the recovery was slow – and slower than usual following a recession. There have been numerous setbacks, and to some extent the world order that developed in the mid-twentieth century has begun to unravel.

Iceland's post-crisis economic contraction was sharper than in other advanced economies, and its recovery was weak and uneven at the outset. In the past few years, however, the recovery has picked up noticeably, putting monetary policy to the test and requiring that it attempt to contain demand growth to ensure that inflation will remain in line with the Bank's legally mandated target. As a result, monetary policy is once again being heavily criticised for keeping interest rates too high.

In the wake of the financial crisis, the pros and cons of various currency and exchange rate options for Iceland became a subject of intense discussion. Opinion was divided on whether it would be better for Iceland to keep an independent currency or join a larger currency area. Another aspect of the discourse was what type of monetary and exchange rate regime would be most suitable if Iceland should retain the króna as its currency. The Central Bank of Iceland participated in the discussion and attempted to deepen it and move it forward by publishing in-depth reports on possible monetary policy reforms and various exchange rate policy options (Central Bank of Iceland, 2010 2012b).

Once again, the monetary and exchange rate framework is prominent in public discourse. During the prelude to the recent parliamentary elections, a number of politicians called for a comprehensive review of the current monetary policy framework, and after the elections, the authorities initiated a project focusing on the existing framework and whether it could be improved upon or should be changed radically and replaced with something else. The options available are not entirely the same as were under scrutiny when the Central Bank published its report in 2012, however, as the current review assumes that Iceland will retain the króna as its currency. As a consequence, the options currently being examined consist largely of different formulations of the current inflation-targeting regime or various versions of exchange rate targeting.

The present report is intended as a contribution to this discussion. It examines Iceland's experience with the inflation-targeting monetary policy framework adopted in March 2001. Particular focus is on the experience of the past few years, after changes were made to monetary policy formulation following the financial crisis, and whether there are signs that monetary policy is more successful than before. The report is organised as follows: the next chapter contains a

broad discussion of the objectives of monetary policy, with particular emphasis on its role and what it can and cannot achieve. Chapter 3 contains a relatively brief review of macroeconomic developments in Iceland over the period since 2001, when the inflation target was adopted. Chapter 4 discusses post-2001 developments in inflation, with special emphasis on whether there have been discernible changes in the behaviour of inflation and inflation expectations in the past few years. Chapter 5 focuses on the exchange rate of the króna and its relationship to the business cycle and the exchange rate differential with abroad. An attempt is made to answer the fundamental question of whether a flexible exchange rate has served as a shock absorber or as an independent source of shocks, and whether there have been discernible changes in the interactions between the exchange rate and the business cycle in recent years. Chapter 6 discusses monetary policy in Iceland since 2001. Interest rate developments are placed in the context of domestic macroeconomic developments, and in this context, developments in Central Bank interest rates are compared with the interest rates indicated by conventional monetary policy rules. Finally, an attempt is made to assess whether monetary policy implementation and efficacy have improved in recent years. The key findings are then summarised in Chapter 7.

2 The tasks of monetary policy

2.1 The role and objectives of monetary policy

In general, it can be said that the role of economic stabilisation policy is to maximise public welfare. This entails, among other things, promoting as much employment and output growth as the economy's potential allows; that is, ensuring that economic activity is as strong as possible without undermining economic stability, one manifestation of which is price instability. It also entails preventing the accumulation of imbalances that could come to the fore later on with an abrupt correction and even a financial crisis. In addition, stabilisation policy aims, insofar as is possible, to mitigate business cycles that tend to exacerbate uncertainty and interfere with efficient factor allocation.

Monetary policy is an important element of economic stabilisation policy; therefore, it seems appropriate that monetary policy objectives should be conceived in a manner similar to economic stabilisation policy in general. However, the general consensus is that, under normal conditions, monetary policy cannot have a permanent effect on employment and GDP growth (see further discussion below). Based on that view, it seems pointless to task monetary policy with long-term GDP growth or employment level objectives. It seems more appropriate to task monetary policy with objectives based on the assumption that in the long run, it can primarily affect monetary conditions as seen in developments in nominal variables such as the price level and the nominal exchange rate.

Even though monetary policy is generally entrusted with more narrowly defined objectives than economic stabilisation policy is, the price stability objective is also conducive to enhancing economic stability. This is because ensuring stable inflation anchors inflation expec-

tations more firmly, thereby stabilising them. Real interest rates (the difference between nominal interest rates and inflation expectations) and the real exchange rate (the nominal exchange rate adjusted for relative price developments domestically and abroad) will therefore be more stable, which in turn will mitigate fluctuations in the exchange rate and economic activity. Furthermore, when inflation expectations are firmly anchored, smaller interest rate changes are needed to control inflation than are needed if inflation expectations are sensitive to short-term developments in prices and exchange rates. As a result, the more securely anchored inflation expectations are, the greater the scope of monetary policy to respond to economic shocks and mitigate short-term volatility in the real economy.

The above-described relationship between greater stability in prices and output can be seen most clearly when demand exceeds potential output and inflation begins rising. A tighter monetary stance then brings demand into line with potential output, and inflationary pressures are eased. The same applies when a slack develops and inflation falls below the authorities' target rate: a looser monetary stance leads to increased factor utilisation and higher inflation.[2]

On the other hand, inflation can rise temporarily for reasons other than demand outstripping potential output. Monetary policy implementation is more complicated under such conditions. This applies in particular to supply-driven price increases such as rises in oil or commodity prices. In this instance, increased inflation and deterioration in terms of trade generally go together, which tends to reduce economic activity, other things being equal. Tightening the monetary stance in order to reduce inflation could then exacerbate the economic contraction. In that case, it could be appropriate to allow inflation to rise temporarily, trusting that it will not affect long-term inflation expectations and will therefore have a limited impact on medium-term price developments. If monetary policy lacks credibility, however, there is the risk that a short-term increase in inflation will affect long-term inflation expectations, therefore narrowing the scope of monetary policy to stimulate the economy in the wake of an economic contraction.

2.2 What monetary policy can and cannot do

It can be concluded from the above that by aiming at low, stable inflation, monetary policy can foster increased macroeconomic stability. It also reduces uncertainty about future price developments and enhances the market's ability to allocate limited resources in the most efficient way. Because wages and prices are sticky (i.e., they do not immediately adjust to a new equilibrium following an economic shock), monetary policy can also have a temporary effect on real wages and real interest rates and, through them, on real variables such as employment and GDP growth. Monetary policy can therefore be applied to dampen business cycles, as is described above.

On the other hand, monetary policy cannot affect employment and GDP growth in the long run, as both wages and prices eventually

2. This is sometimes referred to as the divine coincidence.

adjust; therefore, the impact of monetary policy on real wages and real interest rates tapers off. In the long run, economic activity is determined by factors that monetary policy cannot affect, such as technological advances, and population and productivity growth. All attempts to use monetary policy to systematically maintain a given employment rate or GDP growth in excess of the economy's long-term potential will ultimately lead to an adjustment in wages and prices without delivering permanently higher output growth.

For a small, open economy like Iceland, exchange rate movements are very important, and they can have a wide-ranging impact. A rise in the real exchange rate lowers the price of imported goods and services. Other things being equal, households' real disposable income then rises, imported investment goods become less expensive for domestic firms, and importing additional production factors and new technology becomes easier. A rise in the real exchange rate can therefore boost potential output and productivity. On the other hand, a rise in the real exchange rate erodes the competitive position of firms in the tradable sector. Fluctuations in the real exchange rate also exacerbate uncertainty for internationally active firms and complicate their activities, as the basis of their global marketing operations will be more uncertain than it would be otherwise (see Central Bank of Iceland, 2012, Chapters 5, 6, and 8).

Although the exchange rate is an important channel for the transmission of monetary policy to the real economy (see, for instance, Pétursson, 2001) and monetary policy can affect short-term developments in the real exchange rate, the general consensus is that monetary policy cannot have a permanent effect on the real exchange rate any more than it can on other real variables. Large fluctuations in the real exchange rate are certainly unfortunate, and they can sometimes be greater than is justified by macroeconomic fundamentals. Under such circumstances, it can be desirable to try to lean temporarily against exchange rate movements. Ultimately, however, monetary policy cannot prevent the long-term adjustment of the real exchange rate. In the context of the recent steep rise in the real exchange rate, it would be more appropriate, for instance, to tighten the fiscal stance, put in place structural changes that enhance domestic businesses' competitive position, and take other actions to boost productivity and increase potential output. The same applies to underlying structural changes in the economy that can be attributed to changes in relative prices and are manifested, among other things, in the rise and fall of various sectors and the shift of labour between sectors and employment areas. It is not possible to apply monetary policy to prevent the effects of these forces; other economic policy must be used to that end.

Global economic fluctuations and shocks have also had a strong impact in Iceland in recent years. The global financial crisis has obviously had a major impact, as have the slow economic recovery in trading partner countries and the geopolitical uncertainty of the past few years. Low global inflation and the plunge in oil and commodity prices played a key role in containing domestic inflation, and at the same time, very low global interest rates have complicated independ-

ent monetary policy formulation in Iceland. This shows quite clearly that the scope to apply independent monetary policy in a small, open economy like Iceland's is limited to some extent, as long-term interest rates and financial conditions are increasingly determined by global factors (see, for example, Rey, 2013; Einarsson *et al.*, 2016; and Gudmundsson, 2017). Under such circumstances, it may be necessary to apply other policy instruments – macroprudential tools, for instance – in support of monetary policy. That said, such instruments can never replace conventional monetary policy instruments as the main stabilisation tool (see also Central Bank of Iceland, 2010).

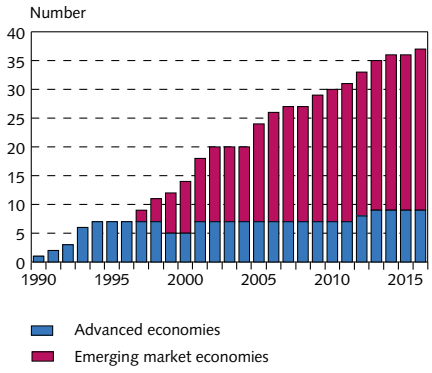
2.3 Inflation-targeting monetary policy

On 27 March 2001, the Central Bank of Iceland adopted an inflation target and, with statutory amendments passed in May of that year, price stability was specified as the principal objective of monetary policy, consistent with the ideas described above. The price stability objective was further defined in a joint declaration by the Government and the Central Bank as a numerical inflation target. According to the declaration, the Central Bank is to aim at keeping twelve-month inflation as measured using the consumer price index (CPI) as close as possible to 2.5%, on average. The statutory amendments also formalised the Central Bank's independence in formulating monetary policy and setting interest rates. The Treasury was explicitly prohibited from directly financing expenditures through its Central Bank account, although the practice had been discontinued in the early 1990s, by agreement between the Bank and the Minister of Finance.

This arrangement was similar to the monetary policy framework that had gradually become more common around the world after New Zealand adopted a numerical inflation target in December 1989. There were 14 inflation-targeting countries by the beginning of this century, and in 2016, India became the 37th country to adopt a formal inflation target (Hammond, 2012, and information from central bank websites). Nine of these 37 countries are advanced economies, including the United States, which adopted a formal inflation target in 2012, and Japan, which did the same a year later.[3] The other 28 are classified as emerging market economies (Chart 2.1).[4]

The objective of a formal yet flexible inflation-targeting regime is to anchor inflation and inflation expectations as firmly as possible while giving monetary policy the scope it needs to stabilise business cycles, as is discussed above. Although the exact details of the inflation-targeting regime differ from one country to another (see, for example, Hammond, 2012), it can be said that its core building blocks include a formal numerical inflation target, monetary policy independ-

Chart 2.1
Number of countries pursuing a formal inflation target 1990-2016



Sources: Hammond (2012) and central bank websites.

3. The European Central Bank (ECB) and the central bank of Switzerland could arguably be added to the list. Both pursue a monetary regime very similar to a formal inflation target, although neither defines it as an inflation-targeting regime.
4. Finland and Spain adopted an inflation target when they abandoned their fixed exchange rate regime in the early 1990s. They exited the inflation-targeting regime when they joined the EMU in 1999. Slovakia also adopted an inflation target in 2005 but abandoned it upon joining the EMU at the beginning of 2009. In spite of this, inflation targeting has proven one of the most durable monetary policy frameworks in history (see, for instance, Mihov and Rose, 2008).

ence, policy transparency, and the policy accountability that arises by giving the monetary policy authority a numerical target (see, for example, Kamber *et al.*, 2015; and Walsh, 2015). Experience gained in the wake of the financial crisis has shown that monetary policy must also take greater account of financial stability and the imbalances that can develop in the financial markets (see, for instance, Blanchard *et al.*, 2010). As a result, central bankers in inflation-targeting countries and others have been working sedulously at monetary policy reform, with the aim of reducing the risk of such problems in the future.

A number of changes have also been made to monetary policy implementation in Iceland following the financial crisis. At the beginning of 2009, monetary policy formulation was entrusted to a Monetary Policy Committee (MPC), two of whose five members are external experts, instead of a three-member Board of Governors. Furthermore, monetary policy transparency was enhanced significantly with the publication of the minutes of MPC meetings and regular meetings between the MPC and parliamentary committees (see Vignisdóttir, 2016, for further detail).[5] Moreover, monetary policy has increasingly used other policy instruments in addition to interest rates – such as intervention in the foreign exchange market – and other measures to temper excess short-term capital inflows. The framework for new macroprudential tools has also been under development (see, for example, Central Bank of Iceland 2010, 2012a).

The steadily increasing number of countries that have adopted a formal inflation target indicates clearly that inflation targeting is considered successful. A number of empirical studies appear to confirm this (see, for instance, the summary and references in Central Bank of Iceland, 2012b, Chapter 3). Inflation has declined and become less volatile. Inflation persistence and uncertainty about the inflation outlook have diminished, and inflation expectations are more firmly anchored. Furthermore, the impact of exchange rate movements on inflation appears to have weakened. These improvements have not come at the expense of GDP growth or business cycle stability: on the contrary, the adoption of an inflation target seems to have mitigated cyclical fluctuations, at least in emerging market economies. Moreover, the post-crisis economic contraction appears to have been generally less severe in inflation-targeting countries than in economies that pursue some other monetary policy framework (see, for instance, Carvalho Filho, 2010; and Fry-McKibbin and Wang, 2014).

Given that the adoption of an inflation target usually has a positive effect, Iceland's experience of inflation targeting is especially striking (see, for example, Pétursson, 2008 and 2010). As is discussed in Chapter 4 below, following a depreciation after the króna was floated, inflation was brought back to target and held there from mid-2002 until mid-2004. Inflation rose gradually from then on, however, and for the most part remained well above the target. Cyclical fluctuations have generally been large, and the pre-crisis economic boom and the

5. According to Dincer and Eichengreen (2014), of 120 central banks worldwide, Iceland's monetary policy transparency increased most in the wake of the financial crisis. Iceland ranked 11th-13th on a list of the most transparent monetary policy frameworks in the survey.

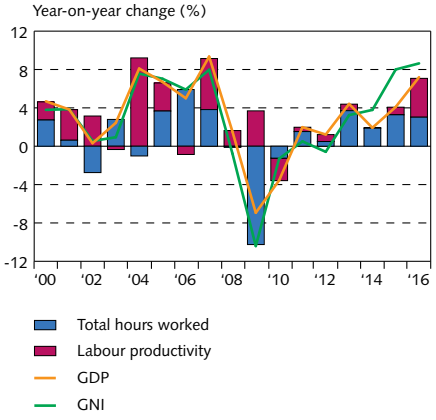
deep recession that followed were not prevented. The new monetary framework was therefore unable to prevent the extreme boom-bust cycles that had long been a feature of Iceland's economic history (see, for instance, Einarsson *et al.*, 2015). The effects of the financial crisis were also much more severe in Iceland than elsewhere, either in inflation-targeting countries or in other economies (Ólafsson and Pétursson, 2011; and Central Bank of Iceland, 2012b).

Chapter 3 of Central Bank of Iceland (2012b) explores the reasons why inflation-targeting monetary policy has performed so poorly in Iceland compared to other countries. In the main, it is argued that the difference can be attributed to structural factors that make the pursuit of independent monetary policy more challenging in Iceland than in larger economies with more diverse production and more mature financial markets; however, the unusual glut of global liquidity over most the 2000s played a role as well. This was compounded by structural changes in the Icelandic mortgage lending market and large-scale investment in energy-intensive industry, which added greatly to the strain on monetary policy. In addition, the conduct of monetary policy was suboptimal, for example because economic activity was systematically underestimated, as can be seen in frequent and large upward revisions of the national accounts. The final conclusion is that monetary policy and fiscal policy were very poorly coordinated: while the monetary stance was tightened repeatedly, the fiscal stance was eased significantly, with enormous spending growth and tax cuts. This, plus large contractual pay increases, led to virtually unprecedented growth in disposable income. In addition, severe flaws in financial system supervision and financial stability policy were revealed.

This report addresses this topic once again, focusing in particular on the experience gained after monetary policy conduct was changed following the financial crisis. It attempts to determine whether there have been discernible changes recently in monetary policy efficacy and whether there are signs of improvement in policy outcomes.

Chart 3.1

GDP growth, total hours worked, and productivity 2000-2016[1]



1. Gross national income (GNI) is GDP adjusted for terms of trade effects.
Sources: Statistics Iceland, Central Bank of Iceland.

3 Macroeconomic developments and cyclical fluctuations since 2001

Iceland has seen more than its share of booms and busts since it adopted its inflation target in spring 2001. The inflation target was introduced at the end of an episode of overheating characterised by rapid credit growth and a current account deficit that undermined the stability of the króna, thereby making it difficult to maintain the exchange rate peg that had been in place until that time. As a result, the króna depreciated rapidly after it was floated, and inflation soared. A minor economic contraction in 2002 was followed by an upswing that gave way to significant overheating and imbalances. This, in turn, was followed by a severe currency and banking crisis and one of the worst recessions the country has ever experienced. The post-crisis economic recovery began in 2010, and the years since then have seen a surge in activity driven by two large positive external shocks: improved terms of trade and the growth of tourism.

Similarly, global conditions have been unusual in many ways over most of the roughly sixteen years since the inflation target was adopted. Macroeconomic imbalances accumulated around the world, ultimately giving way to the global financial and economic crisis. The post-crisis economic recovery has been unusually weak, in part because of severe sovereign debt crises in several countries in the eurozone, Iceland's most important export destination. Among the manifestations of the tepid global recovery are the sluggish growth in world trade and historically low global interest rates.

As a result, monetary policy formulation in Iceland has been unusually challenging throughout the inflation-targeting period. At the same time, however, it must be said that a number of policy mistakes were made over these sixteen years. This chapter gives a brief review of economic developments over this period, partly so as to highlight the progress made in recent years in mitigating business cycle fluctuations.

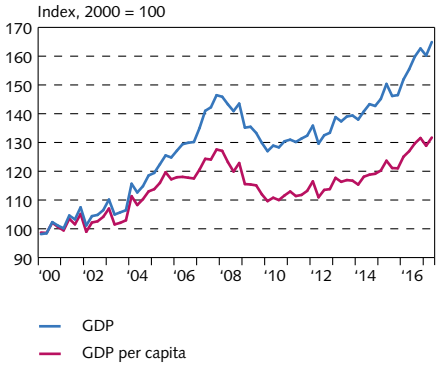
3.1 Economic developments since 2001

As is discussed above, the period since the adoption of the inflation target in 2001 has been a turbulent one for the Icelandic economy. This can be seen clearly in Chart 3.1, which shows GDP growth, on the one hand, and the contribution of the increase in hours worked and labour productivity to it, on the other. Over the period since 2001, GDP growth has averaged 3%, close to its long-term trend, which consists of 2% productivity growth and a 1% increase in total hours worked.

However, the average growth rate masks the wide fluctuations since 2001. The period in question can be broadly divided into five sub-periods of unequal length. The first, which extended until 2003, was characterised by tepid or modest GDP growth and a reasonably well-balanced macroeconomy, both internally and externally. This was followed by the overheating episode from 2004-2007, which began with major structural changes to the domestic mortgage lending market and a surge in energy-intensive industrial development, and evolved into a severe credit and asset price bubble.[6] The third sub-period featured the onset of Iceland's financial crisis in autumn 2008 and the ensuing recession. GDP contracted by more than 13% from the Q4/2007 peak until the start of the recovery in Q2/2010 (Chart 3.2). This marked the beginning of the fourth sub-period and the slow post-crisis recovery. The fifth and last sub-period can be said to have begun in 2015, when GDP growth began to pick up even more strongly, supported by two external shocks. Strong growth in tourism generated a surge in export growth and GDP growth, and at the same time, terms of trade improved strongly, as can be seen in domestic income rising faster than output in Chart 3.1 (gross national income, or GNI, is equivalent to GDP adjusted for terms of trade effects). The chart shows, however, that GDP growth was driven in large part by an

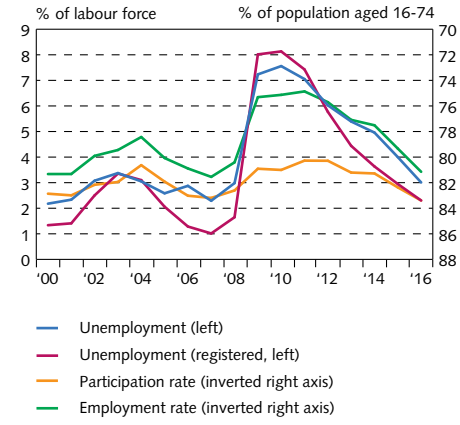
6. A much more detailed discussion of the financial crisis and the prelude to it can be found, for example, in the Report of the Parliamentary Special Investigation Commission (2009) and in Einarsson *et al.*, (2015). A discussion of changes in the mortgage lending market and their impact on the housing market can be found in Elíasson and Pétursson (2009).

Chart 3.2
GDP, total and per capita[1]
Q1/2000 - Q2/2017



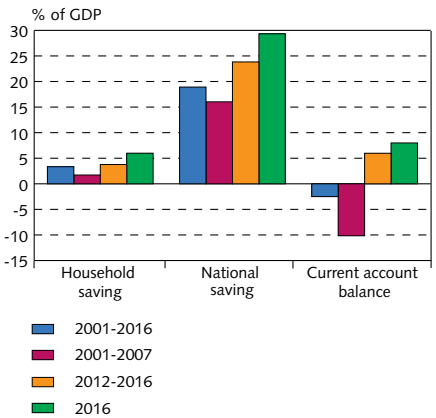
1. Quarterly GDP data, seasonally adjusted by the Central Bank (Q2/2017 data based on *Monetary Bulletin* 2017/3 forecast). GDP per capita, based on the working-age population (aged 16-74), using seasonally adjusted monthly data from the Statistics Iceland labour force survey.
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3.3
Unemployment, labour participation rate, and employment rate 2000-2016



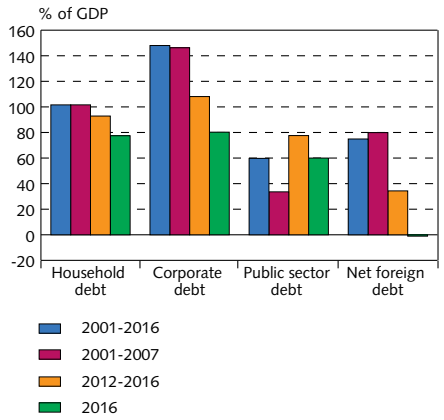
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3.4
Saving and current account balance 2001-2016[1]



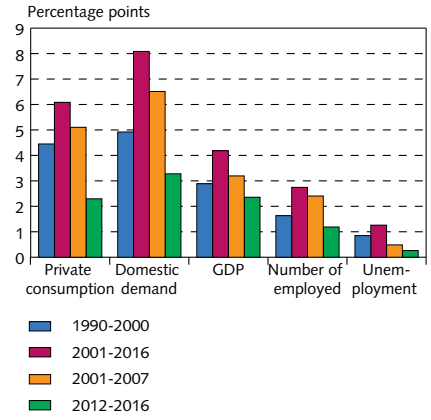
1. Household saving excludes pension funds and is measured as the difference between disposable income and private consumption at current prices. Gross national saving and current account balance adjusted for the effects of the settlement of the failed financial institutions' estates 2008-2015.
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3.5
Debt, selected sectors and the general economy 2001-2016[1]



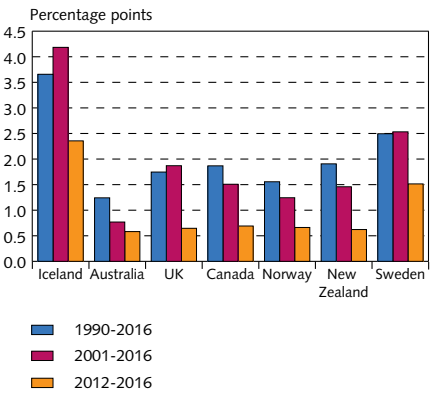
1. Corporate debt (excluding financial institutions and holding companies) to financial institutions and issued marketable bonds. Net foreign debt is the inverted net international investment position of Iceland.
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3.6
Fluctuations in various economic variables 1990-2016[1]



1. Standard deviation of annual changes in various economic variables.
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 3.7
Fluctuations in GDP growth 1990-2016[1]



1. Standard deviation of annual GDP growth.
Sources: OECD, Statistics Iceland, Central Bank of Iceland.

increase in total hours worked, and primarily in a rise in the number of employed, whereas productivity growth was relatively weak, apart from the most recent year. Despite this, GDP per capita has overtaken its pre-crisis peak (Chart 3.2).

As Chart 3.3 shows, unemployment broadly tracked the business cycle: it fell during the pre-crisis upswing and spiked after the crisis struck. As the economic recovery solidified, unemployment declined once again. Iceland's labour participation rate has generally been high and its employment rate likewise. Both fell markedly in the aftermath of the crisis but have risen rapidly again and, by 2016, were roughly back to their 2007 peak.

As Charts 3.4 and 3.5 indicate, the current expansion is much more firmly grounded than the pre-crisis boom. In 2016, household saving relative to GDP was more than three times the 2001-2007 average, and national saving has grown substantially as well, rising last year to its highest since 1965. This provides the basis for a turnaround in the current account balance, which looks set to be strongly in surplus this year, for the ninth year in a row. The surplus on external trade has also played a part in transforming Iceland's debt position: in 2016, Iceland's external assets exceeded its external liabilities for the first time since measurements began. As Chart 3.5 shows, this primarily reflects declining private sector debt – corporate debt in particular. Public sector debt grew in the wake of the financial crisis but has begun to decline again.

3.2 Cyclical fluctuations in Iceland

As Chart 3.6 indicates, cyclical fluctuations increased after the inflation target was adopted in 2001, as compared with the decade beforehand. They have subsided again, however, and the past five years have been much more stable than the 1990s in terms of GDP growth, domestic demand, and the labour market.

That said, the Icelandic economy remains more volatile than other relatively small, open, and advanced inflation-targeting economies (Australia, the UK, Canada, Norway, New Zealand, and Sweden), although the difference has generally diminished (Chart 3.7).[7] In the past five years, the standard deviation of GDP growth has declined by almost half compared to the period since 2001. Output volatility has also subsided in the other six countries, whereas in Iceland it has been about the same in recent years as in Sweden over the entire period.

To some extent it is to be expected that the business cycle is more volatile in Iceland than in larger economies with a more diverse production base (see, for instance, Central Bank of Iceland, 2010 and 2012b, Chapters 3 and 4). This can be seen, for example, in a comparison of fluctuations in export growth, which have been somewhat greater in Iceland than in the other countries (Chart 3.8), although they, too, have been diminishing in recent years (in part because exports have become more diverse than before). It can be assumed that an economy with a relatively narrow and commodity-driven

7. The same result is obtained using output gap fluctuations.

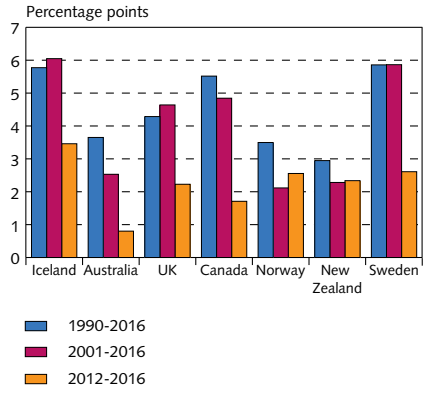
export base (such as Iceland) will be generally more volatile than an economy with a broader export base that is more closely linked with global value chains. Nor is it surprising that fluctuations in terms of trade are generally greater in Iceland than in countries such as the UK and Sweden, where commodities are relatively unimportant in exports (Chart 3.9). However, the fluctuations in Iceland's terms of trade are broadly similar to those in other commodity-exporting countries in the comparison group, or even somewhat less pronounced. Terms of trade fluctuate much more in Norway, for example, and historically they have been much more volatile in Australia, whereas in the past five years the fluctuations in both Australia and New Zealand have been similar to those in Iceland.

Although Iceland's relative macroeconomic volatility can be attributed in part to the small size of the economy, the importance of commodities in its exports, and the narrowness of its export base, there are probably other factors as well. These centre on domestic economic stabilisation policy. As is shown in Einarsson *et al.* (2013), fiscal policy in Iceland has tended to be procyclical rather than countercyclical, unlike that typically found in other advanced economies. For instance, public expenditure increased markedly during the pre-crisis upswing, alongside significant tax reductions. This was coupled with large development projects in the energy-intensive sector, with Government involvement, and structural changes in the mortgage lending market, both of which added further to the overheating of the economy.

As is discussed in the next chapter, inflation and inflation expectations have been volatile in Iceland, albeit less so in recent years. By the same token, the findings in Chapter 6 suggest that the monetary stance was too accommodative for most of this period, although monetary policy conduct seems to have improved in this regard in the past few years. Therefore, it is likely that the marked macroeconomic volatility in Iceland since the adoption of the inflation target can partly be attributed to the lack of a firm anchor for inflation and inflation expectations, leading to large fluctuations in real interest rates and therefore in demand and employment.[8] This can be seen in Chart 3.10, which shows the standard deviation of long-term real interest rates in Iceland and the six comparison countries. As the chart shows, real interest rates have long been much more volatile in Iceland than in the other countries, although the difference has narrowed considerably in the past few years. Although it is normal that external economic shocks should give rise to fluctuations in economic activity and real interest rates, it can also be assumed that a portion of these fluctuations in real interest rates, and therefore in economic activity, can be attributed to monetary policy's inability to create a sufficiently firm anchor for inflation and inflation expectations until the very recent past, as is discussed in the next chapter.

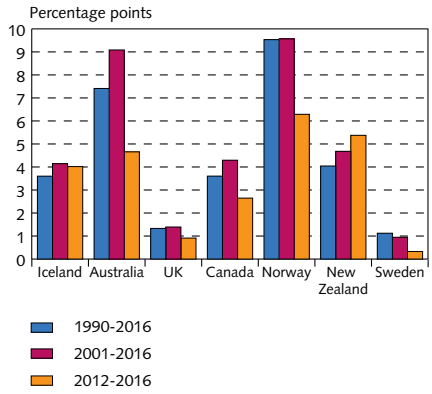
8. The real interest rate is defined as the difference between the nominal interest rate and expected inflation over the lifetime of the financial instrument. Sometimes current inflation is used instead of inflation expectations. Other things being equal, the more volatile inflation and inflation expectations are, the greater fluctuations in real interest rates will be.

Chart 3.8
Fluctuations in exports 1990-2016[1]



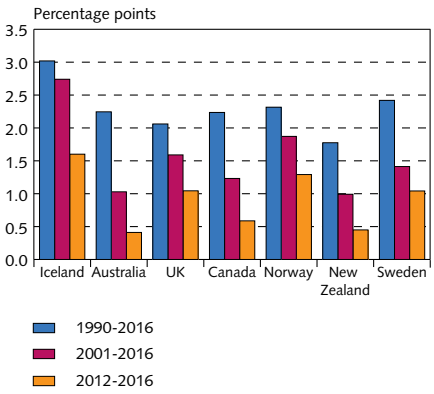
1. Standard deviation of annual changes in goods and services exports.
Sources: OECD, Statistics Iceland, Central Bank of Iceland.

Chart 3.9
Fluctuations in terms of trade 1990-2016[1]



1. Standard deviation of annual changes in terms of trade.
Sources: OECD, Statistics Iceland, Central Bank of Iceland.

Chart 3.10
Fluctuations in long-term real interest rates 1990-2016[1]



1. Standard deviation of quarterly averages of long-term real rates (5- to 10-year Treasury bonds), based on current twelve-month inflation.
Sources: OECD, Statistics Iceland, Central Bank of Iceland.

4 Inflation and inflation expectations since 2001

4.1 General developments in inflation

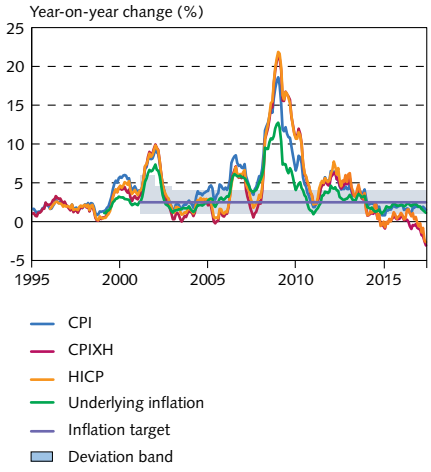
For decades, one of Iceland's biggest economic policy challenges has been controlling inflation. After being high and volatile for long periods, inflation was finally brought under control in the early 1990s but began to rise again, reaching 5.6% by the turn of the century (Chart 4.1). The reasons were all too familiar. Demand pressures had built up in the domestic economy, and GDP growth was strong. Economic activity was driven in part by foreign borrowing, and a large current account deficit had developed. This was compounded by large wage increases in 1997-1998. Ultimately, these severe internal and external imbalances led to a collapse of the exchange rate peg and the adoption of the inflation target in March 2001.

In the early days of the new monetary policy regime, inflation was affected by the currency depreciation following the abandonment of the exchange rate peg. It measured 3.9% in March 2001 and rose to 9.4% by January 2002. It was therefore well above the inflation target from the outset and quickly overtook the upper deviation limit (6% at that time). The imbalances that had developed in the late 1990s gradually unwound, however, and inflation was brought to target late in 2002. It remained at target until the first half of 2004 and then began to rise rapidly as demand pressures mounted. Inflation rose above 3% in May 2004 and overtook the upper deviation limit (now 4%) in February 2005, remaining above the deviation band almost without interruption until the second half of 2010. It was just under 6% at the beginning of 2008 and rose even further as the exchange rate plummeted during the financial crisis, peaking at 18.6% in January 2009. From then on, it subsided once again, aligning with the target late in 2010 and remaining there until spring 2011, whereupon it picked up yet again in the wake of wage settlements providing for large pay increases. Inflation peaked at 6.5% in January 2012 but was brought back to target early in 2014 through a tight monetary stance (see Chapter 6). It remained at target until the end of 2014 and then began to fall still further, driven by a steep decline in global oil prices. It measured 1.5% in mid-2017 and has therefore been at or below target for more than three years running.

CPI inflation has averaged 5% since the beginning of the inflation-targeting regime in 2001. Other measures of inflation tell a similar tale. In terms of the consumer price index excluding housing (CPIXH), inflation has averaged 4.4% since March 2001, or 0.6 percentage points less than inflation according to the CPI. According to the harmonised index of consumer prices (HICP), which also excludes housing, it averaged 4.7% over the same period. The measures of underlying inflation shown in Chart 4.1 have also been above target for a large part of the period, averaging 3.7% since March 2001.

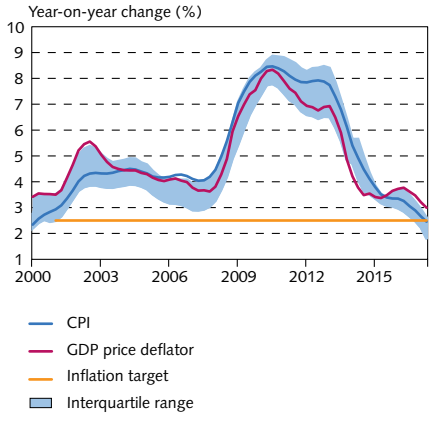
The inflation problem that persisted for most of the period can also be seen in Chart 4.2, which shows the five-year moving average of various measures of inflation. Average inflation in terms of the CPI hovered around 4% for quite some time. It rose still further during the

Chart 4.1
Various measures of inflation[1]
January 1995 - June 2017



1. CPI is the consumer price index, CPIXH is the CPI excluding housing, and HICP is the Harmonised Index of Consumer Prices. Underlying inflation is estimated from the median of six statistical measures (five trimmed means and a weighted median).
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 4.2
Long-term inflation trend[1]
Q1/2000 – Q2/2017



1. Five-year moving average of twelve-month inflation in terms of the CPI and the GDP price deflator. The chart also shows the interquartile range of the five-year moving average of annual changes in the CPI, CPIXH, HICP, underlying inflation, the price deflators of private consumption and domestic demand, and unit labour costs. Q2/2017 data where measured data is not available is based on *Monetary Bulletin* 2017/3 forecast.
Sources: Statistics Iceland, Central Bank of Iceland.

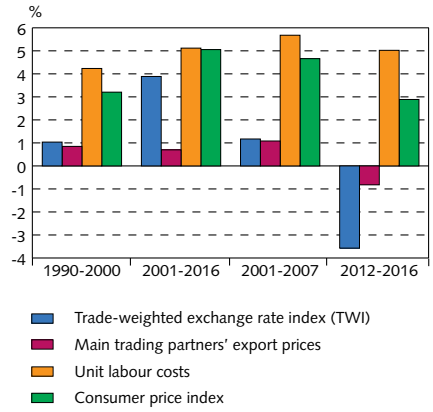
aftermath of the financial crisis but then subsided again, to 2.5% by mid-2017. Trend inflation has also fallen in terms of other measures. As Chart 4.1 shows, inflation excluding housing has fallen very rapidly in the recent term. This reflects the swift rise in house prices in the recent past: for inflation including housing to be close to target, it is clear that prices of other goods and services must rise modestly or even fall. At mid-year 2017, the twelve-month decline in price indices excluding housing – the CPIXH or the HICP – therefore measured close to 3%, and the average increase over the past five years had shrunk to roughly 1½%. The average increase in the past five years is larger in terms of the GDP price deflator, which reflects developments in the price of goods and services produced domestically. By that measure, inflation has averaged 3% over the past five years. The difference between inflation in terms of the GDP price deflator and inflation in terms of the CPI lies mainly in the contribution of imported goods and services, which fell by 3.4% per year, on average, in 2012-2016. This steep drop in import prices has offset domestic price increases, reflecting both the appreciation of the króna and unusually low global inflation: the króna appreciated by an average of 3.6% per year in 2012-2016, while the price of exports from Iceland's main trading partners fell by 0.8% per year (Chart 4.3). At the same time, unit labour costs (wage increases in excess of productivity growth) rose by an average of 5% per year, or twice the level consistent with inflation at 2.5%.

4.2 Deviations of inflation from target

Inflation has therefore been well above the 2.5% target for most of the period since the inflation target was adopted in 2001. These large deviations can be seen clearly in Chart 4.4: deviation from target have averaged nearly 3 percentage points and have been about three times as large as in the six comparison countries over the same period. In addition, the deviations in Iceland are mainly above-target misses, while in the other countries they are more evenly divided between over- and undershooting. As Chart 4.5 shows, inflation has been more than 1 percentage point above target for roughly 60% of the period since 2001, and such large target misses are much more common in Iceland than in the comparison countries. The difference is even greater in terms of deviations of more than 2 percentage points from target: in Iceland, inflation has diverged from the target by more than 2 points in nearly 40% of instances, whereas such large deviations are extremely rare in the other countries (Chart 4.6).

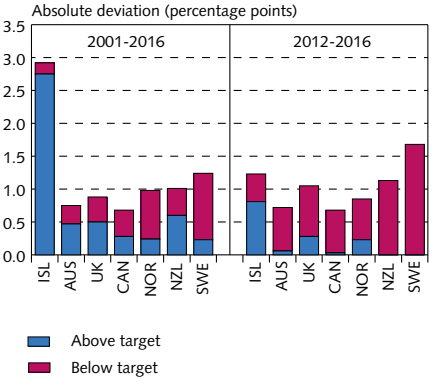
The economy is subjected regularly to economic shocks (positive and negative) that push inflation away from the target. Deviations from target are therefore to be expected. As is discussed in Chapter 2, the role of monetary policy is also to mitigate cyclical fluctuations to the extent that is consistent with medium-term price stability. As a result, it is appropriate to allow a certain flexibility in bringing inflation back to target, as business cycle fluctuations can be exacerbated by trying to bring inflation to target too fast. On the other hand, large and persistent departures from the target, such as those occurring in Iceland, tend to erode the credibility of monetary policy, de-anchor

Chart 4.3
Inflation and domestic and international determinants 1990-2016[1]



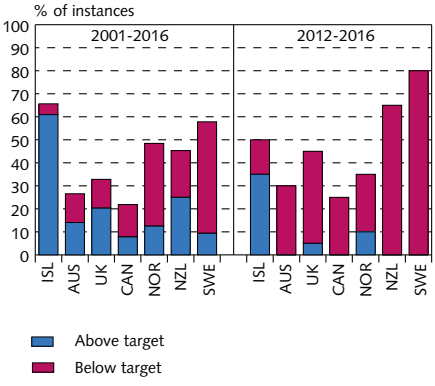
1. A rise in the trade-weighted exchange rate index (TWI) represents a decline in the exchange rate of the króna versus the average of other currencies.
Sources: Macrobond, Statistics Iceland, Central Bank of Iceland.

Chart 4.4
Average deviation from the inflation target[1]
Q1/2001 - Q4/2016



1. Average absolute deviation from inflation target (based on the inflation target measure used by each country) and relative contribution of above- and below-target deviations.
Sources: Central bank websites, OECD, Central Bank of Iceland.

Chart 4.5
Deviation of more than 1 percentage point from target[1]
Q1/2001 - Q4/2016

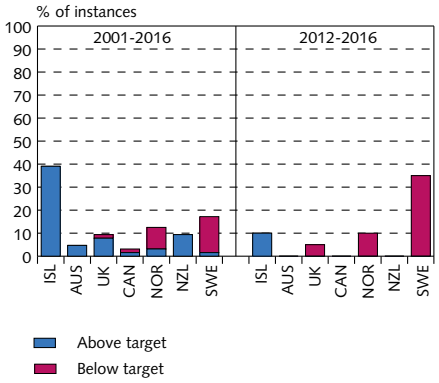


1. Frequency of deviations of more than 1 percentage point from inflation target (based on the inflation target measure used by each country) and relative contribution of above- and below-target deviations.
Sources: Central bank websites, OECD, Central Bank of Iceland.

Chart 4.6

Deviation of more than 2 percentage points from target[1]

Q1/2001 – Q4/2016

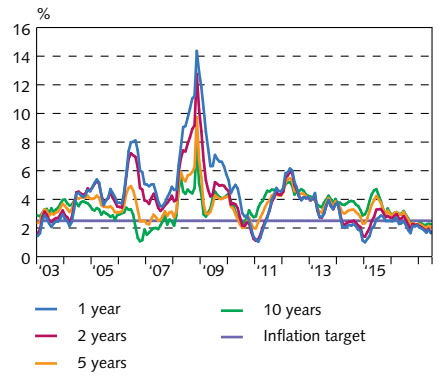


1. Frequency of deviations of more than 2 percentage points from inflation target (based on the inflation target measure used by each country) and relative contribution of above- and below-target deviations.
Sources: Central bank websites, OECD, Central Bank of Iceland.

Chart 4.7

Breakeven inflation rate in the bond market[1]

January 2003 - June 2017

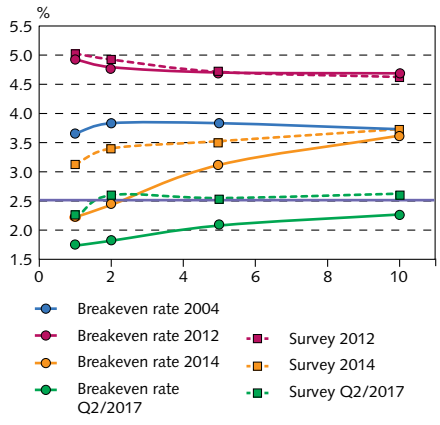


1. One-, two-, five-, and ten-year breakeven inflation rate estimated from the interest rate spread between indexed and non-indexed bonds. Monthly averages.
Source: Central Bank of Iceland.

Chart 4.8

One- to ten-year inflation expectations[1]

Period averages



1. Inflation expectations 1, 2, 5, and 10 years ahead, estimated from the breakeven inflation rate in the bond market and market survey responses. Period averages.
Source: Central Bank of Iceland.

inflation expectations, and exacerbate cyclical fluctuations. Charts 4.4-4.6 show, however, that deviations of inflation from the target have diminished significantly in Iceland in recent years. The average deviation has been reduced by more than half, and large deviations occur much less frequently than before. The frequency of undershooting has increased as well, although overshooting is still more frequent. In the past five years, deviations have therefore been much closer to the pattern seen in other advanced inflation-targeting economies.

4.3 Developments in inflation expectations

Inflation expectations have declined alongside falling inflation. As Chart 4.7 shows, short- and long-term inflation expectations have fluctuated widely since 2003 and, like inflation, have usually been above target.[9] While this is particularly the case for the post-crisis period, it also applies to the period beforehand, when the breakeven inflation rate averaged 3-4%, depending on the length of the horizon. The breakeven rate has declined in recent years, however, and is currently well in line with the inflation target over all horizons. This can be seen more clearly in Chart 4.8, which shows the breakeven inflation rate and market agents' inflation expectations for up to ten years over various periods. As the chart shows, inflation expectations were usually well above the target before the crisis and rose steeply afterwards. As time passed, however, they were brought down towards the target – short-term expectations initially and then, more recently, long-term expectations.

4.4 Fluctuations in inflation and inflation expectations

As inflation and inflation expectations have fallen, fluctuations in both have also diminished (Chart 4.9). Fluctuations in various measures of inflation are only a fourth as large as they were in 2001-2007, and fluctuations in short- and long-term inflation expectations have receded as well. As Chart 4.10 shows, however, inflation remains more volatile in Iceland than in the other six countries, although the difference has narrowed greatly in recent years.

With falling inflation expectations and reduced volatility of inflation and inflation expectations, it appears that uncertainty about future inflation has abated as well. As can be seen in Chart 4.11, households', businesses', and market agents' assessment of the inflation outlook one year ahead grew more divergent during the first years after the adoption of the inflation target, even though inflation and inflation expectations became less volatile. Uncertainty about the inflation outlook grew even further during the aftermath of the financial crisis and the associated spike in inflation, but dispersion of expectations has diminished again in the past few years and is now broadly at the level seen in the early 2000s.

9. The chart shows the breakeven inflation rate in the bond market; i.e., the spread between interest rates on comparable indexed and non-indexed bonds. As is discussed in Box 1 in *Monetary Bulletin* 2015/2, the breakeven inflation rate also contains a variable risk premium compensating for uncertainty about inflation and differences in the bond market liquidity of indexed and nominal bonds. Continuous estimates of the breakeven inflation rate are available from 2003 onwards; therefore, this is the only measure of inflation expectations that extends over a long enough period.

4.5 Indications of changes in the inflation process

Increased price stability and firmer anchoring of inflation expectations also appear to have changed the characteristics of the inflation process. For instance, it appears as though inflation surprises have less impact on long-term inflation expectations than before, and fluctuations in inflation appear less persistent. Furthermore, the relationship between inflation and its key drivers seems to have changed.

Inflation surprises have less impact on long-term inflation expectations

If inflation expectations are securely anchored to the target, unexpected changes in inflation should not affect them, long-term expectations in particular. If the anchor is weak, however, there is the risk that inflation surprises will affect expectations and give rise to stronger inflationary effects than would otherwise exist.

This can be analysed by estimating the following empirical relationship using monthly data for two five-year periods (2003-2007 and 2012-2016):

$$\Delta\pi^e = \alpha + \beta\,(\pi - \pi^f) + \varepsilon$$

where π is the monthly change in the CPI, $\Delta\pi^e$ is the daily change in inflation expectations (the two-, five-, and ten-year breakeven inflation rate) following the publication of the CPI (from the end of the day before publication to the end of the publication day – the index is published at the beginning of the day), and ε is a residual. π^f is a measure of the forecasted monthly change in the CPI and is obtained with a simple forecasting model, where monthly changes are forecast using the monthly change of the previous month, the monthly change six months earlier, and seasonal dummies. $(\pi - \pi^f)$ is therefore a measure of inflation surprises, and β is an estimation of their impact on inflation expectations. As can be seen in Chart 4.12, these surprises significantly affected inflation expectations during the former period but not during the latter.

Inflation appears less persistent than before

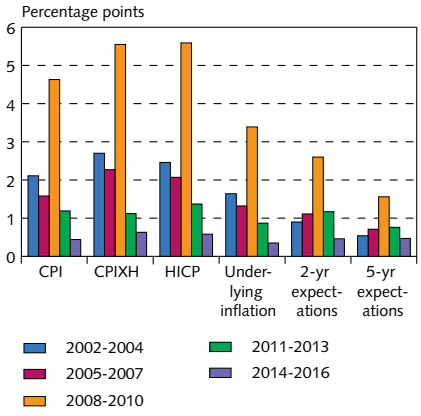
Lower and more stable inflation, a firmer anchor for inflation expectations, and reduced uncertainty about the inflation outlook also appear to have reduced persistence in the inflation process. If inflation is highly persistence, there is the risk that temporary supply shocks such as changes in oil prices will have a lasting impact on inflation, making it harder for monetary policy to control inflation. To measure inflation persistence, the following time series model is estimated for different sub-periods between 1990 and 2016:[10]

$$\pi_t = \alpha + \gamma_1\,\pi_{t-1} + \cdots + \gamma_n\,\pi_{t-n} + \varepsilon_t$$

where π_t is quarterly inflation (the seasonally adjusted quarter-on-quarter change in the CPI) in period t and ε_t is a residual. Inflation

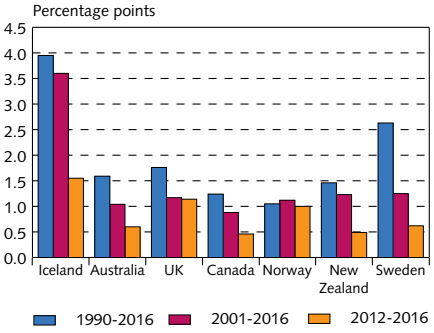
10. Statistical tests indicated that a second-order AR process suffices. Further discussion of methods for estimating inflation persistence can be found in Pétursson (2008).

Chart 4.9
Fluctuations in inflation and inflation expectations[1]
Q1/2002 - Q4/2016



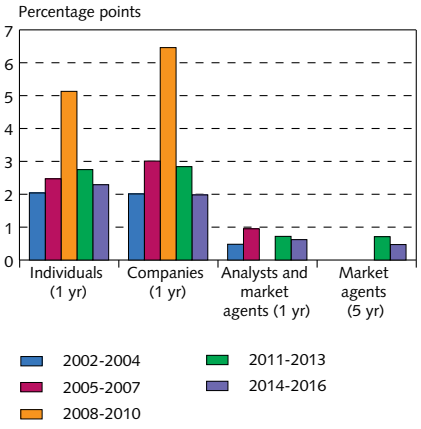
1. Standard deviation in various measures of inflation and inflation expectations for five periods of equal length. Underlying inflation is estimated from the median of six statistical measures (five trimmed means and a weighted median). The breakeven inflation rate in the bond market is used as a measure of 2- and 5-year inflation expectations (data only available from 2003 onwards).
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 4.10
Fluctuations in inflation 1990-2016[1]



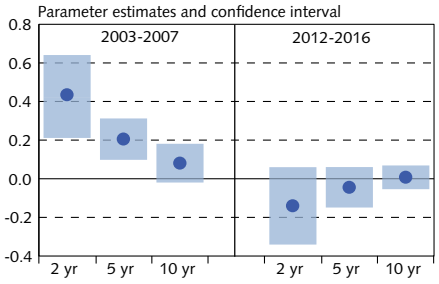
1. Standard deviation in year-on-year inflation based on quarterly averages of the CPI.
Sources: OECD, Statistics Iceland, Central Bank of Iceland.

Chart 4.11
Dispersion of inflation expectations[1]
Q1/2002 - Q4/2016



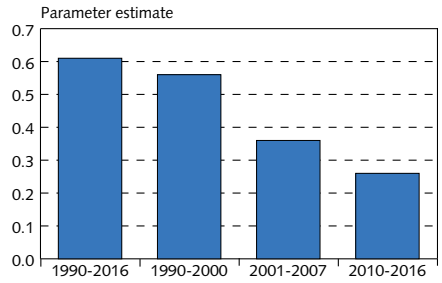
1. Standard deviation in surveys of inflation expectations for five periods of equal length (linear interpolation is used where measurements are missing). No surveys were carried out among analysts and market agents from mid-2008 until the beginning of 2012. From that time onwards, long-term inflation expectations have also been surveyed.
Sources: Gallup, Central Bank of Iceland.

Chart 4.12
Effects of unexpected changes in inflation on inflation expectations[1]



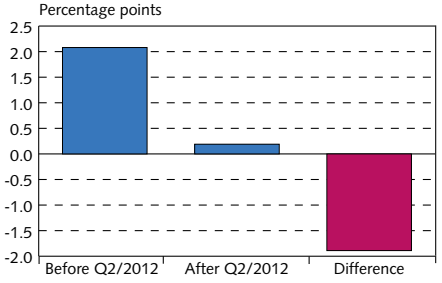
1. The dots show a parameter estimation from a regression of changes in the two-, five-, and ten-year breakeven inflation rate on unexpected changes in the consumer price index (CPI) on index publication dates for two five-year (sixty-month) periods (2003-2007 and 2012-2016). Unexpected changes in the CPI are estimated as a deviation of monthly changes in the index from the forecasted value, using a forecast equation that contains seasonal dummies and one- and six-month lags in monthly changes in the index. The shaded area shows the two-standard-deviation range of the parameter estimates.
Source: Central Bank of Iceland.

Chart 4.13
Inflation persistence[1]



1. Estimated using a second-order AR model for the seasonally adjusted quarterly changes in the CPI: $\pi_t = \alpha + \gamma_1 \pi_{t-1} + \gamma_2 \pi_{t-2} + \varepsilon_t$ where π_t is quarterly inflation during period t and ε_t is a residual. $\rho = \gamma_1 + \gamma_2$ gives an estimate of the level of persistence in inflation.
Source: Central Bank of Iceland.

Chart 4.14
Inflation bias according to Phillips curve[1]



1. The Phillips curve is of the form: $\pi_t = \alpha + \beta\pi_{t-1} + (1-\beta)\pi_t^e + \gamma y_{t-1} + \phi q_{t-1} + \varepsilon_t$, where π_t is year-on-year inflation in period t, π_t^e are 10-year inflation expectations, y_t is the output gap, q_t is the year-on-year change in importers' real exchange rate, and ε_t is a residual. The inflation bias is given as: $\pi - \pi^e = \alpha/(1-\beta)$.
Source: Central Bank of Iceland.

persistence is then estimated as $\rho = \gamma_1 + \cdots + \gamma_n$. As Chart 4.13 shows, inflation persistence has been diminishing in the past few years. The effects of supply shocks on inflation therefore appear to taper off more rapidly than before, indicating increased credibility of the inflation target. It also suggests that the Central Bank has had inflation under better control than before and that deviations from target call for less monetary policy response than was previously needed.

The relationship between inflation and its key drivers appears to have changed

The last indication of changes in the inflation process and of improved management of inflation and inflation expectations can be found by estimating the Phillips curve (see, for instance, Box 5 in *Monetary Bulletin* 2015/2), which is a standard description of the determination of inflation, and to see whether there are signs of a structural break in the relationship between inflation and its key determinants.[11] Thus the following Phillips curve is estimated using quarterly data for the period 2003-2016:

$$\pi_t = \alpha + \beta\pi_{t-1} + (1-\beta)\pi_t^e + \gamma y_{t-1} + \phi q_{t-1} + \varepsilon_t$$

where π_t is twelve-month inflation at time t, π_t^e is inflation expectations (estimated from the ten-year breakeven inflation rate), y_t is the output gap (the difference between actual and potential output), q_t is the twelve-month change in the import real exchange rate, and ε_t is a residual. The steady-state solution of the Phillips curve – i.e., where inflation is at equilibrium, the output gap is closed, and the real exchange rate is constant – is then given as:

$$\pi = \alpha/(1-\beta) + \pi^e$$

and "inflation bias" as $\pi - \pi^e$. If inflation expectations are anchored at the Bank's target, the inflation bias should be zero: $\pi - \pi^e = \alpha/(1-\beta) = 0$.

In order to determine whether and when a possible structural break has taken place in the Phillips curve and whether it means that the inflation bias has grown smaller, the Quandt-Andrews test for structural breaks at an unknown date is used. The test clearly indicates that a structural change took place beginning in Q2/2012 and suggests that the change lies in a decline in the constant in the Phillips curve (α). According to this analysis, the inflation bias was about 2 percentage points before 2012 but has disappeared since then (Chart 4.14).[12]

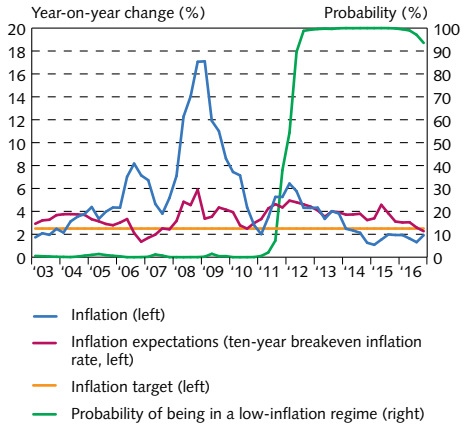
11. The version of the Phillips curve used here is a standard forward-looking version, where the coefficients on past inflation and inflation expectations sum to one (see, for example, Yellen, 2015, for a recent application). This restriction is not rejected by the data (p-value = 0.16).

12. The hypothesis that the inflation bias is zero is strongly rejected by the data before 2012 (p-value = 0.00) but not for the years thereafter (p-value = 0.59). No indications were found of other changes in the Phillips curve; i.e., changes in the slope of the Phillips curve or in the impact of exchange rate movements on inflation.

Similar results are obtained when the Phillips curve is estimated using a with a two-regime Markov switching model. In this case, inflation can fluctuate between high- and low-inflation regimes. One way to motivate this is that the general public is unsure about the Central Bank's determination and ability to keep inflation at the declared 2.5% inflation target. At any given time, the public tries to infer, based on developments in inflation and other economic variables, and on how the Bank responds to deviations from target, how likely it is that the Bank is committed to keeping inflation at 2.5% or whether it actually aims at a higher target (for instance, a target closer to 4-4½%, which is close to the average inflation rate from the adoption of the target until the onset of the financial crisis and can be obtained from the above estimation of the inflation bias). As the public observes improved performance in controlling inflation, its confidence in the Central Bank's commitment to keeping inflation at 2.5% grows, and the credibility of the inflation target likewise.[13] According to the Markov switching model, the inflation process changed at about the same time as is given by the Quandt-Andrews test above (Chart 4.15). Early on, the probability of being in the low-inflation regime is almost zero, but this begins to change in 2012: from the beginning of 2012 onwards, there is a more than 50% probability of being in the low-inflation regime, and from Q2/2012 onwards that probability rises to 90% or more.

As is discussed above and shown in Chart 4.15, inflation began to increase and inflation expectations to rise in the second half of 2011, in the wake of large pay increases earlier that year. In autumn 2011, the Bank's MPC began to raise interest rates again, after steadily lowering them in the wake of the financial crisis (see Chapter 6). The Committee stated explicitly that it was ready to raise rates aggressively in order to prevent high inflation from becoming entrenched. This response and message appears to have played a key role in enhancing the credibility of monetary policy because after that time, the inflation bias that had long been built into the determination of inflation in Iceland began to shrink and inflation expectations finally aligned with the official 2.5% inflation target.

Chart 4.15
Probability of being in a low-inflation regime[1]
Q1/2003 – Q4/2016



1. Smoothed probability of being in a low-inflation regime based on the Phillips curve, estimated with a two-regime Markov switching model.
Sources: Statistics Iceland, Central Bank of Iceland.

5 Exchange rate of the króna

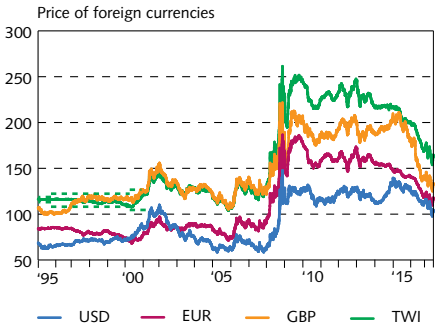
For decades until the adoption of an inflation target in 2001, the Central Bank of Iceland adhered to various versions of exchange rate target (see Central Bank of Iceland, 2012b, Chapter 12). Although the Bank has not had a specific exchange rate target since 2001, this does not change the fact that the exchange rate of the króna plays a

13. As in Barro (1986), it can be assumed, for instance, that the general public considers there to be a probability of h_t that the Bank is determined to keep inflation at π^T (i.e., the 2.5% inflation target), but a probability of $1 - h_t$ that it is willing to deviate from the target if it deems this appropriate. Therefore, in the latter case, it sometimes aims for a target of π^T (with a probability of k_t) but sometime aims for a higher target; for example, $\pi^T + \theta$ (with a probability of $1 - k_t$). It is possible to show that the expected target is in this case given as $\pi^T + (1 - h_t)(1 - k_t)\theta$. If the public updates its assessment of the Bank's determination using the Bayes rule, the probability of being in a low-inflation regime today if inflation was low yesterday is $h_t = h_{t-1}/[h_{t-1} + (1 - h_{t-1})k_{t-1}]$. The anchor for expectations therefore gradually declines from $\pi^T + \theta$ í π^T, as the credibility of the target is enhanced and the probability of being in a low-inflation regime increases.

Chart 5.1

Exchange rate of the króna versus major currencies[1]

3 January 1995 - 30 June 2017

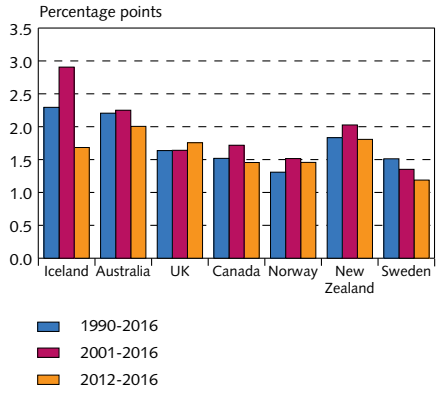


1. Until 5 January 1999, the exchange rate of the euro is based on the exchange rate of the European Currency Unit (ECU). The exchange rate index links the official exchange rate index under the fixed exchange rate regime until 27 March 2001 and the trade-weighted exchange rate index (TWI) thereafter. The broken lines show the deviation band of the exchange rate peg, which was ± 2.25% until 6 September 1995, ± 6% until 14 February 2000, and ± 9% until 27 March 2001, when the peg was abandoned.

Source: Central Bank of Iceland.

Chart 5.2

Fluctuations in the real exchange rate 1990-2016[1]

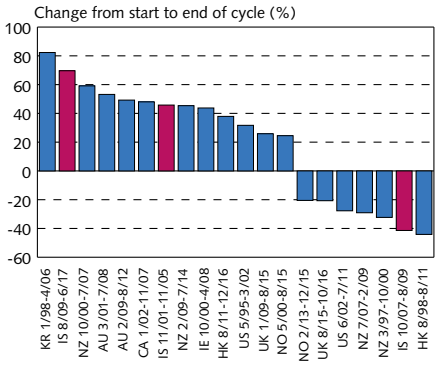


1. Standard deviation of monthly changes in the real exchange rate (relative consumer prices).

Sources: Bank for International Settlements, Central Bank of Iceland.

Chart 5.3

Twenty exchange rate cycles in advanced economies since 1995[1]



1. Changes in the real exchange rate from peak (trough) to trough (peak). The countries are Australia (AU), United States (US), United Kingdom (UK), Hong Kong (HK), Ireland (IE), Iceland (IS), Canada (CA), Norway (NO), New Zealand (NZ) og South Korea (KR).

Sources: Bank for International Settlements, Central Bank of Iceland.

key role in monetary policy formation, as the exchange rate is a very important determinant of inflation and economic activity in a small economy like Iceland.

5.1 Exchange rate developments since 2001

As can be seen in Chart 5.1, the exchange rate of the króna has fluctuated widely since the exchange rate peg was abandoned in 2001. The króna had been under considerable pressure during the prelude to the exit from the peg, and it weakened even further after it was floated. For example, the trade-weighted exchange rate index was just over 110 points at the beginning of 2000, but late in November the króna depreciated by about a fourth, bringing the index to just under 150 points (a rise in the exchange rate index indicates a depreciation of the króna against the average of other currencies). From then until early November 2005, the króna appreciated by nearly half, pushing the exchange rate index down to just under 104 points. Then it reversed course, depreciating by about a fourth by mid-2006. The index remained between 120 and 140 points until February 2008, when the market for currency swaps in Icelandic krónur seized up. At that point, the króna began to tumble, sending the exchange rate index soaring up to 261 points, a depreciation of 56% since the downward cycle began in July 2007. The currency recovered slightly in late 2008, and at the beginning of 2009 the index measured about 227 points. From March 2009 through August 2015, it hovered between 215 and 250 points. After that, the króna began to appreciate again, lowering the index to just under 154 points by June 2017, a year-on-year appreciation of 28%. It weakened slightly in the latter part of June, however, bringing the index to 164 points by the month-end.

The exchange rate has therefore fluctuated widely since the inflation target was adopted. As Chart 5.2 indicates, the standard deviation of monthly changes in the real exchange rate has been nearly 3 percentage points in Iceland since 2001, almost twice as much as in the other six countries other than Australia and New Zealand, which have also experienced wide fluctuations in their real exchange rate over this period. As the chart shows, however, exchange rate volatility has subsided in Iceland, and the monthly standard deviation of the real exchange rate has been broadly in line with that in comparison countries in the past five years.[14]

Although short-term fluctuations in the real exchange rate have been significant through the years, exchange rate cycles like that in Iceland are not unique, particularly among countries that rely heavily on commodity exports. Chart 5.3 compares real exchange rate cycles in selected advanced economies since 1995. Three large exchange rate cycles can be identified in Iceland over this period: from November 2001 through November 2005, when the real exchange rate rose by over 45%; from October 2007 through August 2009, when it fell by

14. As is discussed in Chapter 6.4, this can doubtless be attributed to some extent to the fact that capital controls were introduced in Iceland in November 2008, which helped halt the post-crisis collapse of the króna and supported the currency early on. The controls also helped to mitigate short-term exchange rate volatility, as various types of cross-border financial transactions were prohibited.

more than 41%; and most recently, from August 2009 through June 2017, when it rose by almost 70%. This is broadly similar to the cyclical increase in New Zealand during the period from October 2000 through July 2007, when the real exchange rate rose 60%, but less than the 83% increase in South Korea between the beginning of 1998 and spring 2006.[15] Major real exchange rate cycles can also be found in Australia and Canada during this period. It is also interesting to note that even countries with a currency board (Hong Kong) or those that are members of a currency union (Ireland) can experience major real exchange rate cycles. As Chart 5.4 shows, the exchange rate cycles are, on average, broadly similar to those in New Zealand. The duration of the cycle is similar as well. As is generally the case in other countries, cyclical expansions tend to be longer than contractions.

5.2 Interest rate differential with abroad

Since 2001, the main objective of monetary policy has been to ensure price stability; i.e., to keep inflation as close as possible to 2.5% over the medium term. The Central Bank has therefore applied its monetary policy instruments – primarily short-term interest rates on transactions with domestic financial institutions – so as to achieve this objective. As a consequence, interest rates in Iceland can deviate from global rates, depending on how domestic macroeconomic developments deviate from global developments.

As Chart 5.5 shows, the Central Bank of Iceland's key interest rate has been above the trading partner average ever since 2001, and the nominal interest rate differential has often been substantial, particularly in the lead-up to and aftermath of the financial crisis, when inflation surged in Iceland but declined sharply in trading partner countries. Because of these divergent developments in inflation (see Chapter 4), it can be more appropriate to compare domestic and foreign real interest rates. The real interest rate differential widened substantially during the pre-crisis upswing (Chart 5.6). It narrowed in the wake of the crisis, however, and Iceland's real rate was about as negative as that in trading partner countries early in 2012. Since then, however, the spread has widened once again: the real rate has risen markedly in Iceland, with the growing strength of the domestic economic recovery, while trading partners' recovery has been weak, as is reflected in still-low real interest rates. As Chart 5.7 shows, the risk premium on domestic financial obligations rose steeply during the financial crisis, and this, too, affected the interest rate spread over the period. At first perusal, the interest rate differential seems to have widened significantly until 2009, but when adjusted for the risk premium, it actually narrowed from 2007 through 2012, when it turned around again.[16]

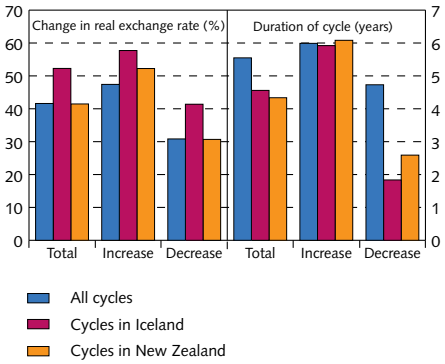
Apart from the period surrounding the financial crisis, the interest rate differential with abroad has generally reflected the higher

15. Unlike in New Zealand, the appreciation in Iceland and South Korea came in the wake of a deep post-crisis economic contraction following a financial crisis.

16. Other things being equal, a declining risk-adjusted interest rate differential would have generated even more downward pressure on the exchange rate of the króna, but this was offset by the restrictions on capital outflows imposed late in 2008 (see Chapter 6.4).

Chart 5.4

Average size and duration of exchange rate cycles in advanced economies since 1995[1]

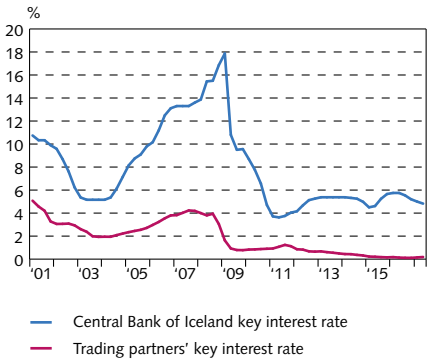


1. Average change in the real exchange rate over 20 exchange rate cycles since 1995 (see Chart 5.3).
Sources: Bank for International Settlements, Central Bank of Iceland.

Chart 5.5

Key policy interest rate[1]

Q1/2001 – Q2/2017

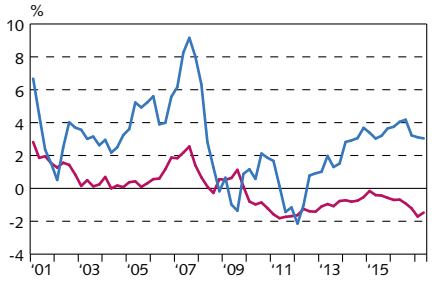


1. Weighted average key interest rate of main trading partners.
Sources: Macrobond, Central Bank of Iceland.

Chart 5.6

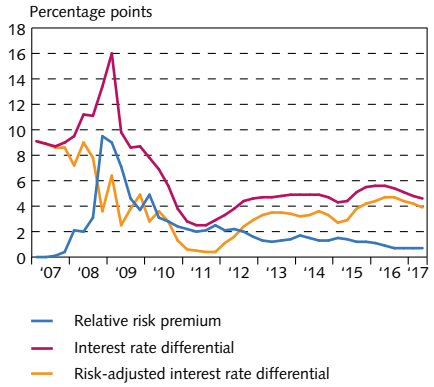
Real central bank interest rate[1]

Q1/2001 – Q2/2017



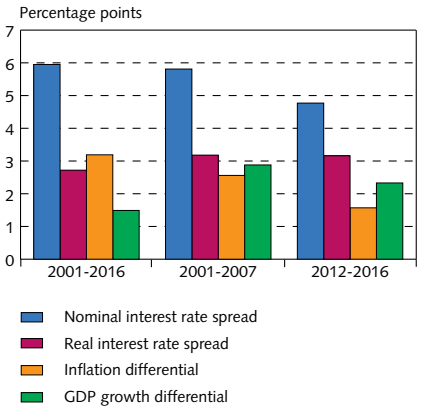
1. Real rate based on current twelve-month inflation. Weighted average key interest rate of main trading partners.
Sources: Macrobond, Central Bank of Iceland.

Chart 5.7
Interest rate differential and risk premium[1]
Q1/2007 - Q2/2017



1. The relative risk premium is measured in terms of the credit default swap (CDS) spread on the Republic of Iceland, on the one hand, and the average spread on the US and Germany, on the other (five-year US dollar obligations in all cases). The interest rate differential is measured in terms of the difference between the Central Bank of Iceland's key interest rate and the weighted average key rate in Iceland's main trading partner countries.
Sources: Bloomberg, Macrobond, Thomson Reuters, Central Bank of Iceland.

Chart 5.8
Interest rate differential, inflation, and GDP growth 2001-2016[1]



1. Spread between key interest rate in Iceland and main trading partners. Difference between inflation and GDP growth in Iceland and main trading partners. Real interest rate based on current twelve-month inflation.
Sources: Macrobond, OECD, Statistics Iceland, Central Bank of Iceland.

inflation rate and faster growth in economic activity in Iceland than in its trading partners. From 2001-2016, the nominal differential averaged 6 percentage points and the real differential 2.7 percentage points (Chart 5.8). As the chart shows, the nominal differential has been an average of 1 percentage point smaller in the past five years than in 2001-2007. This reflects the accordingly smaller difference between domestic and trading partner inflation, and therefore, the real interest rate differential is broadly unchanged. Furthermore, GDP growth is stronger on average in Iceland in the latter period, although the growth differential is somewhat smaller than in the former period.

In order to place developments in the interest rate differential over these two periods in context, it can be useful to assume that monetary policy is formulated in accordance with the Taylor rule (see Taylor, 1993), which is commonly used to describe developments in central bank interest rates (see Chapter 6). According to the Taylor rule, central bank interest rates are determined by:

$$i = (r^* + \pi) + 0.5(\pi - \pi^T) + 0.5y$$

where i is the nominal central bank rate, r^* is the equilibrium real rate (i.e., the real rate that, over the medium term, ensures inflation at target and output at potential), π is inflation, π^T is the inflation target, and y is the output gap. If a corresponding rule also describes central bank interest rates in Iceland's main trading partners, the interest rate differential can be expressed as (the respective foreign variables are denoted by w):

$$(i - i^w) = (r^* - r^{w*}) + 1.5(\pi - \pi^w) - 0.5(\pi^T - \pi^{wT}) + 0.5(y - y^w)$$

The nominal interest rate differential therefore reflects different levels of equilibrium real interest rates, differences in actual inflation rates and inflation targets, and different levels of economic activity. The change in the interest rate differential from one period to another is therefore (Δ denotes a change):

$$\Delta(i - i^w) = \Delta(r^* - r^{w*}) + 1.5\Delta(\pi - \pi^w) + 0.5\Delta(y - y^w)$$

As Chart 5.8 shows, the difference in inflation between 2001-2007 and 2012-2016 has narrowed by 1 percentage point and the growth differential by 0.6 percentage points. If the equilibrium interest rate is unchanged over these two periods, the interest rate differential with abroad should therefore have narrowed by 1.8 percentage points according to the Taylor rule, or 0.8 percentage points more than it actually has. International research indicates, however, that global equilibrium real rates have also fallen markedly in the wake of the financial crisis (see, for example, Holston *et al.*, 2016). Research suggests that they have also fallen in Iceland, but less than global rates, and that they have even risen again with the recent surge in GDP growth (see, for example, Daníelsson *et al.*, 2016). The 1 percentage point decline in the nominal differential between these two periods would therefore be consistent with the results from the Taylor

rule if the equilibrium real rate has fallen by an average of nearly 1 percentage point more globally than in Iceland.[17] Further discussion of monetary policy and developments in interest rates over the inflation-targeting period can be found in Chapter 6.

5.3 The króna: a shock absorber or a source of shocks?

As is discussed above, the exchange rate of the króna has fluctuated considerably since the inflation target was adopted. To the extent that these fluctuations reflect an adjustment to changes in economic conditions in Iceland as compared with the rest of the world, they need not be deemed bad or a problem in and of themselves, although the resilience of firms and sectors faced with changed external conditions is always tested under such circumstances. In this case, the real exchange rate should generally rise when economic activity expands faster in Iceland than in other countries, and the reverse should be true when it is slower. In this way, exchange rate movements can cushion the domestic economy against external shocks, thereby mitigating business cycles. When economic activity grows rapidly in Iceland and macroeconomic pressures build up, the exchange rate rises. This puts a damper on economic activity by cutting into export growth. The appreciation of the króna also lowers relative import prices, thereby reducing domestic activity by shifting expenditure towards foreign goods and services. By slowing down GDP growth, the currency appreciation also helps to keep domestic inflationary pressures under control, and furthermore, it directly reduces inflation through lower imported inflation.[18] In the same manner, a currency depreciation can mitigate a downturn. Without exchange rate flexibility, business cycles could become more volatile, as an important part of the economy's shock absorbing capacity has been removed and an important channel for monetary policy transmission to the real economy has been closed off.

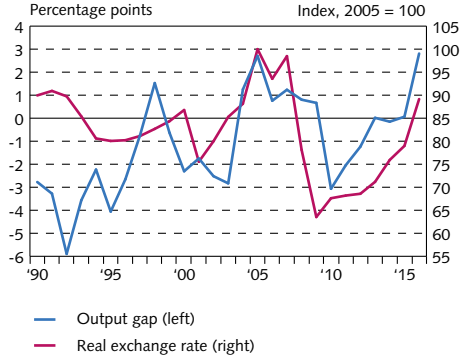
On the other hand, currency exchange rates are also asset prices, and they often fluctuate more than can be justified by macroeconomic fundamentals. A number of studies suggest that currencies are indeed not only shock absorbers but can also be a source of shocks (see Central Bank of Iceland, 2012b, Chapter 13). The results from Breedon *et al.* (2012) suggest as well that this can be particularly important for very small economies like Iceland.

Exchange rate movements and the business cycle

If exchange rate movements serve as a shock absorber, a more rapid expansion of economic activity in Iceland should go hand-in-hand with a rising real exchange rate. This is illustrated in Chart 5.9. As can be seen, the rising real exchange rate in recent years has been accompanied by

Chart 5.9

The business cycle and the real exchange rate 1990-2016[1]



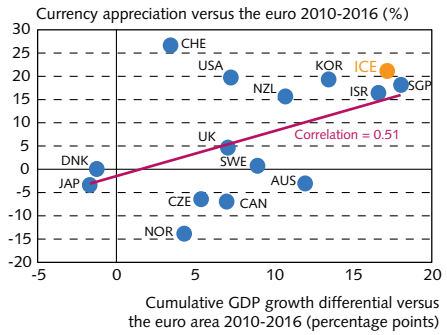
1. Difference between output gap in Iceland and main trading partners. The estimation of the output gap in Iceland is based on the deviation of GDP from potential output, using the production function in the Bank's macroeconomic model. The output gap in Iceland's main trading partner countries is estimated based on the deviation of trading partners' GDP from the Hodrick-Prescott trend path (with λ = 1,600). The real exchange rate is based on relative consumer prices. The chart shows annual averages of quarterly data.

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

17. A similar result is obtained by using the difference between the output gap in Iceland and abroad: the difference has increased by an average of 0.3 percentage points between periods, and this, together with a 1 percentage point smaller inflation differential, would call for a reduction in the interest rate differential of 1.4 percentage points according to the Taylor rule; that is, a decline 0.4 percentage points larger than actually occurred. However, this would be consistent with a ½ percentage point smaller decline in the equilibrium real interest rate in Iceland than in the rest of the world.

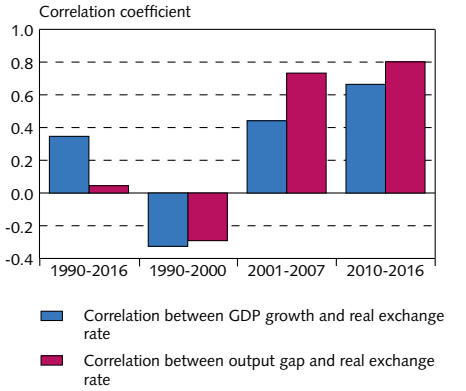
18. See, for instance, the discussion of different economic developments under various exchange rate developments in Chapter 1 of *Monetary Bulletin* 2017/2.

Chart 5.10
GDP growth and exchange rate in 15 advanced economies 2010-2016[1]



1. The cumulative GDP growth differential is the difference in changes in GDP from 2010 to 2016, for each country and for the euro area. The change in currency exchange rates versus the euro is the change between annual averages in 2010 and 2016. An increase represents an appreciation of the currency in question versus the euro.
Sources: Macrobond, Statistics Iceland, Central Bank of Iceland.

Chart 5.11
Correlation between the business cycle and the real exchange rate[1]



1. Correlation between trading partners' relative output gap and GDP growth, on the one hand, and real exchange rate (quarterly data), on the other. The relative output gap is the difference between the output gap in Iceland and its main trading partners. The estimation of the output gap in Iceland is based on the deviation of GDP from potential output, using the production function in the Bank's macroeconomic model. The output gap in Iceland's main trading partner countries is estimated based on the deviation of trading partners' GDP from the Hodrick-Prescott trend path (with $\lambda = 1{,}600$). The real exchange rate is based on relative consumer prices.
Sources: Macrobond, Statistics Iceland, Central Bank of Iceland.

a widening output gap in Iceland as compared with its main trading partners: from the beginning of Iceland's economic recovery early in 2010 until year-end 2016, the relative output gap grew by 6 percentage points, and at the same time the real exchange rate rose by nearly 30%. As Chart 5.10 shows, this is not unique to Iceland: the currencies of countries that have grown faster than the eurozone in recent years have generally appreciated against the euro.[19]

As Chart 5.9 indicates, the relationship between the business cycle and the real exchange rate has been stronger in the past decade than it was earlier on, particularly during the fixed exchange rate period in the 1990s. This can be seen even more clearly in Chart 5.11, which shows the contemporaneous correlation of the real exchange rate with the relative output gap and GDP growth, respectively. As can be seen, the correlation has increased, in terms of both the relative output gap and relative GDP growth. The correlation is also much stronger than is indicated in the Central Bank report (2012b, Chapter 13), which gives a correlation of 0.27 for the period from 1980 through 2010.

Taken together, these finding suggest that exchange rate fluctuations have become more closely connected to the domestic business cycle, which could indicate that the exchange rate of the króna is performing its shock absorber role better than before. Caution is needed here, however, because the correlation of the real exchange rate with the business cycle does not indicate causation. In order to analyse the relationship between exchange rate movements and the business cycle more closely, it is therefore necessary to use economic models with theoretical foundations that make it possible to identify the main drivers of exchange rate fluctuations.

Main causes of exchange rate volatility

In Chapter 13 of Central Bank of Iceland (2012b), a structural vector autoregression (VAR) was used to analyse to what extent exchange rate movements stem from shocks to aggregate supply and demand (further discussion of the underlying macroeconomic model can be found in Box 13.2 in Central Bank of Iceland, 2012b). If exchange rate fluctuations are driven largely by supply and demand shocks, it can be argued that exchange rate fluctuations primarily reflect shocks that the exchange rate is absorbing so as to mitigate business cycles. Failure to find an important role of these macroeconomic shocks would, however, suggest that the exchange rate is more of a source of shocks than a shock absorber. The findings in Central Bank of Iceland (2012b, Chapter 13) were that for the period 1998-2007, exchange rate movements could be traced largely to nominal shocks, such as shocks to monetary policy and money velocity and shocks that can be attributed to the exchange rate itself (such as, for instance, fluctuations in exchange rate risk premia), and only to a small degree to aggregate supply and demand

19. The exceptions are mainly countries that have suffered a severe deterioration in terms of trade (Australia, Canada, and Norway) and the Czech Republic, where the central bank has systematically intervened in the foreign exchange market so as to weaken the koruna and stimulate inflation. There are also several currencies that have appreciated more than can be explained by economic activity, such as the US dollar and Swiss franc, both of which have a somewhat unique position as a safe haven during times of global unrest like that prevailing in recent years.

shocks.[20] According to these findings, exchange rate movements in Iceland appeared to amplify business cycles rather than dampen them.

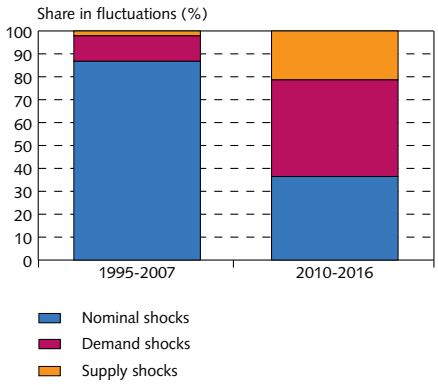
In order to determine whether the properties of the exchange rate have changed in recent years, the structural VAR was re-estimated for the period 1995-2007 and again for the period 2012-2016.[21] As Chart 5.12 shows, the estimation for the former period gives the same result as was obtained in Central Bank of Iceland (2012b): exchange rate fluctuations during this period appear driven primarily by nominal shocks, with supply and demand shocks playing a relatively minor role. This appears to have changed markedly in the past few years, however: nominal shocks now explain only about a third of exchange rate fluctuations, and supply and demand shocks two-thirds. This is closer to what is found in other advanced economies (see Central Bank of Iceland, 2012b, Chapter 13).

Another way to analyse the main drivers of changes in the exchange rate of the króna is to use the Bank's dynamic stochastic general equilibrium (DGSE) model (see Seneca, 2010). Because it is a DGSE model, it is possible to identify underlying structural shocks and their share in fluctuations in individual variables such as the exchange rate of the króna. The model contains 14 different shocks that drive the business cycle.[22] As Chart 5.13 shows, nominal shocks (fluctuations in exchange rate risk premia in particular) explain over 80% of the exchange rate fluctuations over the period 1995-2007, while aggregate supply and demand shocks account for less than 20%. This changes in the latter period, however, when supply and demand shocks weigh as heavily as nominal shocks.[23]

A breakdown of exchange rate fluctuations according to the DSGE model therefore gives a result similar to that obtained with the VAR: historically, nominal shocks have explained the majority of exchange rate fluctuations, but in recent years the fluctuations appear to reflect changes in aggregate supply and demand conditions in the economy to a much greater degree. These results indicate that the countercyclical properties of the exchange rate have grown considerably stronger in recent years. The time period is short, however, and it is therefore appropriate to exercise caution when drawing conclusions

Chart 5.12

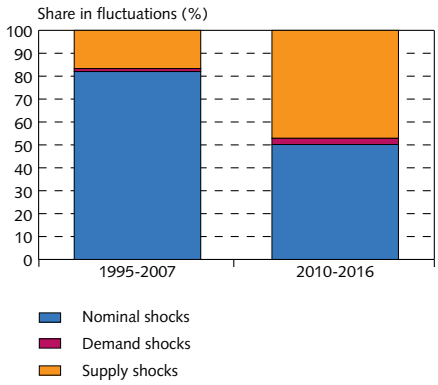
Variance decomposition of exchange rate fluctuations based on structural VAR model[1]



1. The structural shocks are estimated using a VAR model containing the EURISK exchange rate (ECUISK before 1999), GDP in Iceland relative to the euro area, and public consumption in Iceland relative to the euro area. Using seasonally adjusted quarterly data (apart from the exchange rate) for the period from 1995 through 2016. In order to identify the structural shocks, long-run restrictions are imposed on the VAR model (nominal shocks do not have long-run effects on GDP and public consumption and demand shocks to not have long-run effects on GDP).
Source: Central Bank of Iceland.

Chart 5.13

Variance decomposition of exchange rate fluctuations based on DSGE model[1]



1. Contribution of 14 different structural shocks to real exchange rate volatility, based on the Bank's DSGE model. The nominal shocks are the sum of shocks in global inflation, domestic monetary policy, and an ISK exchange rate risk premium. The demand shocks are the sum of shocks in global demand, public sector demand, domestic consumers' preferences, and investment technology. The supply shocks are the sum of shocks in domestic and global price markups and domestic and global technology shocks.
Sources: Seneca (2010), Central Bank of Iceland.

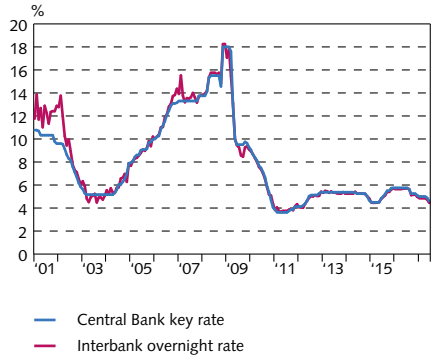
20. This is comparable to the findings of Forbes *et al.* (2017), who posit that monetary policy shocks explain a larger share of exchange rate volatility in Iceland than in other advanced economies.

21. Long-run restrictions are used to identify the structural shocks in the VAR. Thus supply shocks are assumed to have permanent effects on output, prices, and the exchange rate, whereas demand shocks are only allowed to have permanent effects on prices and the exchange rate and nominal shocks only on the exchange rate. As in Central Bank of Iceland (2012b), the three-dimensional VAR from Canzoneri *et al.* (1996) is used, which contains GDP (GDP in Iceland relative to GDP in the eurozone), public consumption (public consumption in Iceland relative to public consumption in the eurozone), and the EURISK exchange rate. Supply shocks are therefore shocks that have permanent effects on all three variables, demand shocks are those with permanent effects on public consumption and the exchange rate, and nominal shocks those that permanently effect the exchange rate.

22. Nominal shocks are the sum of shocks in global inflation, domestic monetary policy, and the exchange rate risk premium. Demand shocks are the sum of shocks in global demand, public sector demand, domestic consumers' tastes, and investment technology. Supply shocks are the sum of shocks in domestic and global price markups and domestic and global technology shocks.

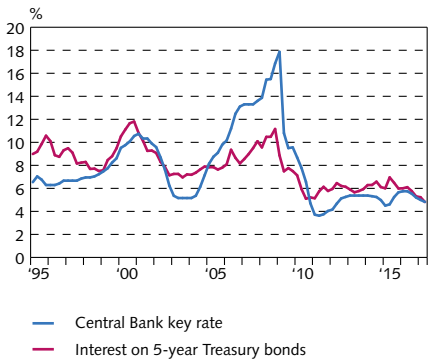
23. According to the VAR, demand shocks account for about 40% of the exchange rate fluctuations of the past five years and supply shocks just over 20%. The DSGE model indicates, however, that supply shocks explain nearly 40% of the fluctuations (particularly fluctuations in Iceland's terms of trade), and that the share of demand shocks is relatively small.

Chart 6.1
Central Bank interest rate and market interest rates[1]
January 2001 – June 2017



1. The Central Bank's key interest rate is defined as follows: the 7-day collateralised lending rate (until 31 March 2009), the rate on deposit institutions' current accounts with the Central Bank (1 April 2009-30 September 2009), the average of the current account rate and the rate on 28-day certificates of deposit (1 October 2009-20 May 2014), and the rate on 7-day term deposits (from 21 May 2014 onwards). Monthly averages.
Source: Central Bank of Iceland.

Chart 6.2
Central Bank interest rate and long-term interest rates[1]
Q1/1995 – Q2/2017



1. Until Q2/2001, Treasury bond interest rates with maturity close to 5 years is used. From Q2/2001 onwards, five-year rates are estimated from the Treasury bond yield curve, using the Nelson-Siegel approach.
Source: Central Bank of Iceland.

about the findings. It is also appropriate to bear in mind that the capital controls were in place during this period, mitigating speculation-driven exchange rate movements. Therefore, the possibility cannot be excluded that the importance of speculative exchange rate fluctuations will increase again now that the capital controls have been lifted (for further discussion, see Chapter 6.4).

6 Monetary policy and interest rate developments

As discussed above, interest rates on the Central Bank's transactions with other financial institutions are the principal tool that the Bank's MPC uses to set the monetary stance deemed necessary at any time to enable the Bank to fulfil its price stability mandate. This chapter reviews developments in interest rates from the adoption of the inflation target in 2001 and places them in context with overall macroeconomic developments during the same period. Interest rate developments are compared with rates obtained from commonly used monetary policy rules, and the question of whether monetary policy conduct and efficacy have improved in recent years is examined.

6.1 Interest rate developments since 2001

The Central Bank's key interest rate has fluctuated considerably since the inflation target was adopted in 2001 (Chart 6.1).[24] The Bank's key rate was just under 11% towards the end of the fixed exchange rate period and the beginning of the inflation-targeting period, but it fell quickly and was down to just over 5% by early 2003. It began to rise again in spring 2004, approaching 8% late that year and rising above 13% by end-2006. From then on, it continued to rise, peaking at 18% at the end of October 2008.

As is discussed in Chapter 2, fundamental changes were made to monetary policy implementation early in 2009. The Bank's key rate was lowered quickly, beginning early that year: it was down to 9.5% by May and 3.6% by early 2011. In August 2011, however, it began to rise again, for the first time since the onset of the financial crisis. From then on, the key rate has fluctuated in a relatively narrow range: it peaked at 5.75% in late 2015 and remained there until August 2016, and it fell to 4.5% in H1/2015 and again in June 2017. Charts 6.1 and 6.2 show how short-term money market rates and long-term bond rates track the policy rate.[25] Beginning in 1995, long-term

24. The Central Bank interest rate defined as the Bank's key rate can change from one period to another, depending on which rate is judged to play the most important role in determining short-term money market rates. The Bank's seven-day collateralised lending rate was defined as the key rate until 2009, but since then financial institutions have not sought credit from the Central Bank; therefore, the key rate has been the rate on various types of Central Bank deposit instruments (currently the rate on seven-day term deposits).

25. The relationship between long-term interest rates and the Central Bank's key rate can be expressed as follows: $i_{Lt} = (i_t + i^e_{t+1} + i^e_{t+2} + \cdots + i^e_{t+n-1})/n + \phi_t$, where i_{Lt} is the long-term interest rate at time t, i_t is the Bank's key rate at time t, i^e_{t+k} is the expected key rate at time $t+k$, n is the duration of the long-term bond, and ϕ_t is the term premium that compensates investors for investing in long-term rather than short-term bonds. Long-term interest rates are therefore determined by the key rate at any given time and expectations about its development over the duration of the bond. The Central Bank can therefore affect long-term interest rates in two ways: by changing the key rate now, and by trying to affect expectations about how it will develop in the future; for example, with forward guidance signalling what the Bank plans to do in the near term.

Treasury bond interest rates fluctuated in the 7-12% range and then, in the wake of the financial crisis, they fell to just over 5% and have hovered in the 5-6% range for most of the time since.

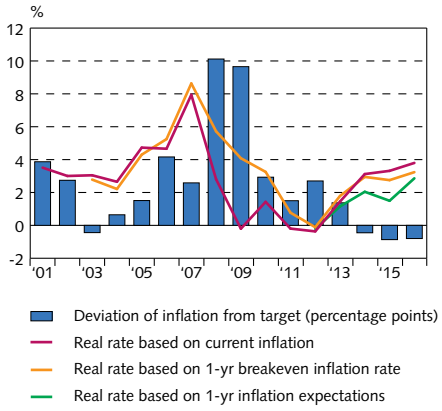
In order to understand developments in Central Bank rates more fully, it is necessary to place them in the context of developments in key macroeconomic variables, particularly those that monetary policy aims to stabilise; i.e., inflation and economic activity. Chart 6.3 puts developments in the Central Bank's real interest rate in context with deviations of inflation from target. The real rate is estimated based on current twelve-month inflation and on 1-year inflation expectations as measured in terms of the breakeven inflation rate, on the one hand, and market agents' expectations, on the other (see Chapter 4). Chart 6.4 compares developments in the real interest rate and the output gap. As can be seen, the Bank's real rate rose rapidly during the pre-crisis upswing, when a large output gap developed and inflation rose well above the target. When the output gap disappeared and a slack developed in the wake of the crisis, the real rate fell steeply, even though inflation was still well above target. The Bank's real rate troughed in 2012 and then began to rise again as the negative output gap narrowed and a positive output gap opened up in 2015. In 2016, the Bank's real rate continued to rise, as demand pressures had built up even though inflation remained below the target.

To shed further light on developments in interest rates in recent years, it is also useful to place the Bank's interest rate decisions of the past few years in the context of developments of inflation expectations and efforts to anchor expectations at target (Chart 6.5). The tightening phase beginning in August 2011 can therefore be placed in the context of the rise in inflation expectations following the large contractual pay rises negotiated in early 2011. Inflation expectations peaked in mid-2012, and the tightening phase ended at around that time. Although inflation expectations began to decline thereafter, the Bank's key rate was held high for a longer period because inflation expectations were still well above target. Not until well into 2014 did the key rate begin to fall in line with a further decline in inflation expectations. The key rate rose again in mid-2015, when inflation expectations began to climb in response to another large rise in wages that spring. The cycle turned around in August 2016, as expectations appeared to become securely anchored to the target.

6.2 Interest rate developments in comparison with standard monetary policy rules

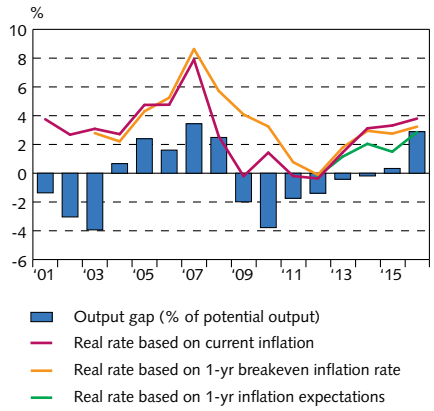
The discussion above places developments in the Central Bank's key rate into the context of developments in economic activity and inflation. What remains, however, is the question of whether the "correct" interest rate level was selected at any given time, or whether the Bank held rates systematically too high or too low. The problem with such an assessment is that there is no single universal metric of whether the interest rates selected by central banks are "correct" at any point in time. When conducting an assessment of this kind, it is also important to distinguish between an *ex post* and *ex ante* assessment of monetary policy: *ex ante* analysis looks at monetary policy based on the

Chart 6.3
Central Bank real rate and deviation of inflation from target 2001-2016



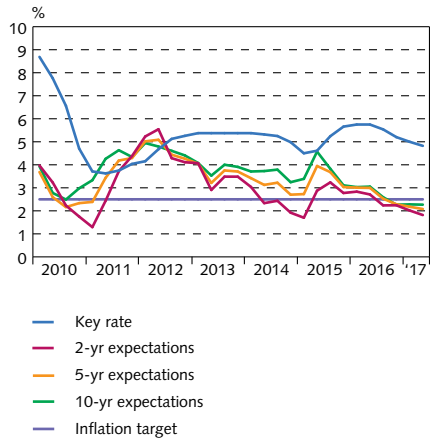
Sources: Statistics Iceland, Central Bank of Iceland.

Chart 6.4
Central Bank real rate and output gap 2001-2016



Sources: Statistics Iceland, Central Bank of Iceland.

Chart 6.5
Key interest rate and inflation expectations[1]
Q1/2010 - Q2/2017



1. Inflation expectations are estimated from the breakeven inflation rate in the bond market.
Source: Central Bank of Iceland.

information available at the time decisions were taken, whereas *ex post* analysis looks at policy decisions using information that was often not available at the time these decisions were made.

One common way to assess whether the interest rate was appropriate at any given time (at least *ex post*) is to compare it to the interest rate obtained using the Taylor rule (Taylor, 1993), which is commonly considered to give a reliable indication of central bank behaviour around the world during periods considered successful in monetary policy (see, for example, Taylor and Woodford, 2010). The Taylor rule is often cited in discussion and analysis of monetary policy, whether in the international media or in academic research, and central banks use it regularly as a reference in decision-making, although no one follows it blindly.

As is described in Chapter 5, interest rates according to the Taylor rule are expressed as:[26]

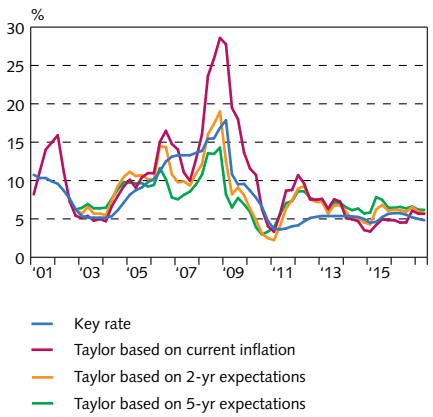
$$i = (r^* + \pi) + \alpha(\pi - \pi^T) + \beta y$$

where i is the nominal central bank rate, r^* is the equilibrium real rate, π is inflation, π^T is the inflation target, and y is the output gap. The values α and β describe the monetary policy response to deviations in inflation from target (α) and deviations in actual output from potential (β).

Originally, Taylor (1993) proposed that $\alpha = \beta = 0.5$ and these values are typically used (see the discussion in Chapter 5).[27] According to the rule, the Central Bank should raise its key rate by $\beta = 0.5$ percentage points for each percentage point by which output exceeds potential. Similarly, it should raise the key rate by $1 + \alpha = 1.5$ percentage points if inflation rises 1 percentage point above the target. As can be seen when the Taylor rule is re-written for the real rate, this implies that the real rate rises by $\alpha = 0.5$ percentage points:

$$(i - \pi) = r^* + 0.5(\pi - \pi^T) + 0.5y$$

Chart 6.6
Central Bank interest rate and Taylor rule[1]
Q1/2001 - Q2/2017



1. The Taylor rate is calculated as $i = (r^*+\pi) + 0{,}5(\pi-\pi^T) + 0{,}5y$ where i is Taylor rate, r^* is the equilibrium real interest rate (4.5% until Q3/2008 and 3% thereafter), π is inflation or inflation expectations, π^T is the inflation target, and y is the output gap (*Monetary Bulletin* 2017/3). The breakeven inflation rate in the bond market is used as a measure of inflation expectations.

Source: Central Bank of Iceland.

Chart 6.6 gives a comparison of the Central Bank's key rate and the rate obtained using the Taylor rule, based on current twelve-month inflation and inflation expectations as determined from the two- and five-year breakeven inflation rates in the bond market (see Chapter 4).[28] It is assumed that the equilibrium real rate was 4.5% before the crisis and fell to 3% afterwards, which is broadly in line with the findings of Daníelsson *et al.* (2016).

As the chart shows, interest rates began from the outset to diverge considerably from Taylor rates, when the Bank's rates fell rapidly while the Taylor rule indicated the need for a large hike. The Bank's key rate was well in line with the Taylor rate in 2003, however,

26. By rearranging the terms of the equation, the Taylor rule can also be expressed as: $i = (r^* + \pi^T) + (1 + \alpha)(\pi - \pi^T) + \beta y$.

27. Some studies indicate that better results can be obtained with $\beta = 1$ (see, for example, Taylor, 1999). As Taylor (1993) shows, if $\alpha > 0$, monetary policy will enhance economic stability. If this condition is not satisfied, it will lead to economic instability. This has been referred to as the Taylor principle.

28. Two- and five-year expectations are used as those horizons most closely align with the transmission lags from monetary policy to the real economy.

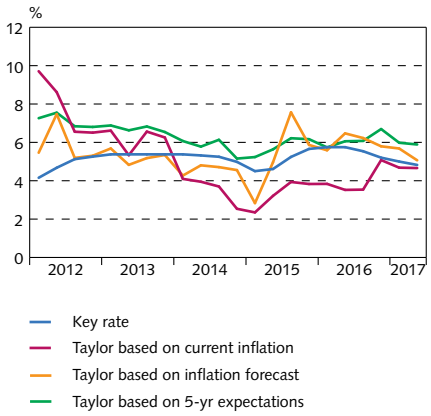
irrespective of whether inflation or inflation expectations are used to estimate the Taylor rate. It began to diverge again from the Taylor rate early in 2006, when it rose considerably less than the rate according to rules based on current inflation and short-term inflation expectations. The deviation between the Bank's rate and the rate according to the rule based on current inflation grew even larger during the financial crisis, while the Bank's rate was closer to the rate from the forward-looking Taylor rules. The policy rate cut from 2009 is also well in line with the forward-looking Taylor rules, while all of the rules suggest larger rate hikes in 2011 than were actually decided. The Bank's rate was then somewhat below the Taylor rate until 2014, but since then it has hovered halfway between the Taylor rate based on observed inflation and the forward-looking Taylor rules.

Chart 6.7 illustrates the developments of recent years more clearly. The chart gives a comparison of the Bank's key rate and Taylor rules from the beginning of 2012 onwards, all of them based on an equilibrium real rate of 2%, which may be closer to the preferred estimate of the majority of the Central Bank's MPC than the 3% equilibrium rate used in Chart 6.6. Apart from the conventional Taylor rule based on the deviation of current inflation from target, the chart also shows the Taylor rule based on the deviation of forecasted inflation one year ahead from the target based on Central Bank forecasts and five-year expectations as measured by the Bank's market expectations survey. As Chart 6.7 indicates, the Bank's key rate has broadly been in line with the rate suggested by the forward-looking Taylor rules but above the Taylor rate in terms of current inflation. By the end of the period the gap has closed, however.

One problem with a comparison like this one is the uncertainty about the level of the equilibrium real rate. As a result, it can be useful to compare changes in interest rates as well, and not merely the interest rate level. Chart 6.8 gives a comparison of the Bank's key rate and various Taylor rates during four monetary tightening and easing cycles from the beginning of 2011 onwards, as can be inferred from the discussion in Chapter 6.1.[29] During the first cycle, from July 2011 through December 2012, the Bank's key rate rose by a total of 1.75 percentage points. This was followed by an easing cycle from April 2014 through January 2015, when interest rates fell by a total of 0.9 percentage points. During the third cycle, from May through December 2015, interest rates rose by a total of 1.25 percentage points. During the last cycle, beginning with the rate cut in July 2016 and extending through June 2017 (the end of the period analysed), the Bank's key rate fell by a total of 0.9 percentage points (between the Q2/2016 and Q2/2017 averages). As the chart shows, the first three rate cycles are broadly similar to what is suggested by the Taylor rule. Actual rate changes tend to be smaller, however, in line with international experience. The last cycle is somewhat different, however, depending on which version of the Taylor rule is used. According to the Taylor rule in terms of observed inflation, the key rate should

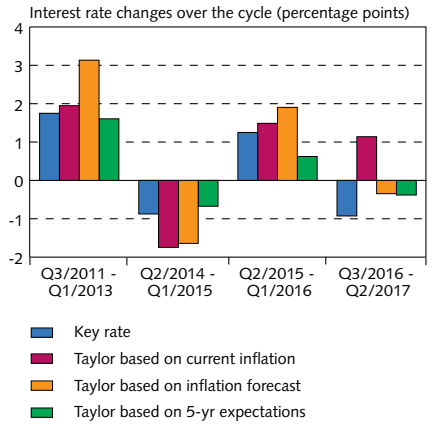
29. Because the Taylor rules are based on quarterly averages, the chart shows a comparison of changes in interest rates between quarterly average which comes as close as possible to the periods specified in the text.

Chart 6.7
Central Bank interest rate and Taylor rule[1]
Q1/2012 - Q2/2017



1. The Taylor rate is calculated as $i = (r^*+\pi) + 0{,}5(\pi-\pi^T) + 0{,}5y$ where i is Taylor rate, r^* is the equilibrium real interest rate (assumed to be 2% during the period), π is inflation or inflation expectations, π^T is the inflation target, and y is the output gap (*Monetary Bulletin* 2017/3). The inflation forecast uses the Bank's forecast for inflation one year ahead and inflation expectations are based on the Bank's market expectations survey.
Source: Central Bank of Iceland.

Chart 6.8
Interest rate cycles since the start of 2011[1]



1. Cumulative change in policy rate over four interest rate cycles since the beginning of 2011, and a comparison with interest rate changes over the same periods using the Taylor rule based on twelve-month inflation, the Bank's inflation forecast, and inflation expectations.
Source: Central Bank of Iceland.

have risen somewhat, whereas according to the two forward-looking rules they should have declined, albeit less than the MPC decided.

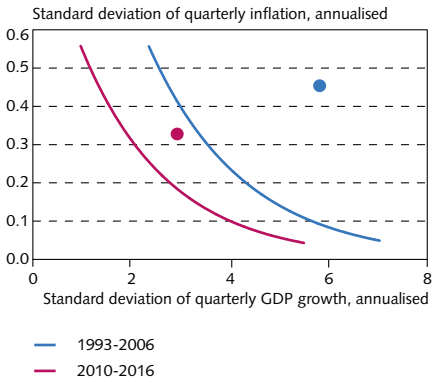
On the whole, it therefore seems difficult to support the argument that monetary policy has systematically kept interest rates too high, as is often maintained in public discourse in Iceland. On the contrary: it appears that interest rate have generally been kept too low since the inflation target was adopted, as is reflected in the fact that inflation has systematically been above the target for most of the period, as is discussed in Chapter 4.[30] This legacy of weak management of inflation has continued to affect monetary policy formulation until the present day. Even though inflation has fallen rapidly in recent years and has now been at or below target for more than three years, inflation expectations were poorly anchored to the target for quite some time (see Chapter 4). This weak anchoring has narrowed the MPC's scope for monetary easing even though inflation has been below target, as can be seen so clearly in the differing developments in Taylor rates in terms of current inflation versus inflation expectations (Chart 6.7). The situation appears to be changing gradually, however, as expectations become more firmly anchored to the inflation target. This is in line with the experience of other countries that have dealt with similar legacy issues stemming from poor management of inflation. These countries' experience shows that it takes quite some time to regain control of inflation expectations and that expectations are not securely anchored until inflation has been at or below target for an extended period of time.

6.3 Have monetary policy conduct and efficacy improved?

The comparison above indicates that, in recent years, monetary policy formulation has broadly aligned with what is suggested by conventional Taylor rules. The results in Chapters 3 and 4 also indicate that macroeconomic stability has increased in the recent term and that inflation and inflation expectations are more firmly anchored to the target. The findings in Chapter 5 indicate as well that this enhanced monetary stability has mitigated exchange rate fluctuations that cannot be attributed to changes in economic fundamentals, and that the shock-absorbing capacity of the króna has increased.

All of this could indicate that monetary policy implementation has improved in recent years and that monetary policy has grown more effective. Chart 6.9 indicates that this is the case. It gives an estimate of the efficient frontier of monetary policy (see Taylor, 1979) for two periods: 1993-2006 and 2010-2016. As is discussed in Chapter 2, the role of monetary policy is to stabilise fluctuations in inflation and economic activity. Sometimes these two factors go together, as in the case of a positive demand shock that boosts output and raises inflation. In such cases, a tight monetary stance contains GDP growth and coaxes inflation back down to the target. Conversely, an

Chart 6.9
Monetary policy efficient frontier[1]



1. The efficient frontier shows the pairs of the standard deviation of inflation and GDP growth (in percentage points) based on the Bank's DSGE model, which minimises $L = \lambda(\pi - \pi^T)^2 + (1-\lambda)(y)^2$ for various λ between 0 and 1, assuming that monetary policy is determined from a simple Taylor rule, where π is inflation, π^T is the inflation target, and y is the output gap. The dots show pairs of actual standard deviations of inflation and GDP growth during these periods. The data are seasonally adjusted Kalman-filtered data.
Sources: Seneca (2010), Central Bank of Iceland.

30. This can also be seen in the results obtained by the Central Bank of Iceland (2012b, Chapter 3) from an empirical estimation of the parameters of the Taylor rule. Typically, the parameter on the deviation of inflation from target (α) is found to be negative for the period until 2007 – therefore violating the Taylor principle.

accommodative monetary stance mitigates the contraction following a negative demand shock, pushing inflation back up to the target. Therefore, monetary policy can mitigate fluctuations in inflation and output when fluctuations stem from the demand side of the economy. Matters grow more complicated, however, when the fluctuations originate on the supply side of the economy. In such cases, elevated inflation can go hand-in-hand with an economic contraction, and under such conditions, monetary policy is faced with two options. It can try to bring inflation back to target relatively quickly, but at the cost of increased fluctuations in output. If it chooses instead to take more time to bring inflation back to target, it can mitigate output fluctuations, but at the cost of increased inflation volatility.

At any given time, monetary policy is therefore faced with a trade-off between inflation and output fluctuations, and the efficient frontier (sometimes called the Taylor curve) shows the best combination that can be achieved at any given time given the shocks that hit the economy (see also Box I-1 in *Monetary Bulletin* 2014/2). The efficient frontier is obtained by minimising the following loss function:

$$L = \lambda(\pi - \pi^T)^2 + (1 - \lambda)(y)^2$$

where π denotes inflation, π^T is the inflation target, and y is the output gap. λ then describes how much emphasis the central bank places on mitigating fluctuations in inflation, and $1-\lambda$ indicates how much emphasis the bank places on stabilising output. As Chart 6.9 shows, the efficient frontier has shifted considerably to the origin in recent years, indicating that monetary policy is able to achieve a more favourable combination of fluctuations in inflation and output than previously possible. The chart also shows that actual fluctuations in inflation and output (the dots in the chart) have grown smaller and have moved much closer to the efficient frontier, which indicates that monetary policy conduct and efficacy have improved markedly in recent years.

6.4 The role of the capital controls and increased foreign exchange market intervention

When the financial crisis struck in autumn 2008, the authorities imposed general restrictions on outflows of capital, so as to prevent disorderly capital flight that would have caused an even further depreciation of the króna. This in turn risked harming Icelandic households and businesses even more, through the adverse effects of the currency depreciation on their balance sheets and the impact of still higher inflation on real disposable income. By restricting capital outflows and directing capital into the domestic asset markets, the capital controls also supported domestic asset prices and reduced the cost of financing the Government's deficit operations. The controls also created the temporary shelter needed for private sector balance sheet restructuring and played a key role in the settlement of the failed banks' estates. Furthermore, they enabled the MPC to lower interest rates faster in the wake of the crisis than would otherwise have been possible, as there were less concern about the impact of lower interest rates and a narrower interest rate differential on the exchange rate and inflation dur-

ing a time when inflation and inflation expectations were being reined in. Although the capital controls have been controversial and may well have economic costs associated with them – particularly if they remain in effect for an extended period – they probably prevented complete economic chaos during the immediate aftermath of the crisis and both expedited and supported the economic recovery (see, for example, Gudmundsson, 2016, and Central Bank of Iceland, 2016).

By greatly reducing the possibility of speculative foreign exchange market activity, the capital controls mitigated short-term exchange rate volatility. Added to this was a significant increase in the Bank's intervention in the foreign exchange market, an important part of its changed monetary policy implementation in the wake of the crisis (see Central Bank of Iceland, 2010). It can be argued that by mitigating exchange rate volatility, the combination of capital controls and foreign exchange market intervention reduced uncertainty about inflation during a time when inflation expectations were poorly anchored, thereby supporting interest rate policy in its attempt to control both inflation and inflation expectations. Therefore, the indications of improved monetary policy performance described in previous chapters can doubtless be attributed in part to these factors.

But what happens now that the capital controls have largely been removed? Short-term exchange rate volatility will probably increase, as has tended to be the case in the short time since the controls were lifted. On the other hand, continued Central Bank intervention in the foreign exchange market could prevent excessive fluctuations. Although volatility will probably increase and exceed that in other advanced economies because of the small size of the Icelandic foreign exchange market (see Central Bank of Iceland, 2012b, Chapter 12), there is no reason to assume that fluctuations will be as pronounced as they were previously. Credibility of monetary policy and a firmer anchor for inflation expectations play a key role here. If credibility has increased and expectations have become more firmly anchored, as the discussion above indicates, fluctuations in real interest rates should be smaller in the future than they have been in the past. To the extent that fluctuations in real interest rates are a source of exchange rate volatility, the exchange rate should also be less volatile than before and more able to play its shock absorber role. The challenges facing monetary policy will doubtless be greater without the capital controls, but there is no reason to believe that the credibility gained in the past few years should be lost because the capital controls have been lifted. That should not happen unless monetary policy abandons its goal of achieving macroeconomic stability.

7 Summary of main findings

This report examines the experience of Iceland's current monetary policy framework since March 2001, when the formal inflation target was adopted. The principal objective is to determine whether there are signs that monetary policy has become more efficient in recent years and whether its ability to secure price stability has improved.

The main conclusion is that this is the case. Inflation has been at or below the Central Bank's inflation target for over three years.

Increased price stability has been achieved in spite of considerable domestic inflationary pressures stemming from large pay increases, and this stability is due in no small part to a steep decline in import prices, which in turn is due to low global inflation and the appreciation of the króna. As inflation has fallen in recent years, it has also grown less volatile. Deviations from the inflation target have also diminished greatly and are now much more in line with those seen in other advanced inflation-targeting economies. Furthermore, short- and long-term inflation expectations have gradually subsided to the target and have become less volatile. Uncertainty about future developments in inflation appears to have subsided as well. Indications of increased price stability and more firmly anchored inflation expectations at target can also be seen in reduced sensitivity of long-term inflation expectations to sudden changes in short-term inflation. Fluctuations in inflation appear to be less persistent than before, and the built-in inflation bias in conventional inflation models seems to have disappeared as the inflation target has gained credibility. By the same token, business cycle fluctuations have diminished. They are still more pronounced than in other advanced economies with a similar monetary policy framework, but the difference has grown significantly smaller.

Since the inflation target was adopted in 2001, the exchange rate of the króna has been highly volatile, particularly at the time the currency collapsed during the financial crisis. Fluctuations in the exchange rate have diminished again, however, and there are signs that their characteristics have changed in recent years. As is discussed in Central Bank of Iceland (2012b, Chapter 13), before the crisis, aggregate demand and supply shocks appeared to play a limited role in explaining exchange rate movements. The exchange rate therefore seemed to be an independent source of shocks rather than a shock absorber. This appears to be changing, however, and exchange rate movements seem increasingly to counteract the effects of aggregate supply and demand shocks. Although the capital controls and increased foreign exchange market intervention by the Central Bank are likely to have played a role in this, it is nevertheless likely that another important factor is at work: that fluctuations in real interest rates have diminished as inflation expectations have become more firmly anchored.

In order to fulfil its price stability mandate, the Central Bank primarily uses interest rates in transactions with domestic financial institutions to affect financial conditions in Iceland. The Bank's key interest rate has fluctuated considerably since the inflation target was adopted, and the interest rate differential with abroad has generally been wide. It appears that the key rate has long been lower than domestic macroeconomic conditions called for, as is indicated by inflation persistently above the target for a large part of the period. Interest rate developments in the past few years appear better aligned with rates obtained using conventional monetary policy rules, however, and monetary policy efficacy seems to have improved: it now appears possible to achieve greater monetary and economic stability than before, and the current combination of fluctuations in inflation

and output seems much closer to what is obtainable given the shocks that hit the economy.

In the current discussion on the monetary policy framework and the options available to Iceland, it is important to bear in mind that all options have advantages and disadvantages, and no monetary regime will be perfectly appropriate under all possible circumstances. Decisions on whether to retain the current framework with or without possible modifications or to make fundamental changes to the monetary policy framework need to reflect this and take account of what the current framework has achieved. This is among the goals of this report.

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