

## Appendix: Evaluation of the macroeconomic impact of the planned aluminium and power plant investments and possible economic policy responses to them

This Appendix discusses the economic impact of the planned large scale industrial projects, i.e. the construction of the Alcoa Inc. aluminium smelter in Reydarfjörður, East Iceland, and a hydropower facility built by Landsvirkjun (the National Power Company) in East Iceland to supply electricity for it. The conceivable expansion of the Nordurál aluminium smelter is not included in this report, since its timing and scope are unclear. The evaluation of the power-intensive investment programme in East Iceland suffices to portray the impact of large-scale investment projects of this kind and the economic policy responses that they call for.

### 1. Main conclusions

The main conclusions of the report that follows are:

1. The proposed power-intensive projects are very large relative to the size of the Icelandic economy. In volume terms the investment is probably the largest in the history of Iceland, while in terms of GDP it is similar to the construction of the Búrfell station and Straumsvík aluminium smelter in the 1960s.
2. Construction work will peak in 2005 and 2006, when some two-thirds of the investment will be made. When the investment reaches its peak in 2006 it will be equivalent to 9% of GDP. Labour use will also peak at the same time at just under 2,500 man-years, or the equivalent of 1¼% of the estimated labour force in Iceland.
3. A distinction must be made between the *temporary* impact caused by the construction of the hydropower facility and aluminium smelter and the *long-term* impact of their operation. The former impact will entail a temporary surge in demand while the latter will strengthen the *supply side* of the economy and strengthen Iceland's export base.
4. The impact during the construction period involves an increase in demand which is financed with foreign equity and credit. It will be accompanied by a short-lived deficit on the current account, which is not a problem, as well as demand pressure and inflationary pressure. Since the construction programme is largely foreseen, the exchange rate of the króna, interest rates and asset prices may be expected to be affected as soon as it is clear that the project will go ahead. The recent strengthening of the króna is at least partly explained by this. Underlying this strengthening is not only the expected currency inflow, but also expectations of a higher Central Bank policy rate than would otherwise be the case in the near term. Thus the rise in the exchange rate cannot be divorced from the tighter monetary stance inevitably associated with a shock on the scale involved here.
5. Calculations made using the Central Bank's models of the economy and its individual components suggest that, in the absence of any exchange rate adjustment and economic policy action, the positive output gap will be considerably wider than when the economy overheated in 2000 and 2001. The reason is that GDP growth will be considerably greater than the equilibrium growth level, or 4-4½ percentage points at peak, which could mean a growth figure of roughly 7%. In consequence, inflation would be around or in excess of 4 percentage points higher than in the absence of these large scale investments in 2005 and 2006, and thereby deviate substantially from the Central Bank's inflation target.
6. In order to prevent this from occurring, economic policy action will be needed. If the exchange rate remains unchanged from what it would have been without these large scale projects and no fiscal action is taken, the Central Bank's policy rate will need to rise in the course of this year, and in 2004 and 2005 it will be significantly higher than

otherwise. Calculations are based on a conventional forward-looking rule for central bank interest rate decisions which takes into account the contemporary output gap but the rate of inflation in the following year. The Central Bank policy rate would then be in excess of 4½ percentage points higher than without the power-intensive projects, which could mean an actual interest rate of as high as 10%. Even this would not suffice to keep inflation within the tolerance limit of the inflation target in 2005 and 2006, so the monetary stance would need to be tighter still if it is not aided by fiscal policy or exchange rate developments.

7. If the exchange rate appreciated in response to this large scale project and/or fiscal action is assumed, a much smaller interest rate hike would be required in order to keep inflation close to the target. In the scenario with exchange rate adjustment which is presented here, the policy rate would only need to rise by just over 2 percentage points in excess of the baseline scenario when it peaks in 2004 and 2005. This could entail a policy rate of just over 7%. Another consequence of an adjustable exchange rate would be that interest rates would rise later than otherwise.
8. Fiscal measures involving a 20% contraction in public sector investment in 2005 and 2006 and a corresponding increase in 2007 and 2008 would require interest rates to rise by only 2½ percentage points from the baseline scenario, assuming a forward-looking monetary policy and unchanged exchange rate. Interaction between the exchange rate adjustment and fiscal measures could reduce the need for higher interest rates even further.
9. Thus the main finding of this report is that, despite the fact that the construction projects will be some of the largest in Icelandic history, it will be possible to maintain economic stability and keep inflation close to the Central Bank's target through the interplay of internal economic adjustment and monetary and fiscal policy measures.

Important reservations need to be made about the conclusions presented here, as explained in more detail in individual sections below. The calculations are based on diverse assumptions which

could fail to hold, such as on household and business sector expectations and a relatively smooth response by financial markets. Exchange rate developments are also highly uncertain. Furthermore, it should be borne in mind that the calculations are based on models reflecting historical relationships which are not certain to apply to such a large shock as this. Models are also inherently imperfect. Thus there are many indications that the impact of interest rates on demand and of demand on inflation are underestimated in the model, jointly developed by the Central Bank, National Economic Institute and Ministry of Finance, partly used in the evaluation. The impact of monetary policy could therefore be underestimated.

As mentioned above, this study does not take into account any investments in connection with Nordurál. It is obvious that this would greatly complicate economic policy implementation if it were to coincide to some extent with the peak of work on the East Iceland smelter. Thus it would be appropriate to find a different time for scheduling that project.

It is of great help that this large scale investment did not begin until the economy had fully cooled down after overheating in 2000 and 2001, and the inflationary hike that accompanied it had subsided. Otherwise it would be more difficult to maintain stability and keep inflation in check. There is some slack in the economy at present and construction activity will not peak until 2005 and 2006. Forecasts which did not take the power-intensive projects into account suggested that the economy would be in good balance in 2004. For this reason among others, the baseline scenario excluding the projects assumes that the economy will be in equilibrium from 2005.

Finally, it should be underlined that monetary policy at any time is formulated on the basis of a comprehensive assessment of the economic situation and outlook. Various other factors besides aluminium projects could have a considerable impact on monetary policy when the time comes around.

## 2. Power-intensive development projects in East Iceland

This section describes the construction projects and puts them in a macroeconomic context. Alcoa plans to build an aluminium smelter in Reydarfjörður with

Table 1 Timeframe for cost of hydropower facility and smelter 2003-2008

At constant 2002-prices and as ratios of gross fixed investment and gross domestic product

	2003	2004	2005	2006	2007	2008	Total
Aluminium smelter and harbour (m.kr.)	85	1,440	22,700	49,400	17,800	0	91,425
Hydropower station (m.kr.).....	9,122	16,004	22,690	28,324	10,909	3,725	95,167
Total (m.kr.).....	9,207	17,444	45,390	77,724	28,709	3,725	186,592
Ratio of gross fixed investment (%) <sup>1</sup> .....	5	9	19	27	12	2	.
Ratio of GDP (%) <sup>1</sup> .....	1	2	6	9	3	0	.

1. The estimated values for gross fixed investment and gross domestic product are based on Central Bank projections.

an annual capacity of up to 322 t.p.y. Harbour facilities will also be built beside the Alcoa site.

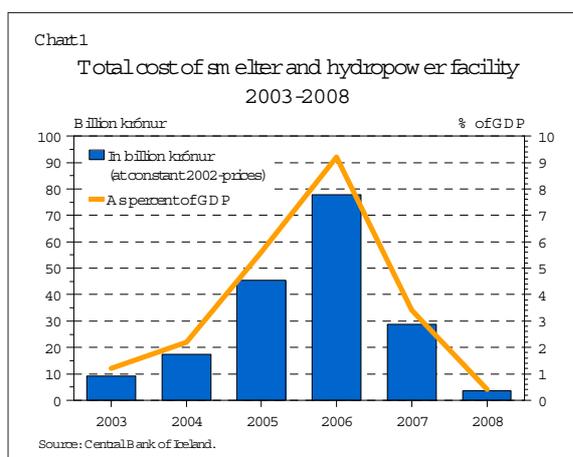
In January this year the agreement between Landsvirkjun and Fjardarál ehf. (Alcoa) was approved by both parties' Boards of Directors. The agreement involves supplying 4,700 GWh of electricity per year, or a total of 537 MW. Hydropower development work is expected to begin in full swing in spring 2003, while various preparatory work has been done beforehand. It is assumed that the electricity will primarily be produced by the Kárahnjúkar hydropower project, including the Fljótsdalur diversion.

The investment made by Alcoa and Landsvirkjun will rank with the largest ever made in the history of Iceland, but relative to GDP it is similar to the construction of the Búrfell hydropower station and the aluminium smelter in Straumsvík in the 1960s. The

total scope of the investment in aluminium and hydropower facilities is 186½ b.kr., with the smelter and harbour in Reydarfjörður estimated at 91½ b.kr. and the hydropower station, diversion and power transmission infrastructure at 95 b.kr. Construction activity will be packed into a tight timeframe. It will be most intense for both the hydro facility and the smelter in 2006, at more than 40% of total project cost. In 2005 and 2006 some two-thirds of construction will take place. Activity is spread differently over the years for the hydropower facility and smelter. The smelter project is on a much tighter schedule, with 80% occurring over 2005 and 2006. Work on the hydropower facility also peaks during these two years, with 54% of total cost incurring in these two years.

Construction of the smelter and hydropower facility will constitute a very high proportion of gross fixed investment in Iceland for the years when these projects are in progress. For the first two years of the construction phase, 2003 and 2004, work on hydropower and smelter development will not make a substantial impression on gross fixed investment: 6% in the first year and 9% in the second year. In the following three years when the bulk of work on hydropower facilities and the smelter takes place, the ratio of the projects to gross fixed investment will rise sharply, to 19% in 2005 and a peak of 27% in 2006.<sup>1</sup>

To evaluate the scale of these projects they can be seen in the context of estimated GDP over the con-



1. Investment cost for the hydropower facility and smelter are represented here as a proportion of annual gross fixed investment.

Table 2 Labour demand 2002-2008

<i>Man-years</i>	2002	2003	2004	2005	2006	2007	2008	Total
Aluminium smelter and harbour.....	0	22	123	460	1,307	362	0	2,274
Hydropower station.....	67	377	662	928	1,162	501	147	3,844
Total .....	67	399	785	1,388	2,469	863	147	6,118
Ratio of total labour demand (%) <sup>1</sup> ...	0.0	0.2	0.4	0.7	1.2	0.4	0.1	.

1. Based on Central Bank projections.

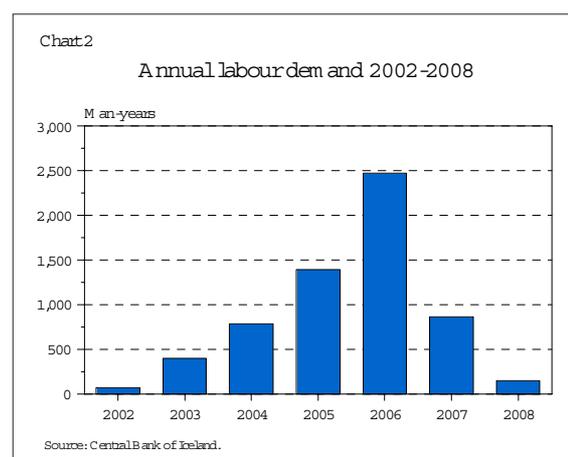
struction period. For comparison, it should be pointed out that construction of the Búrfell hydropower station and Straumsvík smelter at the end of the 1960s peaked in 1968 when it measured 8% of GDP. The scope of the proposed development programme is very similar, or 9% of GDP at its peak in 2006, and an average of 4¼% of GDP for each year over the construction period 2003-2007.

It is estimated that construction cost will be divided 40/60 between domestic and foreign cost. It will, however, will not be spread in even proportions over the construction period. Domestic cost will weigh heavier at the start of the projects, primarily involving earthmoving, construction of tunnels and dams, and concreting. The foreign component will increasingly gain momentum as the projects progress when various imported inputs, materials, equipment and machinery will weigh heavily. Towards the end, sizeable domestic cost can be expected again, when various completion work is done along with installation of piping and wiring, at both the smelter and power station.

An estimated labour requirement of almost 2,300 man-years is needed to build the Alcoa smelter in Reydarfjörður and harbour structures. More than 3,800 man-years are required for work on the hydropower facility, diversions and switchgear. The total is just over 6,100 man-years.

Labour use will be greatest in 2006, at 40% of the total for the entire construction phase. The labour requirement will be around its highest point in 2005 and 2006 when it will amount to almost two-thirds of the total figure. Late in 2007 the labour requirement will rapidly diminish and come to a complete end in late spring 2008. Some 70% of construction workers on the smelter are expected to be Icelandic and 30%

from abroad. Similarly, an estimated 80% of workers on hydropower construction will be Icelandic and 20% from abroad. In total, the labour force will be just over ¾ domestic and just under ¼ foreign. When the domestic labour requirement peaks in 2006 it will amount to 1¼% of Iceland's total labour force. The requirement will probably peak in the first half of that year.



The Alcoa smelter in Reydarfjörður is planned to start operating in late spring or early summer 2007. Some 420 full-time employees are expected to be hired to work in the smelter. Appointment of smelter staff will begin early on in the construction phase and gradually be intensified throughout the period so that all posts will have been filled by the beginning of 2007. It is estimated that it will take the smelter half a year to reach full production capacity, towards the end of 2007.

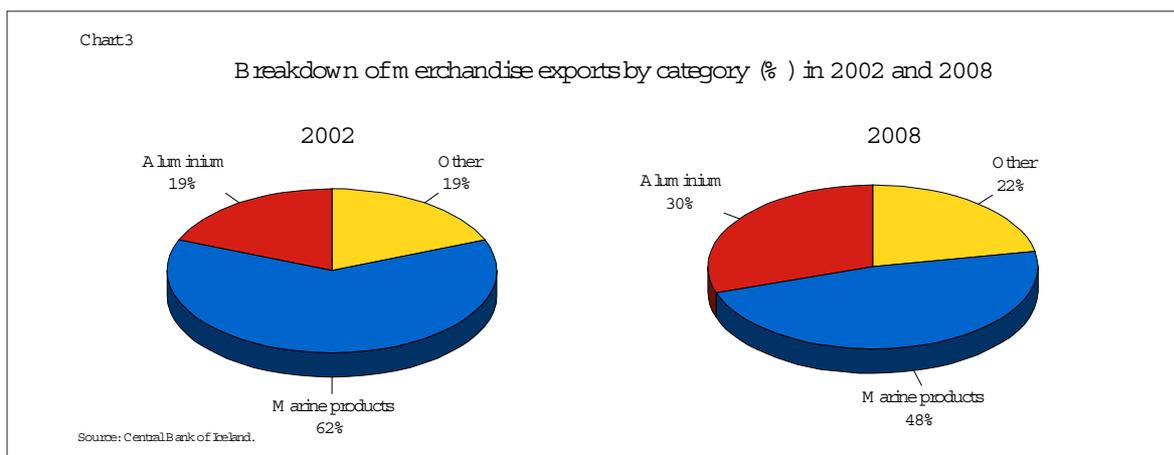
Estimated capacity of the new smelter is 322 thousand t.p.y. which will mean that Iceland's alu-

minium production will increase by more than 120% from 2002.

Aluminium will become a markedly more important export product from Iceland. In 2002 aluminium exports accounted for 19% of Iceland's merchandise exports and marine products 62%. Aluminium prices were relatively low last year and are forecast to rise somewhat as the decade wears on. When the Alcoa smelter reaches full production capacity at the end of 2007, assuming no change in prices from 2002, as a proportion of total merchandise exports aluminium will account for 30% and marine products less than 50%. Assuming that aluminium prices rise in line with forecasts, the proportion of aluminium to total exports will be somewhat higher than that figure at the end of this decade. In recent years aluminium exports have been equivalent to just over 5% of GDP. This ratio will increase substantially when the Reydarfjörður smelter enters full operation and head beyond an estimated 10%.

When the effect of power-intensive industrial projects of this kind is assessed it is important to distinguish between the *short-term* impact of construction of hydropower facilities and smelters and the *long-term* impact of their operation. The impact during the construction phase involves a large-scale investment financed with foreign capital. A considerable part of the investment comprises imports of various types of machinery and equipment, but there will also be a net currency inflow which will be used to finance the use of domestic factors of production. Demand in the domestic goods and labour markets will therefore grow sharply. This impact is temporary, however. It can therefore be termed a *temporary demand shock*. Monetary policy constantly needs to tackle temporary demand shocks. What makes this one unusual is that it is relatively very *large* and also *foreseen*.

In order to understand better the nature of the impact during the construction phase, it can be point-



### 3. Economic impact of power-intensive development projects

This section contains a general discussion of the economic impact that construction of the aluminium smelter and associated hydropower development will have, based on general economic analysis and international experience. Subsequent sections will attempt to make a quantified evaluation of this impact using the Central Bank's models of the Icelandic economy or some components of it.

ed out that the short-term effect of large-scale foreign borrowing for almost any construction project, even if it represented no addition to the production capacity of the economy, is essentially the same. What distinguishes them is the long-term impact. When the smelter starts operating, new production capacity comes into use and export production increases. This strengthens the *supply side* of the economy and gives the economy a boost. Admittedly this is conditional upon a sufficiently large part of the export revenues accruing to domestic parties through power sales to

the smelter, wages, taxes and its purchases of domestic services, to offset the cost of procuring them. Exports increase permanently, or at least for many decades. There has always been a strong long-term relation in Iceland between export revenues and national income. Its level should therefore increase in pace with greater exports. This long-term impact can also be understood in terms of the production of aluminium, and the power that needs to be procured, having a higher productivity than the business activity that may be crowded out in order to create room for them in the economy. Here the success of economic policy and preservation of economic stability during the construction phase may be an important factor. The more success achieved in this respect, the more positive the long-term impact will be, since productive export and import competing industries will suffer less disruption.

In this Appendix, no quantified evaluation of the long-term benefit of these projects will be made. To do so constructively would call for, among other things, a specific study of the profitability of the hydropower project. The reason is that foreign ownership of the smelter but domestic ownership of the hydropower facilities implies that the long-term benefit for the nation depends in part upon how the profitability is shared between them. An assessment is also needed of the extent to which productivity and real wages rise due to the new industries being more productive than those that have been crowded out. Other factors exerting an effect include taxation arrangements for these activities. At this stage the Central Bank does not have the information to make an independent assessment of these factors. Furthermore, it is more consistent with the Bank's role to give priority to evaluating the impact during the construction phase, since monetary policy responds to that impact and not the other. Studies which have been made, such as on the profitability of the hydropower station, suggest that the long-term impact on national income will be positive. The Ministry of Finance, for example, has evaluated the long-term impact on national income using a simple general equilibrium model. Although this does not provide as precise an evaluation as that discussed above, it offers some indication. In the Ministry's opinion, these projects will boost national income in the long-term by three-quarters of a percentage point.

The demand shock which is delivered by the investment is largely foreseen and is described above. Broadly speaking, total investment and labour use are known values, and there are fairly clear ideas about their distribution over time. Specific assumptions are made in the following calculations regarding the division of investment and labour use into domestic and foreign factors. Rather more uncertainty surrounds this point, however, especially regarding labour.

In very rough terms the impact of this kind of demand shock can be predicted on the basis of economic theory. The scope and timing of the impact, however, are highly uncertain. A "correct" statistically estimated economic model that could be used to assess this impact is not at hand and never will be, although constant efforts are made to improve the existing ones. The scale of the shock causes even further complications. Historical experience and data are insufficient to determine with a reasonable degree of accuracy how the economy will react to the demand shock. It is possible that historical relationships of variables may not hold. Furthermore, expectations in the economy could conceivably be exaggerated in the short term. Private consumption could thus grow faster for a while than is justified by the increase in permanent income yielded by the projects. The same could apply to the exchange rate of the króna and other asset prices. Uncertainty also surrounds the effectiveness of economic policy instruments, in terms of both scope and timing. These qualifications must be borne in mind when assessing the results of the calculations presented below.

Like all demand shocks, the projects lift demand above the level where it would otherwise have been. A current account deficit is formed due to heavy imports of investment goods which are used for the projects or form a direct part of the new industrial and power facilities (machinery and equipment). The current account deficit will have no impact on the exchange rate nor create domestic economic pressure since it will be fully funded with foreign equity or borrowed capital. However, a net currency inflow will also take place since foreign capital will be used to finance the use of domestic labour and other factors of production required for the project. The inflow will increase pressure in the domestic goods

and labour markets, contribute to a higher exchange rate and widen the current account deficit. The current account deficit will also grow through increased private consumption and investment in other industries which may accompany the greater optimism that the projects inspire.

Mounting pressure in goods and labour markets is eventually transmitted in the form of greater wage rises and inflationary pressure. The risk is that inflation will get out of control, partly due to increased inflationary expectations. It is this development and the instability that could accompany it that economic policy needs to try to prevent. Not only economic policy operates in this direction, but also certain market forces and adjustment mechanisms that are built into the economy. The exchange rate of the króna and long-term interest rates form part of this process, both of which may be expected to rise during the construction phase and the build-up to it. Another, related adjustment mechanism is the tendency of greater demand to leak out of the economy in the form of a wider current account deficit, thereby easing pressure in domestic markets. It should be added that the excess demand created in domestic goods and labour markets depends to some extent on the proportion of foreign labour and imported capital in construction of the facilities. The higher this share, the less pressure is put on domestic markets. The rise in domestic income will however be smaller.

Fiscal and monetary policy measures can be used in an attempt to reduce excess demand at the very peak of construction and also to soften the contraction that may ensue when it is completed. Monetary policy will strive to keep inflation close to the Central Bank's target and in order to do so will need to maintain higher interest rates than otherwise. The demand shock will be so large that it is uncertain whether this will succeed completely, but as outlined below there is a considerable probability that inflation within the tolerance limits of the inflation target can be achieved. The pressure on monetary policy would be less if accompanied by fiscal countermeasures such as cutbacks in public sector investment at the peak of activity in East Iceland, but increased afterwards and even beforehand. Doing so would be appropriate since monetary measures could have proportionally more effect on export industries than other areas of the economy, by raising the exchange

rate. However, it is not possible that fiscal policy could bear the brunt of the economic policy response. The scale of activity on the project will simply be too great in proportion to, for example, public sector investment.

One important feature of this demand shock is that it is foreseen, as mentioned earlier. This has important consequences for the way in which the economy responds. A good example is exchange rate developments. It is known that the projects will cause a large net currency inflow in the fairly near term. Forward-looking financial markets take immediate account of such information and in effect it is irrelevant that the inflow will not become substantial until after one or two years. All other things being equal, this will cause the króna to appreciate immediately. The exchange rate may also appreciate because the project creates expectations of a rise in the Central Bank's policy rate as the time approaches. This immediately pushes up long-term interest rates, since broadly speaking they reflect expected future short-term interest rates. The interest differential with abroad will widen at the long end of the market, drawing in foreign capital and thereby forcing the exchange rate up.

Thus a rise in the exchange rate during the build-up to the project is only natural, as the Central Bank, and in fact other analysts, have predicted. The higher exchange rate is part of the economy's adjustment to the project. At the same time they help to create room for the project in the economy. The rise in exchange rate reduces inflation and creates slack before construction work enters full swing, thereby causing less pressure in the economy. In fact the same applies to long-term interest rates.

However, a higher exchange rate cannot be a substitute to interest rate rises by the Central Bank, since in part it is based on expectations about them. Although it is convenient to separate the effects of exchange rate and interest rate developments, it must be remembered that under conditions of unrestricted capital movements, these are closely related processes. It can only be expected that one of the largest construction projects in Icelandic history and one of the largest demand shocks that have ever occurred will call for a higher Central Bank policy rate than otherwise, and conceivably a considerably higher one. The following section is an attempt at a quantified

evaluation of what these responses might be. However, it should be reiterated that the following evaluation is only intended to give a rough idea of how monetary policy could respond to the impact of this project, and that there is considerable uncertainty regarding the details of its implementation and ultimate result. The final outcome of this process will not emerge until the construction period wears on. The Central Bank will therefore decide its response when that point is reached.

#### 4. Evaluation of macroeconomic impact without economic policy response

The Central Bank's macroeconomic model was used to evaluate the conceivable impact of the proposed aluminium and power projects on GDP growth, unemployment and inflation. A baseline scenario was set up which did not include the projects. This baseline is consistent with the Bank's economic forecast for 2003 and 2004, except that the forecast incorporates work on the hydropower facilities and aluminium smelter in East Iceland. After 2004 the baseline moves towards equilibrium. The impact of the projects on output growth, unemployment and inflation was assessed as deviations from the baseline scenario for the period 2003 to 2008.

##### 4.1. Assumptions behind the calculations

All the assumptions in the scenarios with and without the power-intensive project were the same as in the forecast presented above. It is assumed that 65% of the investment in the smelter and half of the investment in the hydropower facility are imported, along with one-quarter of the labour force engaged on the projects. Assumptions for labour use and investment are based on information given by the developers and have been used in comparable studies previously made by the National Economic Institute and Ministry of Finance. Furthermore, an unchanged monetary policy was assumed, i.e. the policy rate was kept unchanged for the duration of the period.

Two alternative versions to the baseline were calculated. One assumed that the exchange rate of the króna was unchanged from the baseline scenario. The other assumed that the project would have an impact on the exchange rate. In the latter case, the exchange rate was assumed to strengthen in the first

half of the period, i.e. from 2003 to 2005, because of the capital inflow and expectations of a higher policy rate, then assumed to weaken again towards a new equilibrium. This entails that part of the appreciation that has taken place in recent weeks is the result of the proposed smelter and hydropower projects. For this reason the baseline scenario excluding the projects also assumed that the exchange rate in 2003 would have been somewhat lower than it is at present. In another scenario the exchange rate was assumed to continue to depreciate next year and then rise again towards equilibrium. The scenario incorporating the projects, however, assumes that the exchange rate rises for the first part and then lowers again towards the equilibrium rate. Furthermore, the equilibrium exchange rate is also assumed to be somewhat higher after the smelter enters operation than it would have been without it.

Even though the above exchange rate adjustment is not so improbable, it is clear that precise timing of it is almost impossible to assess, especially because of the impact on investor expectations about future exchange rate developments. As mentioned earlier, it can be argued that at least part of the likely strengthening of the exchange rate has already taken place. Also, expectations about a weakening of the exchange rate at the end of the currency inflow could begin to affect investor expectations as that period comes closer on. Thus it is impossible to give a precise assessment of exchange rate developments over this period. An evaluation of developments had the aluminium projects not arisen is equally difficult to make.

##### 4.2. Main conclusions

As Chart 4 shows, GDP growth in 2003 and 2004 is 1 percentage point higher than if the project had not been launched. Output growth will be 3-4 percentage points greater than otherwise when activity peaks in 2005 and 2006. This assumes no impact of the projects on the exchange rate.<sup>2</sup> A sizeable degree of overheating is therefore involved here, whereby the output gap could measure 6% at most in 2006. By

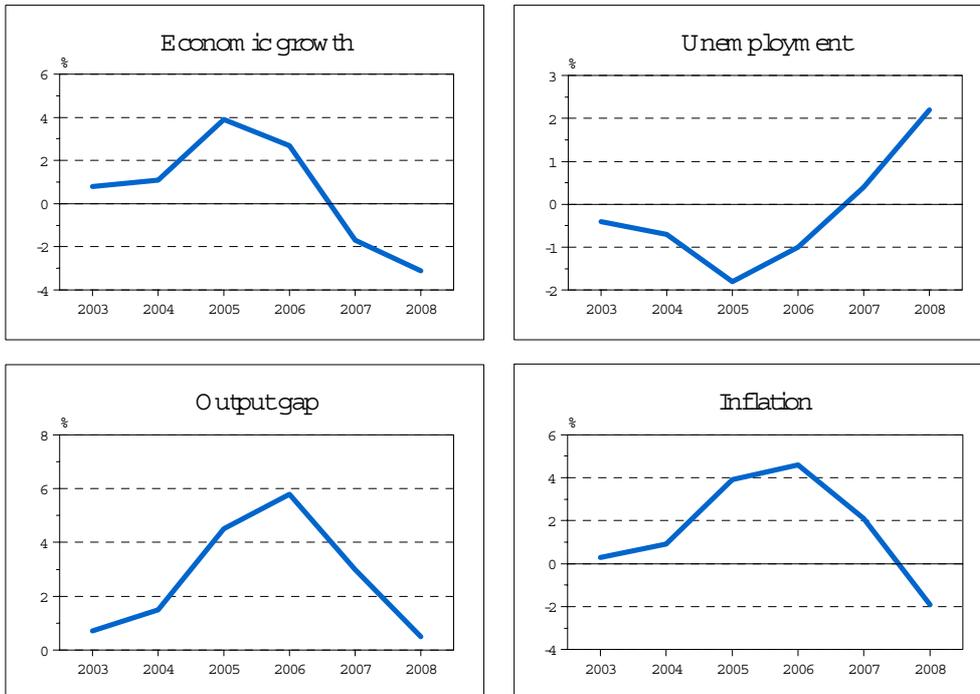
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2. The article on *Economic and Monetary Developments and Prospects* earlier in this edition considers that the project will boost growth by half a percentage point in 2003 and 2004. The discrepancy is the result of different exchange rate assumptions.

Chart 4

Economic impact of the planned power-intensive projects  
without economic policy response and exchange rate adjustment

Deviation from baseline scenario without power-intensive projects (percentage points)



Source: Central Bank of Iceland.

comparison, the output gap was just under 3% in the recent upswing and 3½% in 1987. There would also be a considerable impact on unemployment. Unemployment could be 1½-2 percentage points lower in 2005 than if the project had not taken place, and 1 percentage point lower in 2006, but by then greater labour supply would also be beginning to be felt, taking two forms here: increased labour market participation and increased importation of labour, especially in direct connection with the projects. Overheating of the economy will put pressure on prices and in 2004 inflation could be 1 percentage point higher than otherwise, peaking at 4½ percentage points higher in 2006, which could mean an inflation rate of 6-7%, i.e. considerably above the Central Bank target's upper tolerance limit.

A sharp contraction in investment will take place at the end of the construction phase. When the

smelter starts operating in 2007 and 2008, GDP growth will be considerably slower than otherwise. Unemployment will also be higher, or half a percentage point more in 2007. Part of this increase is the result of more labour market participation because of the projects; the labour market invariably adjusts to the business cycle with some lag. Inflation will also come down in these years and in 2007 it will be only 2 percentage points higher than in the scenario which excludes the project, and in 2008 roughly 1 percentage point lower.

Clearly the sharp swings described here are not only caused by the pending investment. In part their scale is a consequence of the assumptions that were made. Two factors probably weigh heaviest: the assumption that no economic policy responses will be made, and the assumption of no exchange rate adjustment. Conceivable economic policy responses

and their effect on the development of the economy will be addressed below, but an assessment will first be made of the impact of the projects on GDP growth, unemployment and inflation, on the assumption that the exchange rate does not adjust.

If the exchange rate takes part in the economy's adjustment process, the impact on growth will hardly be measurable in 2003 and 2004, based on the exchange rate adjustment described above. Growth will be 1 percentage point higher in 2005 in the scenario that includes the projects and up to 2 percentage points higher in 2006. In 2007 and 2008 it will be marginally higher than without the projects, but the difference will be less than 1 percentage point each year. This is a notably softer impact than when the exchange rate was kept unchanged from the baseline. The same applies to the unemployment rate. Another result is that inflation will be 2 percentage points lower for both years in 2003 and 2004 with the projects included, and just over half a percentage point less in 2005. However, when activity has peaked, and the exchange rate begins to weaken again (but would have been strengthening at the same time in the scenario without the projects), inflation will be higher than otherwise.

Thus the exchange rate adjustment plays an important role in how the economy will absorb this demand shock and clearly has a substantial effect on the outcome. It serves to diminish the effect on the economy compared with assuming an unchanged exchange rate from the scenario that excludes the projects. The impact on inflation also emerges later. However, it should be borne in mind that at least part of such an exchange rate adjustment stems from investor expectations about monetary policy responses. It is therefore difficult to interpret such a development without also taking into account the possible monetary policy responses.

## 5. Assessment of possible economic policy responses and their impact

The calculations presented above are not intended to give an accurate description of economic developments in the next few years and the impact of the aluminium and power projects on the economy, but only to give a rough impression of its scope in relation to the size of the economy and to highlight the need for

taking appropriate economic policy actions in order to create room for this activity in the economy without upsetting its balance.

Assessment of possible economic policy responses to the impact of these investments is based on the Taylor rule which is a simple description of how central bank interest rates respond to the inflation and the output gap (see discussion in Box and Appendix in *Monetary Bulletin*, 2002/2). According to this simple rule, the Central Bank raises its interest rates above a certain equilibrium level if inflation exceeds its target and if there is an output gap in the economy which later imposes a risk of accelerating inflation. This rule is thought to give a good description of the interest rate determination process at the world's main central banks during periods of successful monetary policy, and it is commonly used to estimate the monetary policy response to demand shocks. Different forms of the Taylor rule are applied, depending upon whether the Bank is assumed to smooth its policy rate and the extent to which the rule is forward-looking, i.e. based on an inflation forecast rather than contemporary inflation.<sup>3</sup>

### 5.1. Economic policy actions without exchange rate adjustment

On the basis of the Taylor rule, the Central Bank's policy rate will be somewhat higher than without the aluminium projects. If monetary policy is to some extent forward-looking, the interest rate level can be expected to quickly reach a higher level than otherwise. Calculations suggest that the Bank's policy rate could end up 1½ percentage points higher this year than in the absence of the projects, and up to 5 percentage points higher in 2004-2005 based on an unchanged exchange rate from the scenario which excludes the projects. In 2006, however, it will be only 1½ percentage points higher than in the baseline scenario, and well below the level in the baseline in 2007 on account of the slack generated in the economy at that time.

If the monetary policy is less forward-looking, the policy rate will rise later. This year it would be

3. A macroeconomic model and VAR analysis are used (see article by Thórarinn G. Pétursson, "The transmission mechanism of monetary policy", *Monetary Bulletin* 2001/4, 62-77) to evaluate the monetary policy response and its impact on the economy.

only half a percentage point higher than otherwise, and next year 1½ percentage points higher. In 2005-2006 it would need to be 4½-5½ percentage points higher than otherwise because the Bank had in effect raised the rate too late, i.e. waited too long in order to be able to counter the overheating that the projects generated. On average over the period 2003-2007, the interest rate will be considerably higher than in the scenario based on a forward-looking monetary policy. The Bank will be more successful in constraining inflation and domestic demand, the more forward-looking it is in policy rate decisions. In the following discussion a forward-looking monetary policy is assumed.<sup>4</sup>

As may be expected, the overheating that establishes itself in the build-up to and peak of construction activity can be dampened to some extent. GDP growth will be a maximum of 1 percentage point higher in 2005 than in the absence of the projects, compared with just under 4 percentage points in the scenario without monetary policy response. Monetary policy also manages to smooth the unemployment rate, leaving it at 1 percentage point below the baseline level in 2005 instead of almost 2 percentage points without monetary policy response. In 2006 the unemployment rate is virtually the same in both scenarios, while in 2007 it is rather higher in the scenario with monetary policy responses, due to tighter monetary stance. Since monetary policy manages to dampen the swings caused by the projects, the output gap will also be more stable. It therefore widens much less because of the monetary policy response and is just ½-1 percentage point greater than in the scenario excluding the projects in 2003-2004 and 2 percentage points greater in 2005-2006.

Chart 5 shows that this is also reflected in the inflation rate over the period. Inflation is just under

half a percentage point higher than in the baseline scenario excluding the projects in 2003-2004 and 2 percentage points higher in 2005-2006, compared with 4-4½ percentage points in the absence of monetary policy responses. In 2007 inflation is then a mere half a percentage point higher than in the baseline.

Although monetary policy achieves a substantial reduction in the inflationary impact of the project, it does not seem to manage to keep inflation within the Central Bank's tolerance limits, assuming that it is on target in the baseline scenario. However, the deviation is smaller if a Taylor rule which attaches more importance to keeping inflation close to target or gives less priority to smoothing the policy rate is applied. If this development turns out to be correct, the Central Bank will clearly need to adopt a tighter monetary stance in order to maintain its inflation target than the one described here.

If fiscal policy is also applied to contain domestic demand, inflation is more likely to be kept close to the upper tolerance limit of the target. To give some idea of the impact of public sector restraint, a scenario was calculated which assumed that public sector investments would be postponed so that they contracted by 20% in real terms in 2005 and 2006 but would increase correspondingly in 2007 and 2008. These measures succeed in reducing overheating during the build-up to the projects and soften the contraction when they are over. Inflation remains within the tolerance limits at the peak of activity in 2006 and the Central Bank policy rate could peak at 2-2½ percentage points lower than if monetary policy alone carried the weight of economic policy responses. However, the policy rate would go down more slowly than if no fiscal response were made, since increases in public sector investment at the end of the project softens the downswing that monetary policy would otherwise need to tackle.

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4. It should be reiterated that the forward-looking Taylor rule in effect assumes that the Bank knows the future development of inflation with complete certainty. The results suggest that the Central Bank is more successful in levelling out swings in inflation and the output gap than when it responds only to contemporary developments. In reality the Bank has no such information, so it is unclear which approach proves better, and the findings in the international literature are somewhat ambiguous in this respect. International studies of monetary policy responses usually apply the Taylor rule with contemporary inflation, which is felt to provide a generally good forecast of future inflation developments.

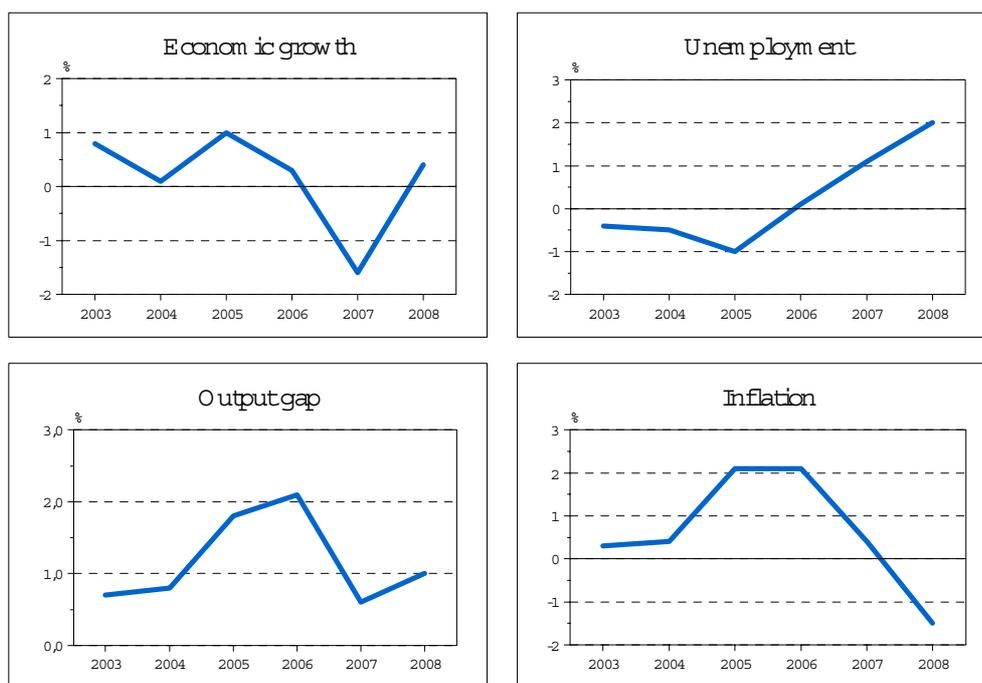
### *5.2. Economic policy responses with exchange rate adjustment*

The above calculations assume that the exchange rate of the króna plays no role in the economy's adjustment to the projects. As pointed out earlier, this is a rather unrealistic assumption, since the exchange rate can be expected to be affected by the cyclical upswing that would accompany the projects,

Chart 5

Economic impact of the planned power-intensive projects  
with economic policy response but without exchange rate adjustment

Deviation from baseline scenario without power-intensive projects (percentage points)



Source: Central Bank of Iceland.

although it is difficult to make a reliable assessment of the size of the effect. Nonetheless, the króna can be expected to strengthen during the build-up to the projects and their peak in conjunction with the large currency inflow that they cause, and with expectations of a rise in the policy rate because of increased inflation.

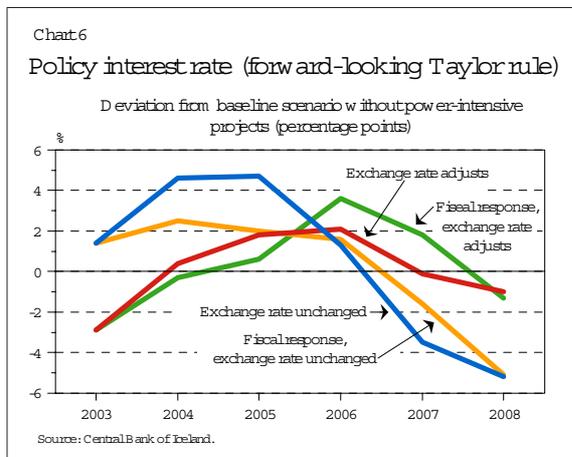
Such an adjustment of the exchange rate helps the economy to absorb the impact of the projects. Their effect on growth and unemployment will be correspondingly weaker since the strengthening of the exchange rate weakens the competitive position of export industries and helps to create room for the projects by crowding out other activities.

This different development is also reflected in the monetary policy response, as shown in Chart 6. Without the projects going ahead, inflation this year would have been considerably higher than currently

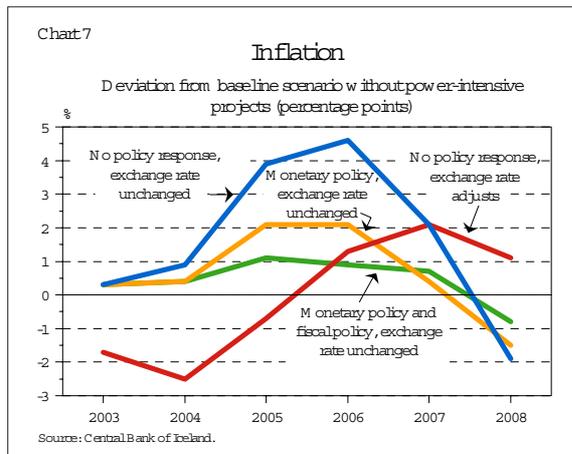
forecast, since the króna would have been significantly lower than at present. Thus the policy rate ought to be as much as 3 percentage points lower this year if the project goes ahead, without any exchange rate adjustment. Assuming a forward-looking monetary policy, however, interest rates would immediately rise next year above the baseline scenario, peaking at 2 percentage points higher in 2005-2006.

With monetary policy responses and an exchange rate adjustment, inflation will exceed the figure in the scenario which excludes the projects by just under 1 percentage point in 2006 and just over 1 percentage point the following year. Thus inflation remains within the tolerance limits of the target. However, this implies that GDP growth will be lower than in the baseline, and unemployment higher.

Thus an exchange rate adjustment clearly helps to counter overheating resulting from the projects and



makes it possible to reach the inflation target at lower interest rates than otherwise. Fiscal action in addition to an adjustment of the exchange rate would then create the opportunity for even lower interest rates. Chart 7 shows the development of inflation based on different exchange rate assumptions and economic policy responses.



### 5.3. Uncertainties and reservations

Various reservations have to be made regarding these calculations, given the great uncertainty involved in such a long-term projection, the economic policy responses and the means by which the economy absorbs them.

One of the greatest uncertainties concerns exchange rate developments. The above calculations are based on two kinds of assumptions as to exchange rate developments. Economic development

based on these exchange rate assumptions, however, are different from scenarios based on the current exchange rate level and in the absence of the projects, since the current strong exchange rate reflects at least in part expectations about their impact. Thus a scenario which incorporates an exchange rate adjustment should be compared with a scenario excluding the projects and an exchange rate which is somewhat weaker than at present and continues to weaken. Although the scenario incorporating an exchange rate adjustment is more credible than the one that leaves it unchanged, it is extremely difficult to make a reliable forecast of the exchange rate trajectory with and without the projects.

Uncertainties about the models used is also great. In comparison with the Bank's conventional inflation forecasting models, for example, the macroeconomic model used in the calculations above is likely to underestimate the impact of excess demand on inflation but overestimate the impact of exchange rate changes. If this is correct, the projects would probably not have as much impact on interest rates in 2003 under an adjustable exchange rate as the above scenarios imply.

On a related point, the effect of exchange rate fluctuations on domestic inflation could be overestimated. Experience from other countries that have moved from a fixed exchange rate regime to a flexible one, and the inflation developments after the króna depreciated in the wake of being floated could give reasons to believe that the impact of short-lived exchange rate fluctuations on domestic inflation is currently weaker than historical relationships suggest.

Related to this is uncertainty about how the economy adapts to policy rate changes. This varies somewhat depending upon the model used. The macroeconomic model is based on historical relationships over a long horizon and suggests that the policy rate needs to be raised more in order to contain inflation in the wake of the projects. The policy rate increases described above would therefore probably prove inadequate for keeping inflation close to the Bank's target. However, the above evaluation is based on a statistical estimation of a simpler model over a shorter period and indicates greater interest rate sensitivity. Since the time series used to estimate the model are relatively short, however, the model could over-

react to the interest rate, creating considerable uncertainty about this impact over and above what generally surrounds the impact of monetary policy on the economy, as discussed in the article by Thórarinn G. Pétursson (2001).<sup>5</sup>

The impact of the project on public's expectations is also highly uncertain, and could be greater than allowed for in the scenarios above. Demand

would therefore be higher than in the scenarios which include the projects, but weaker without them. The difference between economic developments with and without the projects would thus be even greater than assumed here. Hence, the impact on inflation and thereby on interest rates would be greater, and could also be felt earlier than has been assumed.

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5. Thórarinn G. Pétursson, "The transmission mechanism of monetary policy", *Monetary Bulletin* 2001/4, 62-77.