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Optimal Exchange Rate Policy: The Case of Iceland

by

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Optimal Exchange Rate Policy: The Case of Iceland

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Abstract

This paper analysis the appropriate exchange rate arrangement for Iceland, given its structural characteristics, on the one hand, and the need for a credible nominal anchor for monetary policy, on the other. It also discusses the current regime of a currency peg, its rationale, its success in terms of achieving its goals, and how the apparent conflict between the exchange rate arrangement suggested by the structural characteristics of the economy and the arrangement actually chosen, has been resolved. Finally, the paper provides an assessment of alternative future exchange rate regimes. The paper argues that at this point of time a formal inflation target with a flexible exchange rate is the best available option. This does not, however, preclude membership in a monetary union at a later date.

Keywords: Exchange rate regime, Optimal currency area, Iceland

JEL Classification: E52

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1. Introduction

Icelandic financial markets have undergone radical structural changes during the last two decades. Domestic interest rates and external capital movements were highly regulated in the early 1980s but have now been almost completely liberalised. Although highly beneficial from the standpoint of economic efficiency, these changes can make the economy more vulnerable to surges in capital flows. Iceland succeeded in reducing inflation from the high range in the early eighties to below 2% per year in the middle of the nineties. Exchange rate stability was one of the cornerstones of the successful disinflation strategy.[1]

The full liberalisation of financial markets and the end of the disinflation process has called into question whether the current exchange rate regime remains appropriate for the Icelandic economy. Although there have been substantial changes in the implementation of exchange rate policy, with the goal of price stability more prominent than before, the formal arrangement of using the exchange rate as the intermediate target and the cornerstone of monetary policy still remains intact. Some have argued that the costs for Iceland of having its own currency, reflected in e.g. high interest rate differentials, are far bigger than the benefits and have thus argued for adopting the euro as a legal tender, either unilaterally or through EMU membership (which of course implies EU membership). Others have pointed out that while the current regime was very important during the disinflation process, the long-run sustainability of the regime is questionable. A more flexible exchange rate is therefore argued for, adopting an inflation target as an alternative monetary anchor.

This paper sets out to analyse in detail the appropriate exchange rate arrangement for Iceland, given its structural characteristics, on the one hand, and the need for a framework for monetary policy that enhances the credibility of the goal of low inflation, on the other. The inflationary bias of monetary policy in the past is still having a negative influence on its credibility today and restraining choices of monetary frameworks. The paper also discusses the rationale for the choice of the current regime of a currency peg, and how successful it has been in achieving its goals. The paper then tries to explain how the apparent conflict between the exchange rate arrangement suggested by the structural characteristics of the economy and the one actually chosen, has been resolved. Finally, the paper discusses alternative policies that could be pursued in the context of increasingly agile capital markets and the advent of the euro.

[1] See Andersen and Guðmundsson (1998) for an analysis of the disinflation process in Iceland.

The remainder of the paper is organised as follows. Section 2 gives a historical account of exchange rate policy in Iceland, assessing its successes and failures in the last three decades. Section 3 analysis the optimal currency area (OCA) criteria for Iceland. The findings suggest that Iceland fails to fulfil all, or most, of the OCA criteria for a successful euro-peg, suggesting that the structural characteristics of the economy all support a flexible exchange rate regime. Section 4 discusses some limitations to the OCA framework. Section 5 discusses the establishment of the EMU and the single currency and possible effects on the króna. It is argued that a successful implementation of EMU will have positive effects on growth and stability in Iceland. The effects will, however, depend critically on which countries will finally join the union. Section 6 discusses possible future monetary policy options for Iceland. The alternatives to the current arrangement considered are an inflation target, various forms of euro-pegs, adoption of the euro as a legal tender and direct participation in EMU. Considering the long-run vulnerability of the current regime (and other unilateral pegs) and the fact that a bilateral agreement with EMU or full EMU membership are rather unlikely at present, it is argued that an inflation target offers more flexibility and credibility than the current regime and is more consistent with the structural characteristics of the Icelandic economy. Section 7 concludes the paper.

2. A Review of the Icelandic Exchange Rate Arrangement

2.1. History of exchange rate policy in Iceland

The history of exchange rate policy in Iceland broadly reflects international developments. Iceland started the century in a monetary union and ironically, at the end of the 20th century, the question of belonging to a monetary union did again become relevant. Table 1 provides an outline of the various phases of Icelandic exchange rate arrangements through the century. [2]

[2] This summary draws from a review of the history of Icelandic exchange rate policy over the period from 1922 to 1973 in Nordal and Tómasson (1995). A review of exchange rate development from 1973 to 1989 is provided by Felixson and Jónsson (1989). A discussion of exchange rate policy in the 1990s is in Guðmundsson and Kristinsson (1997).

Table 1. Exchange rate policy episodes in Iceland

Period	Characteristics of exchange rate regime
1873-1914	Nordic currency union, gold standard.
1914-1922	Gold standard abolished in August 1914, but parity with Danish krone maintained.
1922-1925	After a 23% devaluation against the Danish krone in June 1922, a floating exchange rate regime is established. The British pound replaces the Danish krone as a reference currency. The króna depreciates against the pound until 1924, after which the króna appreciates under a policy of revaluation.
1925-1939	Iceland's longest period of exchange rate stability. After the pound was taken off the gold standard in 1931 the króna and other Nordic currencies continued to be linked to the pound. Icelandic authorities responded to a deteriorating competitive position by foreign exchange restrictions and protectionism.
1939-1945	After 14 years of exchange rate stability the króna was devalued by 18% in the spring of 1939. As terms of trades improved and the pound depreciated, the króna was linked to the US dollar. Over the period the króna depreciated against the dollar but appreciated against the pound. An overheated economy led to a surge in inflation, leading to doubling of domestic relative to foreign prices over the period.
1946-1949	Growing external imbalances in the first years after the war were initially cushioned by very large foreign exchange reserves and favourable external conditions, but were at a later stage met by extensive capital controls and protectionism. In 1949, when the pound (and soon after most other European currencies) was devaluated by 30½% against the dollar, it was decided to let the króna follow the pound. Due to the large share of European countries in Icelandic trade, however, the country's competitive position did not change much as a result of it.
1950	After Iceland became a founding member of the IMF in 1947, an attempt was made to bring the external accounts closer towards a sustainable equilibrium under liberalised trade. This included a 42,6% devaluation of the króna. This experiment failed i.a. due to unfavourable external conditions. Moreover the devaluations did not seem to be sufficient to bring about sustainable external balance.
1951-1959	After the devaluation of 1950 failed to achieve external balance, a regime of multiple exchange rates and extensive export subsidies was established. The arrangement implied a substantial effective devaluation, but did not suffice to balance the external account.
1960-1970	A more fundamental and far reaching effort to restore sustainable external balance was made in 1960, when the króna was devalued by 1/3 to 57%, depending on the relevant exchange rate premium on foreign exchange transactions. In effective terms, this brought the real exchange rate back to the level of 1914 and 1939 and much lower than in 1950. The devaluation was followed up by extensive trade liberalisation. Moreover, the flexibility of the exchange rate regime was enhanced, as the Central Bank assumed the power to change the exchange rate, no longer requiring a change in law. During the period the króna was devalued on several occasions in response to external as well as internal macroeconomic disturbances.

Table 1. Exchange rate policy episodes in Iceland (continued)

Period	Characteristics of exchange rate regime
1970-1973	After the Bretton-Woods system of pegged but adjustable exchange rates fell apart and the dollar was devalued, the Icelandic króna broadly followed the dollar. During this period, however, the króna was devalued once (1972) and revalued twice (1973) against the dollar, until the króna was effectively floated in December 1973.
1974-1989	During the period to 1983 the Icelandic exchange rate regime became increasingly flexible and could be characterised as managed floating. However, in the mid-1980s the monetary and exchange rate policy stance became more restrictive. Over the period 1974 to 1989 the króna was devalued 25 times. Moreover, the króna was allowed to depreciate gradually (without formal announcements) during the period March 1975 to January 1978. An effective devaluation was also achieved in 1986 and 1987 by changing the currency basket. Over brief intervals the value of the króna was kept stable, first against the dollar and then against various baskets of trading partner currencies.
1990-1995	During the first half of the 1990s the role of the exchange rate as a nominal anchor received stronger emphasis. A path-breaking moderate wage settlement in early 1990 was supported by a public commitment to a stable exchange rate, which became the cornerstone of a disinflation strategy that proved successful. However, there were two devaluations during this period, in 1992 and 1993, in both cases in response to external shocks. In 1994 regulation of long-term capital movements was abolished.
1995-	Regulation of short-term capital movements was abolished in 1995. Exchange rate flexibility was gradually increased in the latter half of the 1990s, subsequently giving inflation prospects a greater role in the formulation of monetary policy.

As the review in Table 1 indicates, the exchange rate regime has gone through fundamental changes throughout the 20th century. In the last 30 to 40 years we have seen a gradual return to the environment of relatively free trade that characterised the beginning of century. One could argue that these periods of relatively free trade were only interrupted by two world wars and a depression that led to extensive restrictions on international trade and capital movements. The restrictions imposed in the wake of the Great Depression and World War II took a long time to unwind, especially in Iceland. There have been two relatively brief periods of floating or semi-floating exchange rates, the first one in the context of a return to a liberal trading regime after World War I and the second after the collapse of the Bretton-Woods fixed rate system.

Otherwise, the Icelandic króna has been pegged against or at least managed with respect the currency of some trading partner country or a basket of currencies, but with varying degree of adjustability and commitment. Consequently, the line between a peg and managed floating is often rather blurred. At times commitment has been so weak that the exchange rate regime could be characterised as one of managed floating, rather than an adjustable peg.

It is interesting to note that when looking at the development of the real exchange rate over the period from 1914 to date, one may conclude that, excluding the two

periods of extensive restrictions of foreign trade and foreign exchange transactions, there is no obvious trend in the real exchange rate, indicating that PPP may indeed hold in the very long run. Over the medium term, however there has been substantial variability, though fluctuations have tended to moderate in recent decades.[3] Figure 1 shows the development of the real exchange rate (all the data used in this paper is described in Appendix C).

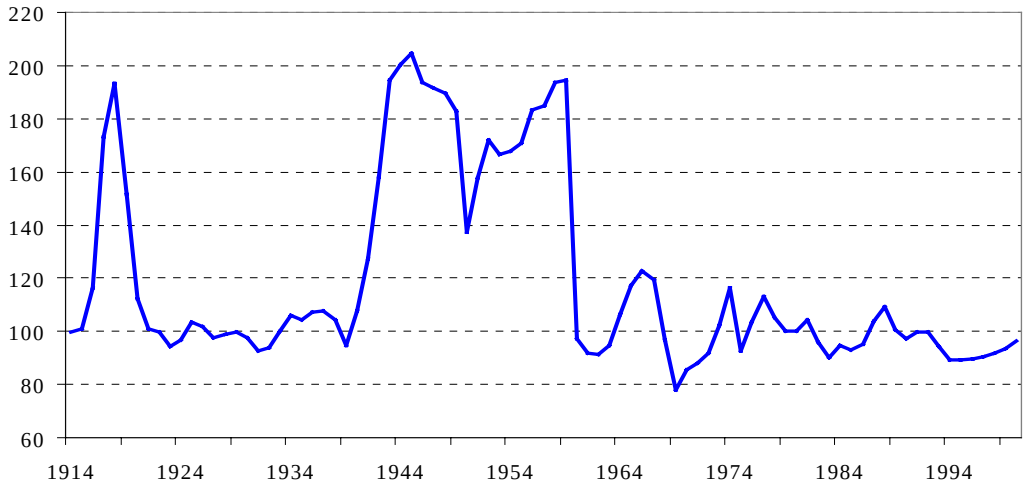

Figure 1. The real exchange rate

In the following section we will take a closer look at the post Bretton-Woods era and the rationale behind the exchange rate policies that were adopted in an environment of floating exchange rates of the main currencies.

2.2. The motivation of exchange rate policies in the 1970s and 1980s

The post Bretton-Woods era can be roughly divided into two periods with respect to exchange rate regime. The first one spans the period from 1973 to 1989 and is characterised by a highly accommodative exchange rate policy with frequent adjustments, on average about 1½ times per year if two periods of gradual depreciation are not counted. The latter spans the period from 1990 to date. During this period exchange rate policy has been much less accommodative, notwithstanding two devaluations in 1992 and 1993. During both periods the Central Bank statute was basically guided by the same principles. According to the law, the Central Bank has multiple but potentially conflicting objectives. The Bank should aim to maintain a stable exchange rate, but in such a way as to maintain external balance and a sufficiently competitive position of export and import competing industries.

[3] The finding that deviations from PPP are large and persistent is not specific to Iceland. See, for example, Rogoff (1996). A Dickey-Fuller unit root test rejects a unit root in the real exchange rate at the 5% critical level, supporting the claim that the real exchange rate is stationary.

It is debatable whether the 1973-1989 period should be characterised as one of managed floating or rather adjustable peg with a heavy emphasis on adjustability. When the flexibility of the exchange rate regime is evaluated, it is not enough to look at the frequency of exchange rate adjustment. The structure of the economy, its regulatory environment as well as the external conditions that contributed to conditions of chronically overheated economy with high inflation all need to be considered. During this period, the Icelandic economy was still highly regulated. Interest rates were, for instance, not liberalised until the mid-1980s. As a result, in the highly inflationary environment, real interest rates became negative over protracted periods. At the height of the inflation cycle in 1979-1983, the real interest rate on non-indexed bank loans averaged -9.8%. Maintaining exchange rate stability in an environment of much higher inflation than in trading partner countries with very limited ability to use monetary instruments to support such a policy would hence have been extremely difficult. During the 1980s the effective monetary stance was progressively tightened by the introduction of financial indexation and the gradual liberalisation of interest rates in 1984 to 1986. These developments can be seen as important prerequisites for the more restrictive exchange rate policy adopted during the 1990s.

The frequency of exchange rate adjustments during the 1970s and 1980s was also affected by external economic conditions. Thus, external conditions were highly conducive to a rapid rate of capital accumulation in the country's main export industry, the fisheries.[4] The scope for expanding output via capital accumulation, rather than increasing total factor productivity, during these two decades, contributed to a chronic shortage of labour and constant pressure on wages. In turn, this led to a rapid erosion of the competitive position of other industries and a rising real exchange rate during each short period of stable nominal effective exchange rate. At the same time, notwithstanding an external environment generally conducive to growth, the frequency of negative external shocks rose (see Andersen and Guðmundsson, 1998). Widespread use of wage indexation early in the period added further fuel to the fire and posed a serious dilemma for policy makers when the exchange rate was adjusted in response to external shocks.

This can be seen in Figure 2 which shows the development of inflation, exchange rate depreciation and the growth of export revenue, which can be used as a proxy for

[4] Iceland's exclusive economic zone (fishing limits) was expanded from 12 to 200 nautical miles in two steps, encouraging investment in the marine sector to fill the gap left by other nations. Investment was further encouraged by a public policy to build up industries outside the capital area.

external shocks.[5] As the figure shows, inflation usually peaks one or two years after the economy is hit by negative external shocks (measured by a decline in export revenue) and these peaks are always associated with a devaluation of the króna.

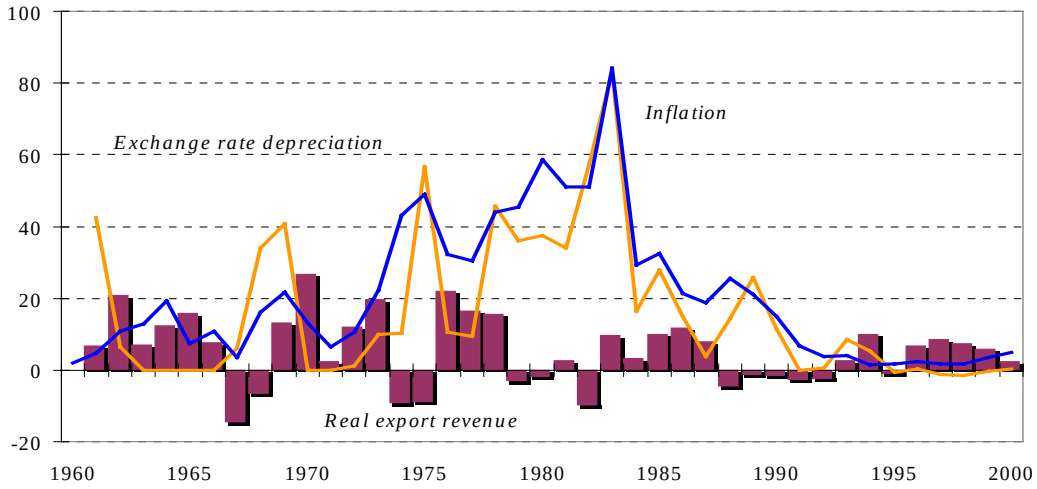

Figure 2. Inflation, exchange rate depreciation and export revenue (%)

The frequent exchange rate adjustments during the 1970s and 1980s not only reflect an accommodative policy stance, but are, to some degree, also resulted from a dearth of other means of adjustment in an external environment conducive to over-investment that was further encouraged by structural policies. At the same time, Iceland's proneness to external shocks demanded frequent exchange rate adjustment to keep the external inbalance within limits. Nevertheless, there is strong evidence that Icelandic exchange rate policy during this period was characterised by a devaluation bias (cf. Andersen and Guðmundsson, 1998). A great importance was attached to maintaining a very high level of employment and indicators of the competitive position of industries carried a considerable weight in the formation of policies. Notwithstanding high and increasing inflation, the real exchange rate of the króna was generally on a declining trend from the end of the Bretton-Woods era to the early 1980s, when inflation was at its peak. This can be seen in Figure 3, which shows the real exchange rate from 1980 and the current account as a percentage of GDP.

[5] Export revenue is defined as exports of goods and services in current prices, deflated by import prices. It thus measures the purchasing power of exports against imports.

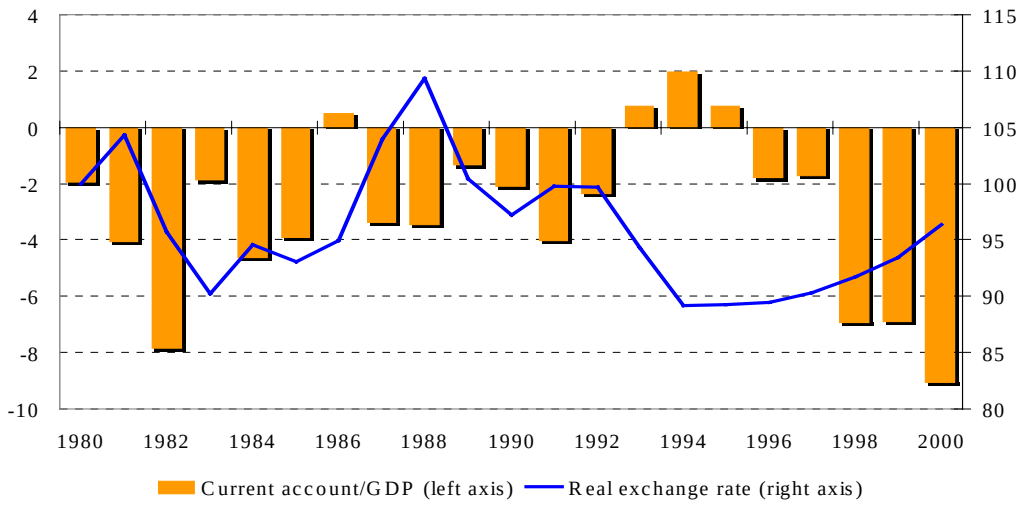

Figure 3. The real exchange rate and the current account deficit

When facing external shocks, the exchange rate was adjusted such as to maintain a high level of employment, with unemployment rates almost always within 1% between 1970 and 1989. On the other hand, the exchange rate was hardly ever revalued when positive shocks hit the economy. Indeed the labour market was in a chronic state of excess demand, as indicated by vacancy rates that exceeded the unemployment rate until 1989, as seen in Figure 4.

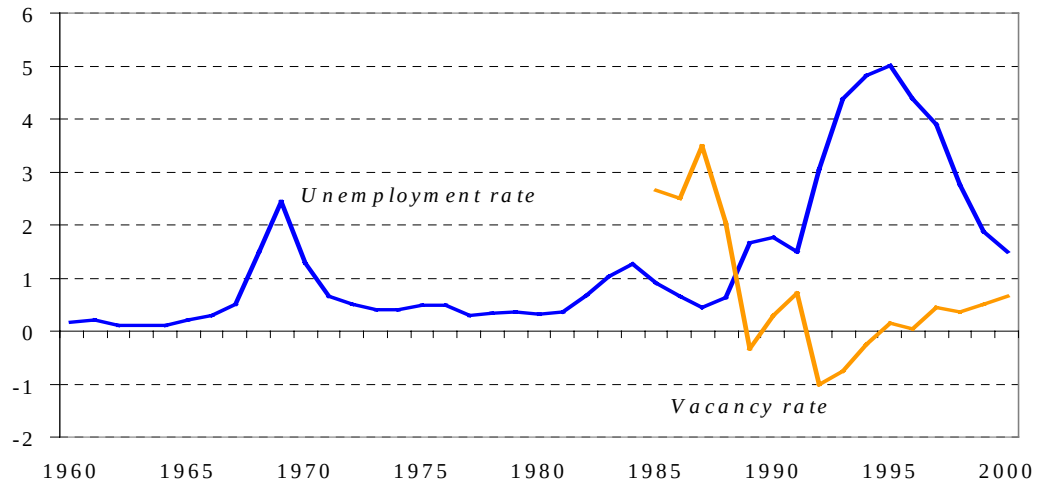

Figure 4. Unemployment and vacancies (%)

Hence, one may conclude, that a disproportionate burden of adjustment was placed on the exchange rate relative to fiscal policy. Moreover, as pointed out by Andersen and Guðmundsson (1998), a comparison of the size of external shocks (as measured by the cumulative change in real export revenue) and the resulting cumulative devaluations, indicates that until the mid 1980s the bias became progressively stronger.

After inflation had reached its peak during the early months of 1983 and threatened to become even higher a range of stabilisation measures were implemented that included a policy of exchange rate stability, following an initial devaluation of 15%. Other measures included suspension of wage indexation, ceiling on wage increases for the rest of the year and compensatory social security and tax changes. These measures succeeded in bringing inflation down from a peak of about 80% to about 30%. The inflation rate stayed close to that level for the next three years, but failed to adjust to the level of the main trading partners. Consequently, the competitive position deteriorated sharply, by more than 17% between 1984 and 1988 (see Figure 3), despite a substantial nominal depreciation. With continued rapid growth of domestic demand, the deteriorating competitive position led to a growing imbalance in the current account and an unsustainable build up of foreign liabilities. This cycle of inflation and devaluation was not broken until at the end of 1989.

2.3. The motives for exchange rate policy in the 1990s

There was a clear shift in the priorities of economic policy makers towards stronger emphasis on price stability around 1990. The experience with high inflation in the preceding two decades was a large factor behind this shift, but international trends towards greater emphasis on price stability probably played a role too. In terms of exchange rate policy the shift led to an increasing emphasis on the role of the exchange rate as a monetary anchor rather than an instrument of adjustment. A policy of exchange rate stability played a vital role in the disinflation process that brought inflation down from the high levels of the preceding decades to a level comparable to that of the main trading partner countries. The success of this policy in achieving rapid disinflation is rather unique in international comparison as described in Andersen and Guðmundsson (1998). The conflict between the role of the exchange rate as a monetary anchor, on the one hand, and the principal adjustment price in a volatile economy, on the other, was though still present, as reflected by two devaluations during the early 1990s. Indeed, the policy of adjustable peg can be seen as a compromise between these two functions of the exchange rate.

Although the policy of managed floating had worked reasonably well during the 1970s and 1980s in terms of adjusting the real side of the economy to external shocks and keeping unemployment low, its inflationary bias was a side effect that became increasingly unpopular among policy makers and the public. Arguably, the policy may also have been harmful to long-term growth by shielding export industries excessively from external shocks, hence providing little incentive for internal adjustment. In December 1989 a period of gradual depreciation came to an end and a

policy of having a stable exchange rate against a trade-weighted basket of currencies was announced. This marked the beginning of a period of exchange rate stability that has lasted to this date. Even during this period, policies were shifting from time to time in terms of commitment to exchange rate stability, the flexibility by which the stable exchange rate policy was executed and the basket of currencies to which reference was made.

In the first years of this renewed commitment to exchange rate stability, the króna was kept completely stable against a basket of currencies. Although there was a formal exchange rate band of ±2¼%, it was not used. This rigidity in the implementation of the policy does not necessarily reflect the degree of commitment to exchange rate stability but rather the underdevelopment of the domestic foreign exchange market.[6] An interbank market for foreign exchange did not exist at that time.[7] In 1990 and 1991 a trade-weighted basket of 17 currencies was used, but in early 1992 the composition of the basket was changed such as to give more weight to the ERM currencies. The trade-weighted basket was replaced with one composed of the ECU (76%), USD (18%) and the Japanese yen (6%), reflecting the relative trade weights of Europe, North-America and Japan respectively. The change was made in the wake of a decision by Iceland's Nordic neighbours to peg the currencies of Norway, Sweden and Finland to the ECU and by Britain to join the ERM. It was considered an intermediate step towards a full ECU-link, pending a decision to be made in 1993. The most significant change was the reduced weight of the pound (to ca. 10% whereas around 25% of merchandise trade is with Britain). Furthermore, although the Nordic currencies remained in the basket through their ECU pegs, their weights were smaller than actual trade would suggest.

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[6] It was argued that without a functioning inter-bank market for foreign exchange, changes within the formal fluctuation limits would lack credibility and any depreciation be interpreted as a permanent devaluation and hence have larger impact on the domestic price level than a transitory market driven change in the exchange rate. See Sighvatsson (1992). However, the lack of liquidity in the inter-bank market when it was in its infancy and hence heavy Central Bank involvement, blurred the distinction between the two arrangements. Another argument for keeping rather narrow fluctuation limits in the period immediately following the commencement of the inter-bank foreign exchange market was that widening of the fluctuation limits might be misinterpreted as a weakening of the commitment to exchange rate stability.

[7] Before the inter-bank market was established, the exchange rate was fixed unilaterally by the Central Bank each morning. The banks were then required to use the fixed rates during the remainder of the day. With the liberalisation of capital and foreign exchange transactions this system became untenable.

Table 2. Exchange rate arrangements in the 1990s

Period	Pegged against	Fluctuation bands	Note
Dec. 1989 – Jan. 1992	Basket of 17 currencies, weighted by share in merchandise trade.	±2¼%	Fluctuation bands not applied in practice.
Jan. 1992 – Sep. 1995	ECU (76%), USD (18%), JPY (6%).	±2¼%	Interbank market for foreign exchange established in May 1993. Devaluations in November 1992 (6%) and July 1993 (7%).
Sept. 1995 –	Basket of 16 currencies, weighted by share in trade in goods and non-factor services.	±6%	Daily fixing abolished and banks assume responsibility as market makers in 1997.
Feb. 2000 –		±9%	

The change in the basket can be seen as a further step in the direction of a hard currency policy, as the composition of the new basket was intended to give more weight to the currencies of low inflation countries, notably the German mark. However, the risk associated with this hardening of exchange rate policy and its credibility implications may not have been fully appreciated. A smooth sailing towards a monetary union was generally assumed and hence the risk of an unintended change in effective exchange rates, resulting from a composition of the currency basket that diverged significantly from Iceland's patterns of trade and the rigidity of the exchange rate arrangement, was discounted. Had the Nordic currencies and the pound remained stable against the ECU as intended, the change in the basket would not have substantially affected the effective exchange rate of the króna. But as it turned out, the withdrawal of the pound from the ERM and the floating of the Nordic currencies in the autumn of 1992 led to an unintended appreciation of the króna.

The Icelandic authorities responded to the disturbances by devaluing the króna by 6% in November 1992 (see Figure 5), a somewhat larger devaluation than warranted by the preceding "technical" effective appreciation. The action indicates that although the shift towards an ECU peg reflected a desire by the authorities to achieve greater price stability on the basis of a hard currency policy, they were not willing to face the consequences of a relatively modest shock to the terms of trade, despite earlier rhetoric that devaluations were a thing of the past. The króna was devalued again in July 1993, this time as a result of an external shock caused by a severe cut in fishing quotas and falling marine export prices. The devaluations of 1992 and 1993 were successful in term of lowering the real exchange rate and both were pre-emptive in the sense that in neither case was there any sign of a speculative attack against the króna. It should be noted, however, that this was before the full liberalisation of international capital movements.

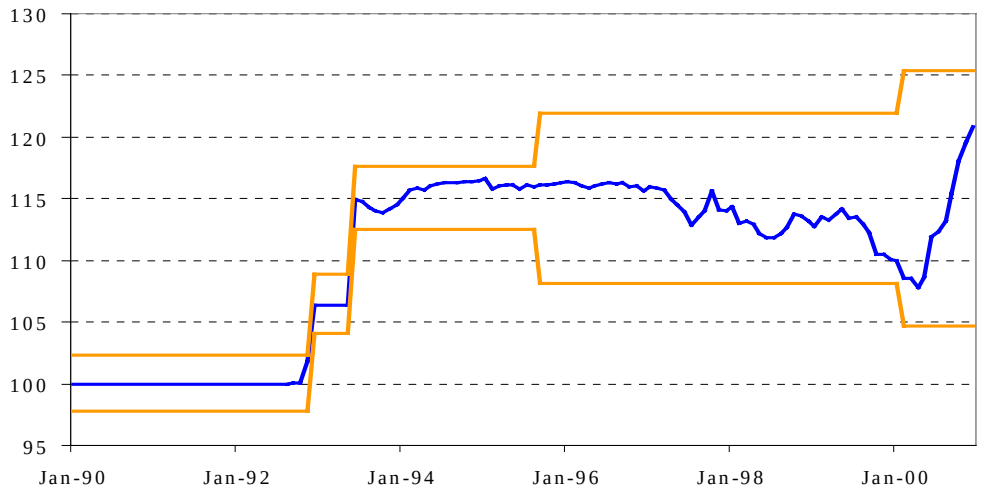

Figure 5. The official exchange rate index and exchange rate bands

Following the devaluations of 1992 and 1993 and the debacle of the ERM in 1993, which led to the adoption of a ±15% fluctuation band for the ERM currencies, there was an increasing awareness, both domestically and internationally, of the risk of a one way speculation against a currency under a rigid exchange rate regime in an environment of liberalised capital movements. This risk was further demonstrated during the Mexican crisis in 1994 to 1995 and later in Asia and other emerging markets. The changes in the exchange rate arrangement that were made in the autumn of 1995 reflected increasing scepticism concerning rigid exchange rate regimes. The ERM crisis of 1993 seemed to demonstrate that narrow exchange rate bands could encourage one-way bets against a currency. In September 1995 the exchange rate band was widened from ±2¼% to ±6% and a trade-weighted currency basket of 16 currencies was adopted, which, unlike previous trade-weighted baskets, included non-factor services and third-country effects. In practice, the widening of the fluctuation bands did not have much immediate significance. The previous narrow bands of ±2¼% had in fact hardly been used at all, even after the interbank market for foreign exchange was established in 1993, and, for a year and half, the widening of the exchange rate bands did not lead to significant changes.

The changes made in the autumn of 1995 were not intended to weaken the commitment to a stable exchange rate. An effort was made to send a clear message to the markets that the changes were not to be understood as an indication that the commitment of the authorities to exchange rate stability had weakened. The Central Bank intervened quite actively in the market during the year following the announcement in order to secure the stability of the exchange rate and so underscore its commitment. This activist policy was not relaxed in any significant way until 1997, when the króna was allowed to appreciate somewhat. The basis for increased

exchange rate flexibility was improved in July 1997, when the daily fixing sessions at the Central Bank were terminated and the banks assumed the obligation to quote two-way prices on a continuous basis.

In February 2000 a further step in allowing increased exchange rate flexibility was taken when the fluctuation bands were widened to ±9%. It was the Central Bank's view that the current regime was beginning to constrain the Bank in tackling inflation as the exchange rate was approaching the upper band, therefore constraining further appreciation of the currency following interest rate hikes. The króna remained relatively stable until the middle of June 2000 when it came under pressure, following negative news on total allowable fish catches and the general macroeconomic outlook. The Central Bank intervened in the foreign exchange market for the first time for over a year and raised its repo rate. This stabilised the market for a while. The króna came again under heavy pressure in the middle of July, with the market temporarily closed on 13 July. After heavy Central Bank intervention the market stabilised but the króna has gradually depreciated since then as seen in Figure 5.

To summarise, during the 1990s exchange rate policy became more restrictive than in the preceding decades of the post Bretton-Woods era, although the emergence of an interbank foreign exchange market in 1993 and the restructuring of the foreign exchange market in 1997 also provided some scope for introducing some short term flexibility. More importantly, economic policies were in general more supportive of exchange rate stability. They involved a reorientation of policy priorities away from maintaining full employment towards reducing inflation in a sustained manner. These policies were based on a consensus between the government and the partners in the labour market, whereas previous stabilisation efforts relied on government decree. The experience of the previous inflation crisis and the widespread use of indexation of household debt from the beginning of the 1980s contributed to this shift in attitudes.

The degree to which the devaluation bias was reduced during the 1988-1996 period is demonstrated in Table 3 below. Nominal devaluations during the period were much smaller in relation to the size of the shocks than during preceding high inflation periods, but achieved real depreciation much more efficiently.

Table 3. Negative external shocks 1962-1996 and exchange rate behaviour

		1967-68	1974-75	1979-80	1982	1988-92
(1)	Cumulative % change in real export revenue	-20.0	-17.0	-4.7	-9.7	-13.6
(2)	Inflation peak %	21.7	49.0	58.5	84.3	25.5
(3)	Year of real exchange rate peak	1966	1974	1977	1981	1988
(4)	Year of real exchange rate low	1969	1975	1980	1983	1994
(5)	Real exchange rate % change*	-36.3	-21.9	-11.6	-13.9	-21.1
(6)	Cumulative nominal depreciation*	50.0	36.1	63.3	65.3	37.6
(7)	Response ratio = -(6)/(1)	2.5	2.1	13.5	6.7	2.8
(8)	Success ratio = -(5)/(6)	0.7	0.6	0.2	0.2	0.6

The table shows periods of falling export revenue that occurred during 1962-1996. * Between years of real exchange rate peaks and lows. Source: Andersen and Guðmundsson (1998).

2.4. An assessment of the success of Icelandic exchange rate policy during the 90s

The performance of exchange rate policy of the 1990s can be measured, on the one hand, in terms of its success in bringing down inflation and its cost in terms of lost output on the other. While the exchange rate based stabilisation measures taken during the 1990s were quite successful in bringing down inflation, it is difficult to assess how critical the role played by exchange rate policy was in the process. The question remains whether alternative packages of policy measures could have yielded the same results with similar or lesser cost. It should however be kept in mind that in the beginning of the period, structural reforms had not reached the point of making some alternative strategies, such as direct inflation targeting, a feasible option. A functioning interbank market for foreign exchange did, for instance, not exist until 1993 and many other instrument of monetary control were at an early stage. Without fully developed instruments of monetary policy it is difficult to see how other strategies could have been pursued successfully at a lower cost.

The policy of a stable exchange rate was an important element of the economic policies that were implemented in the late 1980s and the 1990s and succeeded in bringing inflation down from a moderate level (between 15 to 30%) to the rate prevailing in trading partner countries. The success in bringing down inflation, however, cannot be ascribed only to exchange rate policy. Fiscal policy tightening in late 1988 and tight financial conditions, as reflected in a continued high level of real interest rates, also played a role in terms of preparing the ground for the onslaught against inflation during the 1990s. An important aspect to note about the role played by exchange rate policy is its interdependence with incomes policy. The economy-wide wage settlement reached in February 1990 played a critical role in achieving rapid disinflation. A crucial element of this settlement was its forward looking nature, based on an inflation forecast and a fixed exchange rate. The settlement involved a

7% increase in wages at a time when inflation was running at about 20%. In subsequent settlements (in April 1992, May 1993 and February 1995) wage moderation continued on the same basis. The consensus on wage moderation that prevailed during this period was of course not only the result of the policy of exchange rate stability, but reflected increasing concern by the labour unions about rising unemployment. Nevertheless, these results could hardly have been reached without a commitment to exchange rate stability; indeed, it was an explicit part of the February 1990 settlement.

One aspect of evaluating the success of the exchange-rate-based stabilisation policies of the 1990s is to consider their short-term costs in terms of lost output relative to the long-term gain in efficiency expected from lower inflation. This is not an easy task in the case of Iceland, as output is highly affected by external shocks as well as the stabilisation measure applied. In general, it is to be expected, according to several international studies, that the cost of moving from moderate inflation to low inflation is higher than the cost of moving from high inflation to moderate inflation. According to Andersen and Guðmundsson (1998) the disinflation measures taken in the mid 1980s were clearly accompanied by net gains. The output cost of the disinflation measures taken during the 1990s seems to have been larger, but is still small in international comparison. As output was also affected by adverse external shocks during this period, the negative short-term impact of stabilisation may have been smaller than it appears at first sight. One of the specific features of the Icelandic economy, widespread use of financial indexation, probably reduced the cost of disinflation resulting from expectation errors. As normally is the case, the decline in inflation expectations in Iceland lagged considerably behind actual inflation during the disinflation period of the 1990s (see Pétursson, 1997).

A related question is whether the exchange rate regime of the 1990s, vital as it was in bringing inflation down to international levels, will also be the best in maintaining that success, especially considering that the environment of exchange rate policies has changed in a fundamental way following the full liberalisation of short term capital movements in the beginning of 1995. The turbulence in the foreign exchange market in the summer of 2000 and the experience of several countries in recent years indicates that the sustainability of exchange policies of intermediate flexibility can be extremely difficult in an era of free capital movements.[8]

[8] On the other hand, as the external environment has in some ways become more challenging, one can argue that the authorities are at present endowed with more effective instruments of dealing with such imbalances than before.

These difficulties are reflected in recent trends in exchange rate arrangements among IMF member countries.[9] According to the new IMF classification scheme, in 1991 only 14% of the IMF member countries had a "hard" fixed exchange rate regime in the form of having adopted another currency as legal tender or using a currency board, whereas 53% had chosen a more conventional (formally or informally) "soft" peg of a fixed but adjustable currency regime or a managed float with frequent interventions. About 33% of the countries relied on an independent float or a managed float with infrequent interventions. In 1999 25% of the countries had adopted a "hard" fixed exchange rate regime, 35% relied on an intermediate regime and 41% chose an independent float or a managed float with infrequent interventions. Thus, it is clear that the trend is towards "harder" fixed exchange rate regimes or greater currency flexibility (Pétursson, 2000a).

2.5. Why an exchange rate target?

Why has Iceland chosen to target the exchange rate rather than opting for some other form of anchor, such as an inflation target, monetary aggregates or nominal GDP (see Guðmundsson, 1994)? A more flexible or a floating exchange rate would give the monetary authorities more room of manoeuvre in terms of setting domestic interest rates. However, given the ultimate goal of price stability and the strong link between the exchange rate and the domestic price level in a small open economy, the room of manoeuvre is not as large as it might appear at first sight. Indeed the close link between the exchange rate and the price level is what makes exchange rate targeting so attractive. No other variable that the monetary authorities may have at their disposal has a comparably strong link with the price level. The reasons why Iceland has chosen the exchange rate as a monetary anchor rather than targeting inflation directly, nominal GDP or some monetary aggregate are thus much the same as in other small open economies. The close link between exchange rates and the price level, the transparency of the target, which makes it easily understood among the public and politicians, make it very attractive as a monetary anchor.

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[9] This is also reflected in the literature. Many economists now argue that the polar regimes of free floating or rigid pegs are the only regimes viable in today's world of free capital movements with the intermediate regimes no longer tenable, see Eichengreen (1999) and Frankel (1999). Mishkin (1999) argues that this holds even more strongly for emerging markets, which are especially vulnerable to financial fragility. For an alternative view, however, see Williamson (1999). See Pétursson (2000a) for further discussions.

The problems with an exchange rate peg are, however, many. One is the difficulty of maintaining the peg with free capital movements (see Pétursson, 2000a). Another difficulty is the possibility of a conflict between the currency peg and price stability for countries with a fluctuating equilibrium real exchange rate, such as Iceland, which is frequently hit by external shocks (see below). Furthermore, under such a policy, deciding when and when not to adjust the exchange rate became of critical importance. Too frequent or excessive adjustments would undermine the credibility of such a policy. Discrete devaluations of the exchange rate in response to external shocks probably had adverse effects on inflation expectations given the long history of inflation in the country. Given the substantial degree of uncertainty about the size and durability of external shocks when decisions were taken on exchange rate adjustments, there was a risk of excessive reaction so that expectations would adjust to a future path of exchange rates that *ex post* turned out to be excessively low. If these expectations were validated, the real exchange rate would return to its long-term equilibrium path when the impact of negative external shocks petered out, by means of rising wages and prices rather than exchange rate readjustment, since the adjustable peg was operated in such a way that adjustments were only downwards. Under such circumstances a more flexible exchange rate framework with an alternative nominal anchor might be more appropriate.

One alternative would be some type of monetary target, which became popular in the 1970s in many countries. Although monetary targets have been used successfully in some of them, like Germany and Switzerland, most countries which tried monetary targeting, have now turned to some other nominal anchor,[10] because monetary aggregates became less and less reliable indicators of nominal income and inflation due to financial innovation.[11] This breakdown in the short to medium-term relationship between monetary aggregates and inflation indicates that hitting the target does not ensure that the desired inflation will result.[12] Hence, the monetary target may

[10] On 10 December 1999 Switzerland became the latest country to adopt a formal inflation target. Furthermore, as the target ranges, set by the German and Swiss central banks, for money growth were missed about 50% of the time (Mishkin, 1999), one can argue that both countries have always had an inflation target, albeit in disguise.

[11] As the former governor of the Bank of Canada, Gerald Bouey, once said, "We didn't abandon monetary aggregates; they abandoned us". Mishkin (1999).

[12] Another potential problem with money targeting is that whereas the central bank can control narrow money, it has much less control over broader measures of money. This makes money targeting very difficult, especially in countries such as Iceland where money multipliers have been very unstable.

not be a sufficiently good signal about the appropriate stance of monetary policy. The problem of not hitting the announced target is, however, not a major one for countries with highly credible central banks, such as Germany and Switzerland, but could be a serious problem for countries trying to establish a credible central bank, such as Iceland. For this reason, targeting monetary aggregates has been considered untenable for Iceland.[13]

Although Pétursson (2000c) has found a reasonable and stable demand function for M3, it requires controlling for the effects of financial innovation on the opportunity cost of money, changes which can be difficult to predict in the future. In addition, other studies have found that the causation seems to run from prices to money rather than the other way around (cf. G. Guðmundsson, 1994). The explanation for this is probably the accommodating monetary policy followed in Iceland for most of the period 1979-1993. Were money targeting to be adopted this causation should be reversed. But the relationship might not even withstand the regime shift and could break down completely. Despite the lack of information in money on future inflation, M3 has been found to be a reasonably good indicator of contemporaneous nominal GDP and is therefore considered an important indicator variable for the conduct of monetary policy in Iceland.

Another alternative would be targeting nominal GDP, which could be seen as attractive possibility due to its built-in countercyclical properties. The lag and infrequent measurement of GDP, however, are serious drawbacks, even more so in Iceland than in countries which produce national accounts on a quarterly basis.

Direct inflation targeting has in recent years become an increasingly attractive option. There are usually thought to be three preconditions for a successful inflation targeting: relatively developed financial markets, the ability to forecast inflation with reasonable degree of accuracy, and central bank instrument independence. The first two conditions are largely in place in Iceland, whereas the third could be fulfilled by government decision (see Pétursson, 2000a, b). At the beginning of the 1990s, however, targeting inflation and letting the exchange rate float was not technically feasible due to the absence of a domestic foreign exchange market and the underdeveloped stage of indirect monetary control. Inflation targeting, however, has

[13] Furthermore, Svensson (1999) shows that money targeting is only the optimal intermediate-targeting rule if money is the sole predictor of future inflation. Since this is not the case, money is in general not the ideal intermediate target variable.

become an option in recent years that deserves serious consideration, especially in view of the recent difficulties with rigid exchange rate regimes and apparently positive experience with inflation targeting in neighbouring countries.[14]

3. The Optimal Currency Area for Iceland

At least three issues need to be considered when choosing the appropriate exchange rate regime for a country. First, it needs to be determined whether the structure of the economy is more suitable for a fixed or a flexible exchange rate regime. Second, whether the country can provide a framework for a credible monetary policy on its own, or whether it needs to import credibility from outside sources. Finally, the political motives for joining a currency area need to be considered.[15]

The theory of optimal currency areas (OCA) (cf. Mundell, 1961), tries to organise the economic considerations that motivate the choice of an exchange rate regime. According to this theory a country is more suited to join a currency area:[16]

1. The more open the economy is and the more integrated it is with the proposed currency area.
2. The more symmetric the shocks that impinge on the domestic economy and the proposed currency area are.
3. The more flexible the domestic labour market is in terms of wage flexibility and labour mobility.

The OCA theory therefore states that the more open a country is, the greater are the net benefits of giving up an independent monetary policy to a common monetary institute. The reason is twofold. First, tradable goods are an important part of the overall price level in open economies. Nominal wages are therefore likely to be strongly linked to the exchange rate in open economies through import and export prices. An exchange rate devaluation will therefore have little effect on the real exchange rate since the effects of the devaluation will transmit quickly to the domestic price level and to nominal wages. Furthermore, as fixing the exchange rate in a more

[14] It should also be noted that inflation targeting, using the consumer price index (CPI), involves exchange rate stability to some degree, since the share of import prices in the CPI is about 40% in Iceland.

[15] Another important issue, not discussed here, is the extent of fiscal transfers within the monetary union, which can speed up adjustment to asymmetric shocks by transferring purchasing power from booming to depressed countries.

[16] See Tavlas (1994) for a recent survey of the literature and Guðmundsson (1992) and Krugman (1991) for an earlier analysis of the OCA criteria for Iceland.

open economy goes further toward anchoring the inflation rate than in a less open economies, a credible exchange rate peg is more likely to pin down inflation expectations. Second, transaction costs associated with international trade, such as the cost of trading one currency for another, are reduced when the exchange rate is fixed. As the importance of these transaction costs is likely to be proportional to the openness of the country, a fixed exchange rate becomes more appropriate the more open the economy is.

On the other hand, if the two economies are regularly hit by asymmetric supply or demand shocks, an adjustment in relative prices between the two countries is the least costly measure to restore equilibrium when prices and wages are sticky. Exchange rate flexibility may speed up this adjustment. Furthermore, it is important to consider whether shocks originate on the supply or demand side of the economy, cf. Henderson (1979). When real supply shocks are the dominant source of fluctuations in the domestic economy, a flexible exchange rate might be more appropriate. If, however, financial shocks are more important, a fixed exchange rate should be chosen.

The strain on monetary policy in the face of asymmetric shocks is considerably lessened the greater the flexibility of the domestic labour market. In this case wage flexibility or labour mobility may work as the adjustment mechanism instead of the exchange rate. Thus, labour market flexibility reduces the need for an independent monetary policy.

Despite some criticism (see, for example, Gros, 1996 and Section 4 in this paper), the OCA theory has been the dominant framework for thinking about the choice of an exchange rate regime for the last three decades. In the following section this framework is therefore used to analyse the choice of an appropriate exchange rate regime for Iceland.

3.1. Openness of the economy

The fact that the Icelandic economy is very small would immediately suggest that it is too small to function as an independent currency area. The small size of the economy would also suggest an open economy, measured in terms of the share of international trade in aggregate activity. It turns out, however, that this is not necessarily the case.

Table 4 shows the share of international trade, measured as the sum of exports and imports of traded goods and services as a percentage of GDP, for a group of industrial countries. Two measures of a potential currency area are used. The first is the EMU area containing Germany, France, Holland, Italy, Luxembourg, Belgium,

Finland, Ireland, Austria, Portugal and Spain. The second is the EU area adding the United Kingdom, Denmark, Greece and Sweden to the former group.[17]

Table 4. Openness of economies in 1997 (in %)

Countries	Share of international trade	Share of exports to the EU area
Austria	85.3	17.5
Belgium & Luxembourg	143.4	48.0
Denmark	68.6	18.6
Finland	70.8	17.3
France	46.2	12.8
Germany	49.8	13.6
Greece	39.7	4.0
Holland	100.0	43.0
Iceland	71.6	15.0
Ireland	155.1	47.9
Italy	46.3	11.4
Japan	21.0	1.6
Norway	75.5	23.6
Portugal	65.3	17.9
Spain	55.6	13.6
Sweden	80.6	19.5
Switzerland	75.2	17.7
United Kingdom	57.3	10.9
United States	25.0	1.7
Average for EU area	76.0	21.1
Average for EMU area	74.3	22.1
Simple average	70.1	18.7

The share of international trade is defined as imports and exports of goods and services as a percentage of GDP. The share of exports to the EU area is defined as the share of exports of goods to the EU area as a percentage of GDP. Sources: Central Bank of Iceland: *Hagtölur mánaðarins*, January 1999 for Iceland and IMF: *Direction of Trade Statistics*, September 1998 and IMF: *International Financial Statistics*, February 1999 for the other countries.

Seven European countries have a larger share of international trade than Iceland, with Iceland's share approximately equal to the group's average. The table also shows the share of exports of goods to the EU area with Iceland again close to the group average.

As Table 5 shows, only about 30% of Iceland's total trade is with the EMU area, whereas close to 60% is with the EU area. This suggests that the effects of EMU on Iceland critically hinge on whether the three EU countries that have not joined EMU will eventually join the union. This especially applies to the United Kingdom.

Tables 4 and 5 clearly indicate that although Iceland is a relatively open economy, many European economies are more open. That Iceland is an "outlier" regarding size and openness can be further seen by regressing the measure of openness in Table 4 on population size (measured in millions). The relationship

[17] Greece joined EMU on January 1 2001.

between the two seems to be non-linear with larger countries less open on average, but openness seems to decrease at a declining rate as countries become larger. [18]

Table 5. Share of countries in Icelandic trade 1997 (in %)

Country	Goods	Services	Goods and services
Austria	0.4	0.4	0.4
Belgium & Luxembourg	1.7	0.9	1.5
Canada	1.1	1.0	1.1
Denmark	7.5	8.7	7.8
Finland	1.4	0.8	1.2
France	4.8	3.3	4.3
Germany	12.4	10.1	11.7
Greece	0.3	0.1	0.2
Holland	5.0	2.8	4.3
Ireland	0.7	0.7	0.7
Italy	2.5	1.1	2.1
Japan	5.7	1.4	4.5
Norway	8.7	4.5	7.5
Portugal	1.6	0.7	1.3
Spain	2.9	2.9	2.9
Sweden	4.0	3.5	3.9
Switzerland	2.6	1.6	2.3
United Kingdom	14.3	11.9	13.6
United States	11.6	39.2	19.7
Total	100.0	100.0	100.0
EMU area	33.4	23.6	30.5
EU area	59.5	47.7	56.0

Source: Central Bank of Iceland: *Hagtölur mánaðarins*, January 1999.

$$OPEN = \underset{(8.3)}{90.95} - \underset{(3.8)}{0.78}\, POP + \underset{(3.2)}{0.002}\, POP^2$$

OLS, $N = 19$, $R^2 = 0.42$, $SE = 27.7$

According to these estimates, exports and imports as a ratio to GDP should be about 91% for Iceland instead of the actual 72%. Thus, Iceland seems to be less open than its small size would suggest. It is therefore not clear whether Iceland fulfils the first OCA criteria for joining the EMU or pegging the króna to the euro.

One of the reasons for this result is probably Iceland's production structure. In many other small European countries, imports of intermediate goods is an important source of international trade, as these economies import intermediate goods and export them as processed or final goods. This leads to large shares of imports and exports of industrial goods. This "throughput" is much lower in Iceland's case due to

[18] Heteroscedasticity consistent *t*-values are in parenthesis. A significant negative relation was still found when only a linear term was included.

its heavy reliance on natural resources as the main source of exports. Value added in the export sector as a share of GDP is therefore probably relatively higher than the share of gross exports.[19]

3.2. Symmetry of aggregate fluctuations

The second OCA criterion argues that symmetry of fluctuations is an important argument for a common currency. Tables 6 and 7 report correlations of key economic variables in individual countries, on the one hand, and in the EU area, on the other, finding little evidence of symmetry between Iceland and the EU area.[20] The only significant symmetry found is between the growth rate of export revenue. Table 7 shows, however, that this is mainly due to the oil shocks in the 1970s. For the period after 1979 the symmetry is no longer significant.

From Tables 6 and 7 it appears that the two EFTA countries Norway and Iceland seem to have little in common with the other European countries in terms of fluctuations of economic aggregates. Furthermore, the tables show that output fluctuations in Iceland have been larger than in the other countries studied. However, these fluctuations have decreased in Iceland and at a faster rate than in the EU area.[21]

[19] The theoretically most accurate measure of openness would be value added in international trade as a percentage of GDP. This measure is, however, not available.

[20] In a study by the Central Bank of Iceland (1997), the same analysis was conducted for a "narrower" EMU containing Germany, France, Holland, Luxembourg, Belgium, Finland, Ireland and Austria. The correlations were even smaller than those reported here.

[21] It should be emphasised that these results are robust to the particular measure of asymmetry used here. For example, Guðmundsson and Harðarson (1992) get similar results using a spectral analysis. They find no correlation between Iceland's exports and aggregate output of 11 OECD countries.

Table 6. Symmetry of fluctuations with the EU area 1961-1995 (%)

	Output growth		*Terms of trade*		*Export growth*		*Export revenue growth*	
Country	Total fluctuations	Share of symmetric Fluctuations	Total fluctuations	Share of symmetric fluctuations	Total fluctuations	Share of symmetric fluctuations	Total fluctuations	Share of symmetric fluctuations
Austria	1.9	**49.5**	3.7	**71.9**	4.2	**50.2**	3.8	**51.3**
Belgium	2.2	**63.2**	3.2	**76.3**	4.6	**63.5**	5.0	**45.8**
Denmark	2.3	**63.1**	8.0	**71.6**	2.8	**36.1**	3.4	**53.3**
Finland	3.2	**34.3**	4.5	**35.9**	6.3	**27.6**	6.2	**32.9**
France	2.0	**71.2**	10.5	**83.1**	4.5	**57.9**	5.4	**78.3**
Germany	2.2	**66.9**	6.2	**30.9**	4.1	**56.5**	4.1	**53.4**
Greece	3.6	**44.9**	6.2	**51.3**	8.1	3.6	8.8	13.9
Holland	2.4	**62.6**	2.7	**60.0**	4.0	**66.9**	4.3	**67.1**
Iceland	4.0	5.0	8.6	0.3	7.7	2.9	9.7	**23.5**
Ireland	2.2	6.9	7.2	**52.0**	4.5	4.3	6.0	**29.2**
Italy	2.5	**45.8**	9.2	**70.0**	4.9	**26.7**	5.8	**36.4**
Japan	3.4	**53.2**	22.5	**77.2**	7.2	**26.6**	8.6	**32.0**
Luxembourg	3.0	**32.4**	4.3	**27.7**	6.3	**61.0**	8.4	**27.4**
Norway	1.7	7.2	11.8	0.0	3.3	**13.8**	6.0	4.1
Portugal	3.3	**45.6**	8.6	**36.5**	9.9	11.8	11.1	**38.9**
Spain	3.0	**54.1**	12.1	**18.8**	12.3	14.3	14.2	**32.5**
Sweden	2.1	**48.5**	8.1	**63.0**	4.8	**44.5**	4.8	**50.2**
Switzerland	2.6	**45.6**	8.5	3.9	3.8	**46.7**	3.9	**40.6**
United Kingdom	2.1	**48.9**	5.1	12.3	3.6	**61.5**	3.3	**42.3**
United States	2.1	**33.9**	10.4	**65.5**	5.5	**23.1**	5.3	**29.8**

The total fluctuation of each variable is its standard deviation. Symmetry is defined as the percentage of the standard deviation explained by fluctuations in the EU area, measured by R^2 from regressing each variable on the corresponding variable from the EU area. Bold numbers indicate significance at the 95% critical level. Source: Central Bank of Iceland (1997).

Table 7. Symmetry of fluctuations in Iceland and the EU area (%)

		1961 – 1995	
Variable	Total fluctuations in EU area	Total fluctuations in Iceland	Share of symmetric fluctuations
Output growth	1.7	4.0	5.0
Terms of trade	4.5	8.6	0.3
Export growth	2.9	7.7	3.0
Export revenue growth	3.2	9.7	**24.0**
		1961 – 1979	
Variable	Total fluctuations in EU area	Total fluctuations in Iceland	Share of symmetric fluctuations
Output growth	1.7	4.3	0.2
Terms of trade	3.7	11.2	0.0
Export growth	3.2	8.8	1.0
Export revenue growth	3.6	11.3	**27.0**
		1976 – 1995	
Variable	Total fluctuations in EU area	Total fluctuations in Iceland	Share of symmetric fluctuations
Output growth	1.3	3.3	5.6
Terms of trade	3.1	4.9	6.4
Export growth	2.1	6.3	3.0
Export revenue growth	2.4	8.1	10.0

See notes to Table 6. Source: Central Bank of Iceland (1997).

An important shortcoming of the above analysis is that no distinction is made between underlying shocks and the propagation mechanism that follows. This distinction is important since finding that aggregate variables in two countries move together may either imply that the two countries experience the same shocks or that factor mobility is working fast enough to offset differences in underlying shocks hitting each country. Alternatively, the two countries may experience common shocks but differences in their economic structure or in their policy responses may reduce the co-movement in aggregate time series.[22] It is therefore important to try to separate the effects of the adjustment mechanism from the effects of the underlying shocks.

A standard approach to identifying underlying, structural shocks in economic time series is to use a structural vector autoregressive (VAR) models. This approach can be used to identify structural shocks within countries which can then be compared to evaluate the symmetry of shocks between countries, see e.g. Bayoumi and Eichengreen (1993) and Bergman (1999). The structural VAR approach can also be used to evaluate which type of structural shocks are most common, another important issue for designing an appropriate exchange rate regime.

Symmetry of permanent and transitory shocks

In order to identify country-specific structural shocks in Iceland and the EU and to measure the symmetry of these shocks, a structural VAR model along the lines of Bayoumi and Eichengreen (1993) is estimated. They use an identifying approach based on Blanchard and Quah (1989), which imposes only long-run restrictions on impulse response functions to identify shocks that have permanent and transitory affects on output. These shocks are usually interpreted as supply and demand shocks respectively, although this interpretation is questionable, as one can think of many types of demand shocks that can have permanent effects, or at least persistent effects that may be difficult to distinguish from truly permanent effects in finite data samples.[23] A minimum requirement for the demand and supply shock interpretation to hold is that positive supply shocks lead to lower prices whereas positive demand shocks lead to higher prices. This does not hold for Iceland since both types of shocks lead to higher prices.[24] One should therefore be careful in interpreting the permanent shocks as supply shocks and the transitory shocks as demand shocks. However, as discussed below, it turns out that a large part of the permanent shocks in Iceland are truly supply shocks, originating from the economy's fish resource and the terms of trade. The supply and demand interpretation is therefore probably not too far off the mark.

The structural VAR includes real output and consumer prices in Iceland and 19 other countries for the period 1960 to 1998 (annual data). This information set identifies two structural shocks, by allowing one shock to have a permanent effect on output and the other only a transitory one. The identifying approach is described in more detail in Appendix B.[25] Table 8 reports the correlation coefficients of permanent and transitory shocks in Iceland and other countries. The results are very much in line with those found in Table 6, with practically no correlation between shocks in Iceland and the other countries. This result holds both for permanent and transitory shocks.

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[22] An example would be the responses to oil price shocks of net oil exporting countries, such as Norway and the UK, and net oil importing countries.

[23] As Blanchard and Quah (1989) point out, changes in the subjective discount rate and fiscal policy may affect savings, and subsequently the long-run capital stock and output. Furthermore, in the presence of increasing returns, learning-by-doing and hysteresis, demand shocks can have long-run effects.

[24] The same results are found for Norway, Japan, Austria, Belgium, Denmark, Italy and Holland. Bayoumi and Eichengreen (1993) get similar results for Norway and Ireland.

[25] As in Bayoumi and Eichengreen (1993) we estimate all the VAR models with 2 lags.

Table 8. Correlation coefficients of underlying shocks between Iceland and other countries

Country	Permanent shocks	Transitory shocks
Austria	0.35	0.01
Belgium	-0.08	0.40
Denmark	0.07	-0.05
Finland	0.09	0.34
France	0.01	0.27
Germany	0.07	0.08
Greece	-0.20	-0.10
Holland	0.07	0.19
Ireland	-0.15	0.04
Italy	0.05	0.29
Japan	-0.05	0.18
Luxembourg	0.24	0.27
Norway	0.18	0.29
Portugal	-0.03	-0.17
Spain	0.00	0.00
Sweden	-0.23	0.22
Switzerland	-0.03	0.09
United Kingdom	-0.02	0.05
United States	-0.20	-0.06
European Union	-0.06	0.15

Sources of shocks

Another important factor affecting a country's choice of exchange rate regime is the degree to which the domestic economy is insulated from various types of shocks. Henderson (1979) analysis this question for an open economy with imperfect substitutability between domestic and foreign assets. He shows that a flexible exchange rate is the best exchange rate regime when the economy is hit by real shocks, while a fixed rate is preferred when the economy is hit by financial shocks.

If shocks with permanent real effects are the main source of aggregate fluctuations in Iceland, a flexible exchange rate would seem the most appropriate exchange rate policy. When shocks alter the equilibrium real exchange rate an adjustment of the exchange rate can be used to help restore internal and external balance more quickly than any other instrument of adjustment.

To analyse whether permanent or transitory shocks are mainly responsible for economic fluctuations in Iceland, and which type of permanent shocks are most important, the structural VAR model above is altered to include output, investment, consumption (all measured per capita), the terms of trade and fish catch.[26] The estimation period is 1950 to 1998. This data set allows identification of three permanent shocks driving output, investment and consumption, with two remaining

[26] An underlying economic model used to identify these shocks is described in Appendix A. The econometric procedure for identifying the permanent shocks is described in Appendix B.

transitory shocks. The three permanent shocks are interpreted as a terms of trade shock, a resource shock and a domestic shock.[27] The identification of these shocks is obtained by assuming that the domestic shock has no long-run effect on fish catch and the terms of trade, and that the terms of trade shock has no long-run effect on fish catch. It has to be born in mind when interpreting the findings that the domestic shock includes an amalgamation of factors like domestic productivity shocks but also possibly domestic demand shocks with very persistent effects (e.g. some type of fiscal shocks).

Table 9 decomposes the variation in the five variables at different forecast horizons between the three permanent shocks, on the one hand, and between permanent and transitory shocks, on the other. The forecast uncertainty in the fish catch and the terms of trade are mainly due to their own shocks. The terms of trade and domestic shocks are similarly important at short horizons for output variation, but the importance of domestic shocks increases with the forecast horizon, accounting for 75% of the forecast uncertainty in output in the long run. For consumption and investment, terms of trade shocks are most important at short horizons, but domestic shocks become increasingly important as the horizon lengthens, accounting for 25% of the variation in investment and 45% of the variation in consumption in the long run.[28]

The table also decomposes the forecast uncertainty between the permanent and transitory shocks. The results indicate that the forecast uncertainty in the data is almost fully accounted for by the three permanent shocks, or 80 to 95% of the variation at the one-year horizon. The two transitory shocks have almost no significance, even in the short run. Only in the case of fish catch and investment is there some evidence of significant effects of transitory shocks in the short run.

As discussed above it is not clear how much of the domestic shocks can be attributed to supply shocks. Although many would argue that most, if not all, permanent shocks to real variables are from the supply side, nothing in this analysis precludes that an important element of the domestic shocks comes from the demand

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[27] The VAR model is estimated with 3 lags. Misspecification tests indicated no evidence of serial correlation, heteroscedasticity or non-normality in the residuals. Cointegration tests indicated two cointegrating vectors, as suggested by the underlying theoretical model. However, the long-run restrictions implied by the model were rejected and the empirical vectors therefore used in the analysis instead. These results are similar to the results in Mellander *et al.* (1992). The rejection of the theoretical long-run relations does not, however, affect the identification of the permanent shocks as pointed out by e.g. Warne (1993). One only needs to specify the number of cointegrating vectors for identifying these shocks.

[28] It is perhaps somewhat surprising that resource shocks are not more important to variations in output than found here. The reason may be that the small data set used here makes it difficult to distinguish between the three permanent shocks.

side. The uncertainty in the interpretation of the domestic shocks is probably most prominent in the short-term; in the long run, most of the domestic shocks are likely to be domestic productivity shocks.

Table 9. Decomposition of structural shocks

Variable	Shocks	1 year	2 years	5 years	10 years	20 years	∞
Catch	Resource	0.464	0.618	0.744	0.853	0.920	1.000
	Terms of trade	0.109	0.078	0.047	0.033	0.018	0.000
	Domestic	0.216	0.139	0.126	0.067	0.036	0.000
	Permanent	0.788	0.835	0.917	0.952	0.974	1.000
	Transitory	0.212	0.165	0.083	0.048	0.026	0.000
Terms of trade	Resource	0.107	0.109	0.053	0.032	0.019	0.001
	Terms of trade	0.677	0.644	0.777	0.852	0.916	0.999
	Domestic	0.064	0.185	0.126	0.088	0.050	0.000
	Permanent	0.847	0.938	0.956	0.972	0.984	1.000
	Transitory	0.153	0.062	0.044	0.028	0.016	0.000
Output	Resource	0.018	0.158	0.210	0.143	0.108	0.078
	Terms of trade	0.475	0.387	0.321	0.202	0.196	0.182
	Domestic	0.340	0.356	0.400	0.618	0.678	0.740
	Permanent	0.833	0.901	0.931	0.962	0.982	1.000
	Transitory	0.017	0.099	0.069	0.038	0.018	0.000
Consumption	Resource	0.129	0.078	0.062	0.029	0.014	0.001
	Terms of trade	0.780	0.675	0.665	0.546	0.545	0.548
	Domestic	0.046	0.210	0.216	0.396	0.427	0.451
	Permanent	0.955	0.963	0.943	0.970	0.986	1.000
	Transitory	0.045	0.037	0.057	0.030	0.014	0.000
Investment	Resource	0.192	0.101	0.048	0.075	0.081	0.090
	Terms of trade	0.602	0.688	0.682	0.591	0.624	0.660
	Domestic	0.003	0.062	0.182	0.266	0.249	0.250
	Permanent	0.797	0.851	0.912	0.932	0.955	1.000
	Transitory	0.203	0.149	0.088	0.068	0.045	0.000

It is, however, clear that the resource and terms of trade shocks are true supply shocks. They, therefore give an estimate of the lower bound for the importance of supply shocks for the variation of aggregate variables. Thus, supply shocks explain at least half of the variation in output, over 90% of the variation in consumption and 80% of the variation in investment at the one-year horizon. At the five-year horizon the lower bound estimates range from over 50 to over 70%. As the forecast horizon increases, domestic shocks become more important, especially for output. If one is willing to accept that most of the domestic shocks in the long run are productivity shocks, it becomes clear that supply shocks are indeed the dominant source of economic fluctuations in Iceland at all horizons.

Thus, permanent, or at least very persistent, real (supply) shocks account for most of the fluctuations in output, investment and consumption, even in the short run. These results are consistent with results from other countries. For example, King *et al.* (1991) find that permanent shocks are very important for the US economy and Gavosto and Pellegrini (1999), Mellander *et al.* (1992) and Bergman (1999) reach the same conclusion for Italy, Sweden and the Scandinavian countries, respectively. The results here imply that permanent, real (supply) shocks are even more important than for those economies.

Taken together, our findings support the view that the Icelandic business cycle is largely unconnected with the business cycle in other countries.[29] The empirical results suggest that the shocks hitting the Icelandic economy are mainly shocks that are not shared by other countries. This implies that Iceland does not fulfil the second OCA criteria for joining the EMU or pegging the króna to its currency. Furthermore, the fact that the economy seems to be dominated by persistent real (supply) shocks, even in the short run, implies that a flexible exchange rate is more appropriate than a fixed rate.

3.3. Wage flexibility

According to the OCA criteria the more flexible the domestic labour market is in terms of wage flexibility, the smaller is the cost of the loss of an independent monetary policy. Instead of using the exchange rate to lower real wages in the face of a negative shock, a decrease in nominal wages could be used. Thus, flexibility of nominal wages can ease the strain on monetary policy when shocks impinge on the economy. This would of course call for a downward flexibility of nominal wages, as well as upward flexibility. However, a decrease in nominal wages has only happened once in the last four decades (in 1959), which suggests that nominal wages have not been downward flexible as is needed to fulfil the OCA criteria.

Real wages have, however, been very flexible in Iceland. This real wage flexibility has been accomplished in spite of widespread wage indexation. Facing a

[29] Hall *et al.* (1998) cannot reject that the "regular" cycles in Iceland and Europe are the same. They obtain this result by testing whether the parameters in an AR(2) regression for output growth in Iceland and Europe are the same. The problem with this approach is that it is not relevant for the policy issue at hand. Two countries can have exactly identical AR parameters even though the business cycles in the two countries are completely independent. Furthermore, the statistical power of this test is very low. For short annual series, the AR parameters (especially the second one) are usually relatively poorly determined, making it hard to reject that they are identical across countries. For example, when this procedure is followed for Iceland and Ghana (to take a randomly chosen country), it could not be rejected that the AR(2) parameters are the same (p-value = 0.19).

negative shock, wage indexation was simply put aside and real wages decreased with an exchange rate depreciation.

Table 10 compares real wage flexibility between countries. The standard deviation of real wage growth is 7.7% in Iceland and is much higher than the standard deviation of output growth. According to the table, real wage flexibility was greatest in Iceland and in Portugal (measured as the ratio of standard deviation of real wage and output growth). The table also shows that there is a strong correlation between real wage growth in Iceland and current and previous two years output growth, not only suggesting a strong connection between real wages and the state of the economy but also that output growth leads real wage growth.

Table 10. Real wage and output growth 1981 to 1996

Countries	Standard deviation of $\Delta\ln(w/p)_t$ (%)	Standard deviation of $\Delta\ln y_t$ (%)	Ratio	Correlation between $\Delta\ln(w/p)_t$ and $\Delta\ln y_t$	Correlation between $\Delta\ln(w/p)_t$ and $\Delta\ln y_{t-1}$	Multiple correlation between $\Delta\ln(w/p)_t$ and $(\Delta\ln y_{t-1}, \Delta\ln y_{t-2})$
Belgium	1.7	2.1	0.8	-0.057	**0.571**	0.328
Denmark	1.7	1.6	1.1	-0.102	0.129	0.295
Finland	1.7	3.5	0.5	0.45	**0.599**	0.374
France	1.8	1.4	1.3	0.004	-0.170	0.030
Germany	1.9	2.0	0.9	0.471	0.118	0.187
Holland	1.6	1.6	1.0	0.088	0.166	0.256
Iceland	7.7	3.0	2.6	**0.673**	0.470	**0.581**
Italy	1.8	1.3	1.4	-0.100	-0.070	0.031
Japan	1.3	1.8	0.7	0.447	0.075	0.350
Norway	2.1	2.0	1.1	0.349	0.417	0.174
Portugal	5.6	2.2	2.6	0.379	0.354	0.169
Spain	1.4	1.9	0.7	-0.291	-0.089	0.014
Sweden	2.4	1.9	1.3	**0.619**	0.199	**0.411**
Switzerland	1.9	1.4	1.4	0.008	-0.379	0.210
UK	1.3	2.1	0.6	0.493	-0.093	**0.449**
USA	0.9	1.9	0.5	-0.012	-0.145	0.022
Average	2.3	2.0	1.2	0.214	0.135	0.243

$\Delta\ln(w/p)_t$ denotes real wage growth and $\Delta\ln y_t$ denotes output growth. Bold letters denote significant correlations at the 95% critical level, i.e. where $\rho[(T-2)/(1-\rho^2)]^{1/2}$ is larger than a t-value with $T-2$ degrees of freedom, where ρ is the correlation coefficient. Source: Central Bank of Iceland (1997).

It is, however, not clear whether nominal wages are flexible enough to take the burden completely off monetary policy in face of major negative shocks.[30] What is, however, clear is that in a low inflation environment the kind of real wage flexibility that has existed in Iceland in the past, requires more flexibility of nominal wages than has been experienced. It is therefore highly unlikely that real wage flexibility can play

[30] A fall in nominal wage growth in the face of smaller productivity shocks could though be sufficient to keep the growth of unit labour cost consistent with the inflation target.

the same role in the adjustment process in the future as in the past and that Iceland cannot be expected to fulfil this OCA criteria within the current low inflation regime.

3.4. Labour mobility

The final OCA criteria states that the more mobile labour is the less critical is the availability of an independent monetary policy, since adjustment to exogenous shocks can take place through reallocation of labour instead of trough changes in the exchange rate.[31] The costs of migration imply, however, that labour mobility is a more plausible mechanism for adjusting to permanent shocks rather than temporary shocks.

Due to the geographical location of Iceland and the language barrier, labour mobility, especially in to the country, has not been so great as to make an important difference in the adjustment to exogenous shocks. There has been some movement of labour out of the country during recessions, especially to the other Nordic countries. This relatively low mobility of labour might, however, be changing in the wake of Iceland's membership in the EEA, that implies free movement of labour vis-à-vis EU countries, and with the opening up of the Eastern European labour market. This has resulted in an increased import of a highly mobile foreign labour during the current upswing.

To give an idea of the effects of the business cycle on labour mobility in Iceland, the net emigration per 1,000 inhabitants (n_t) was regressed on the past year's output growth for the period 1962 to 1997. The resulting regression gave (t-values in parenthesis)

$$n_t = \underset{(3.0)}{1.862} - \underset{(2.8)}{0.290}\,\Delta \ln y_{t-1} + \underset{(2.4)}{0.348}\, n_{t-1}$$

OLS, $T = 36$, $R^2 = 0.29$, $SE = 2.5\%$

Previous year's output growth therefore reduces net emigration significantly. A 1% permanent reduction in output growth leads to a net outflow of 0.03% of the total population in the following year and a permanent net emigration of 0.045% of the population in the long run. In terms of the current population in Iceland (280 thousand) this implies a net outflow of 80 people the year after the output shock and 125 people in the long run. A temporary shock to output growth has no long-run

[31] The mobility of financial capital can also substitute for exchange rate flexibility. For example, in Atkeson and Bayoumi (1993) agents diversify away the risk of country-specific shocks by holding financial assets with returns uncorrelated with country-specific sources of labour and capital income shocks. Capital mobility can, however, only serve as an imperfect substitute for labour mobility except under restrictive assumptions, as noted by Bayoumi and Eichengreen (1993).

effects on net emigration. More than half the number of people who move out of the country in the year of the recession will return the year after although the full adjustment to the new steady state can take up to nine years from the initial shock to output growth.[32]

Turning to the domestic labour market, changes in labour participation and hours worked offer an additional source of flexibility. During the stagnation period from 1988 to 1995 the labour participation rate fell from over 80% to 76% and average working hours of skilled and unskilled workers fell by approximately two hours per week. Thus, the labour market responded to stagnating activity with reduced labour participation and fewer hours worked, preventing unemployment from rising more than it actually did. For example, if labour participation and average hours had remained stable at the 1980-1995 average, the unemployment rate would have risen to about 7% instead of the actual 5% at the bottom of the recession in 1995. However, one can argue that labour market adjustment through the participation rate and hours worked is in practice akin to changes in the unemployment rate in the sense that they involve, at least partly, involuntary aspects and is therefore not fully optimal as an adjustment mechanism.

Together, these results imply that although the effects of the business cycle on labour mobility are significant they are still too small numerically to be of critical importance for the adjustment mechanism in the face of shocks to the Icelandic economy within a time span relevant for monetary policy. This OCA criterion does therefore not seem to be fulfilled by Iceland. Again, it should be emphasised that these results might be changing and might change dramatically if an independent monetary policy was not available to reduce the short-term effects of adverse shocks.

4. Limitations of the OCA criteria

The OCA literature concentrates on the macroeconomic costs of fixed exchange rates, while more or less overlooking the potential microeconomic benefits of a single currency. These mainly involve the reduction of transaction costs and price uncertainty that follow from the use of separate currencies in international trade.[33] To the extent that these factors reduce trade, there will be fewer gains from economic specialisation. The reason that the potential microeconomic benefits are so often

[32] Similar results are obtained by Hall *et al.* (1998) in a simulation exercise.

[33] Although one might expect that the importance of these costs would decline with increasing financial innovation, they should not be discounted altogether. For example, McCallum (1995) finds that trade among Canadian provinces is substantially greater than trade between Canadian provinces and nearby US states. The most important explanation for this seems to be that the Canadian provinces share a common currency.

overlooked is simply that economists have found modelling them exceedingly difficult (cf. Krugman, 1995). That does not, however, imply that they are less important than the macroeconomic costs of a common currency.

Furthermore, several authors have questioned the relevance of the OCA criteria for a successful monetary union (cf. Flandreau, 1995). For example, the Scandinavian currency union (which Iceland was a part of) from 1873 to 1913 has been called "the most successful of all European currency unions" (de Cecco, 1992 p. 67), even though intra-Scandinavian trade was relatively unimportant, labour mobility was relatively small, and the economic structure of the participant countries differed considerably (Bergman, 1999). In addition Bergman (1999) finds that country-specific shocks in the Scandinavian countries were not highly symmetric during this period, leading him to conclude that the Scandinavian countries did not form an optimal currency area according to the OCA criteria.

Finally, there are several important issues that the OCA criteria do not satisfactorily address. These include the important role of fixed exchange rates as a nominal anchor for countries lacking credibility in monetary policy, the possibility that flexible exchange rates overshoot and become an independent source of economic fluctuations rather than an important tool of adjustment to shocks, and the time dependence of the OCA criteria and its dependence on the policy framework. We now turn to each of these limitations.

4.1. Credibility of monetary policy

Although the OCA criteria indicate that Iceland would benefit from a flexible exchange rate regime, there may be other aspects that have to be considered when a decision is made concerning Iceland's future exchange rate arrangements. The OCA approach assumes that economic policies, under a flexible exchange rate regime, are pursued in an optimum way such as to make full use of the potential benefits of flexible exchange rates. If monetary independence is not applied in an optimum way or is abused it may result in an erosion of credibility which makes monetary independence quite costly. Under those circumstances the constraints that a membership in a monetary union (or a credibly fixed exchange rate if such an ideal arrangement exists) puts on these policies may still make a monetary union preferable to an independent currency. It should be noted in this context that when the OCA criteria are applied to identify the optimum exchange rate arrangement, no distinction is usually made between participation in a fully-fledged monetary union and a unilateral fixed exchange rate. This distinction is, however, critical as a unilateral peg can never be fully credible. Hence, the actual results of these two options can be

vastly different. Neither does the OCA criteria provide answers as to the appropriate degree of flexibility. Considering that completely free floating hardly exists (although the main currencies come close) and that all forms of a pegged exchange rate are adjustable to some degree, the OCA criteria do not provide a precise answer to the question of whether Iceland's existing exchange rate arrangement is indeed optimal or not.

Recent history provides examples of both a sub-optimal and a constructive use of monetary independence. The inflationary bias of the 1970s and 1980s can be contrasted to the use of monetary independence during the 1990s to relieve the negative effects of external shocks on employment. The inflationary bias in monetary policy in the past, especially in the 1980s, probably caused substantial damage to the credibility of monetary policy. Although it can be argued that in the 1990s the use of the exchange rate as a monetary anchor and an instrument of adjustment was balanced quite successfully, interest rates are still considerably higher in Iceland than in other European countries. This is partly because Iceland is in a different phase of the business cycle than other European countries, but high interest rates also reflect a risk premium, which partly measures the price of keeping an independent currency. This cost of an independent monetary policy in terms of a high interest rate premium can obviously have detrimental effects on investment and growth in the long run, which will offset some of the gains from speedy adjustment.[34] This cost should however decline as the credibility of monetary policy increases. This, and the different monetary policy options available are discussed in Section 6 below.

4.2. Uncertainty and incomplete foreign exchange markets

The credibility deficit may not always come as a result of bad policies. In some cases it may result from the inefficiency of markets in evaluating changes in a highly uncertain external environment. The problem of uncertainty and herd behaviour in expectations driven foreign exchange and capital markets is not explicitly addressed by the OCA approach, but may substantially reduce the benefits of monetary independence.[35]

There is, however, a growing literature addressing this issue (see Coleman, 1999 for a survey). For example, Neumeyer (1998) shows that if exchange rates are more volatile than justified by economic fundamentals (as empirical evidence clearly suggests), an independent currency may be a source of economic shocks, rather than

[34] Exchange rate uncertainty may also affect investment and growth via other channels such as the location of industrial activity, as discussed below.

[35] Many economists, such as Williamson (1999), have used this argument against floating regimes.

the ideal mean of adjustment to shocks, by introducing additional random noise into prices. Hence, if the foreign exchange market is incomplete, an independent currency may have destabilising effects on the economy. Joining a monetary union can therefore be welfare improving, by insulating the real economy from speculative bubbles originating in foreign exchange markets.

Furthermore, if foreign exchange and capital markets are indeed prone to overshooting, monetary authorities may actually be forced to tighten monetary policy at a time when easing (resulting in a measured depreciation) would be more appropriate considering the economic conditions. This problem has been clearly demonstrated during the recent crisis in emerging markets, and hotly debated in the context of IMF programs. Thus, although a flexible exchange rate regime does provide protection against one-way speculation, such a regime is not immune from destabilising speculation and overshooting originating in foreign exchange markets.

4.3. The endogeneity of the OCA criteria

A further shortcoming of the OCA criteria is that they fall victim to the Lucas critique. As argued by Frankel and Rose (1998), the extent of trade between countries and business cycle correlation will critically depend on each country's policy choices, including its choice of exchange rate regime. Thus, participation in a monetary union may in itself change the structure of the economy in such a way that a country may qualify for a monetary union membership *ex post* even when not *ex ante*.

This view has, however, been challenged by Bayoumi and Eichengreen (1993) and Krugman (1993). They argue that greater trade integration will lead to concentration and specialisation of manufacturing industries, thus reducing income correlations. If this effect were to dominate, participation in a monetary union would actually move Iceland further away from the OCA criteria.

Theoretically, trade integration thus has an ambiguous effect on business cycle correlations, so empirical evidence is required to determine which effect dominates. Frankel and Rose (1998) provide such evidence for 21 industrial countries over the period 1959 to 1993. They find that there is a significant positive effect from trade integration on income correlations, suggesting that increased trade integration leads to more correlated business cycles. Further evidence is provided by Frankel and Wei (1995), using a gravity model of bilateral trade, who find that membership in the EU increases trade with other EU members by at least 60%.

It thus appears that joining a monetary union increases trade with other union members, and that increased trade integration leads to more symmetric business cycles. This implies that although historical evidence suggests that Iceland does not

satisfy the OCA criteria, increased trade with the EU countries and, subsequently, increased income correlations with the EU area might result in Iceland satisfying the criteria in the future.

5. EMU and the króna

5.1. Economic impact on Iceland

Whether the establishment of EMU will lead to significant long-term benefits in terms of growth and stability and how these benefits weigh against the risk of disruptions, if the monetary union proves less successful than hoped, is uncertain. But assuming that EMU will be successfully implemented, it should contribute to growth and stability, not only within the euro-zone, but also in countries that are highly integrated with the euro-zone. Some of the most important benefits are the following:

1. With one currency replacing eleven currencies, transaction costs in foreign trade and tourism will decline.
2. Any growth benefits that might flow from EMU will also accrue to outsiders, depending on their share of trade with the EMU countries. For a small country with a relatively low overall market penetration the benefits are, however, likely to be modest.
3. Outsiders will also benefit from reduced costs of financial transactions due to deeper and more liquid financial markets in the euro area.
4. The end of uncertainty in inter-euro area exchange rates that has presented risk in foreign exchange transactions and trade with individual euro-zone countries will also benefit outsiders.
5. The Maastricht criteria have become the standard for economic policies not only within the euro-zone and among prospective members but among outsiders too. Icelandic policy makers, as well as foreign observers, frequently judge the success of economic policies against these criteria. Interest rates offered to Icelandic borrowers on international financial markets might be influenced by Iceland's standing with respect to the criteria and credit rating agencies might make adherence to them a requirement for favourable credit ratings. In view of the above and the possibility that Iceland might at some stage join the EU, these criteria are likely to affect economic policies in Iceland in the coming years. In that sense EMU will affect the economic policies of outsiders, irrespective of the exchange rate arrangements or relationship to the euro they choose.

The benefits that accrue to outsiders will in all cases be smaller than those that will accrue to insiders, but larger the bigger the euro-area. Later on the euro-zone could embrace all present members of the EU plus the countries of Eastern Europe and the Baltic. In the case of a wide-EMU, including all the present 15 EU members, the share of EMU countries in Iceland's merchandise trade would rise to 60% (see Table 2 above). Among industrial countries, the potential accession of Britain, which is Iceland's largest export market, with a share of merchandise exports of around 20%, matters most. It would profoundly affect the relevance of EMU for Iceland as well as Norway.

There might also, however, be negative aspects facing outsiders. Firstly, the country's position in terms of relative living standards might deteriorate vis-à-vis insiders as the benefits accrue disproportionally to the insiders. Secondly, there might be an increasing tendency by multinational firms to locate their activities in Europe within the euro-zone in order to minimise exchange rate risk. This might put outsider countries at a disadvantage in terms of attracting foreign direct investment. Thirdly, the interest rate margin of outsiders against their trading partners might widen temporarily as interest rates in high interest rate insider countries converge to the core rates. Fourthly, small countries at the margin of a big currency area might find it difficult to maintain stable exchange rates with free capital movements. Fifthly, the competitive position of financial institutions in outsider countries with respect to financial institutions within the euro-zone might be adversely affected. Finally, there is the possibility of some currency substitution, especially among the smallest outsiders, with adverse effects on seigniorage.

6. Options for future exchange rate policy

The results so far can be summarised in the following way:

- Iceland is a candidate for a flexible exchange rate arrangement based on the structural characteristics of the economy as captured by the OCA criteria.
- In spite of this Iceland has adopted a stable exchange rate policy as the intermediate target of monetary policy. The reasons were a lack of an alternative nominal anchor and a market structure permitting a floating exchange rate. A stable exchange rate was also a very important part of the disinflation strategy.
- The apparent conflict between what the OCA criteria seem to suggest and the adopted framework has in practice been resolved by devaluations in the past and more flexibility of the exchange rate within a wider band in recent years. The

actual flexibility has thus been substantial, notwithstanding formal commitment to a stable exchange rate.

- EMU will affect the Icelandic economy in various ways, as Iceland is a close trading partner with the EU and a part of the internal market through the EEA agreement. But these effects will be much stronger if all EU members enter the euro area, as the euro area only accounts for a third of Iceland's foreign trade in goods and services, whereas the EU as a whole accounts for 60%.[36]

We can now use these results to assess the following options for Iceland's future exchange rate policy:

- Maintain the current arrangement.
- Adopt an explicit inflation target with a floating exchange rate.
- Peg to the euro, either unilaterally or under a bilateral agreement.
- Adopt the euro as a legal tender without being a full member of EMU.
- Join the EMU.

The assessment of the costs and benefits of these options will mostly be qualitative as information for making quantitative evaluation is in many cases lacking. We will compare various cost and benefit aspects of these options, using the current system as a benchmark.

The first is the *interest rate differential towards trading partners* that has to be sustained on average over the business cycle in order keep inflation at the trading partners level over the medium term. The size of this differential will of course at any given time depend on the credibility of monetary policy. But apart from that it can be seen as an insurance premium that has to be paid for having an independent currency with the option of using monetary policy to facilitate the adjustment to asymmetric shocks. The smaller this differential the better is the given exchange rate arrangement, all other things being equal. The second aspect to be considered is the *degree of flexibility or inflexibility in the face of shocks or adverse developments*. An exchange rate arrangement that makes it possible to speed the adjustment to external shocks is to be preferred over one that does not, all other things being equal. The third aspect is the *degree of vulnerability to external adverse developments.* The increasing

[36] If we further add the EFTA countries the share goes to 70%. These countries are closely integrated with the EU through the EEA-agreement (Norway) and bilateral treaties (Switzerland) but have formally a flexible exchange arrangement towards the euro. Their share in Iceland's foreign trade is therefore not an argument for pegging to the euro, as long as that is the case. On policy options for EFTA-countries vis-à-vis the euro see Guðmundsson (1999).

international mobility of capital, which has made unilateral exchange rate pegs more vulnerable to speculative attacks, has made this an increasingly important question. The fourth aspect has to do with *transaction costs*. These involve both "pure" transactions costs associated with using two or more currencies in foreign trade and uncertainty created by the possibility of changes in exchange rates. The fifth and final aspect has to do with the *degree of sovereignty*. It is taken for granted that the less the loss of sovereignty the better, all other things being equal. But a distinction should be made between sharing sovereignty and delegating sovereignty to a foreign country. Participation in a monetary union with some say in the monetary policy pursued by that union is preferred over using the currency of that union as a legal tender with no say, provided that everything else is equal. Under this heading we include also the issue of command over seigniorage.

6.1. The current arrangement

The current arrangement has in many ways served Iceland well. The stable exchange rate policy played a big role in the disinflation process and it has so far survived free capital movements and a strong economic upswing. That is partly due to the flexibility, albeit limited, of the arrangement.[37] On the cost side we can list the high interest rate differential that seems to be needed and the vulnerability in an environment of free capital movements. The underlying problem is that a flexible exchange rate is more in agreement with the structural characteristics of the Icelandic economy, which makes it less credible that Iceland will, at least unilaterally, sustain a fixed exchange regime. Substantial flexibility can and has been achieved by adjusting the exchange rate whenever deemed appropriate. The fundamental problem, however, is how a policy of stable exchange rate can be implemented in a flexible way without leading to a devaluation bias that will undermine the credibility of the peg.

6.2. An inflation target

There are two reasons why Iceland did not adopt a flexible exchange rate in spite of the structural characteristics of the economy. These were a lack of an alternative nominal anchor and a lack of markets sufficiently developed for a floating exchange rate. The end of the disinflation process, growing international experience with direct

[37] The flexibility of the current arrangement is twofold. Firstly, the króna is pegged to a trade-weighted basket with the weights being changed annually on the basis of the last year's trade composition. Secondly, there is a ±9% fluctuation band. The króna fluctuated within the old ±2¼% band until 14 May 1998. Recently, the width of the band has, however, been used more extensively with the króna

inflation targeting and the development of the money and foreign exchange markets has made inflation targeting a more attractive option. It is superior to the current arrangement in terms of flexibility and vulnerability. But it has to be supplemented with a full instrument independence of the Central Bank in order to maximise the likelihood that the use of the flexibility is not at the cost of medium-term price stability. Such independence will in turn call for other changes, especially regarding transparency of the whole framework and the accountability of the Central Bank.[38] On the cost side, this framework might increase transactions costs due to more exchange rate volatility. However, it is not clear if it will bring any significant benefit in terms of the interest rate differential. Having the potential of being more credible than the current arrangement might suggest that it would, but increased exchange rate volatility will work in the other direction. But as the benefits are clear and the costs are mostly associated with exchange rate volatility it is preferable to the current arrangement, especially considering the difficulties the current regime might experience in the face of external shocks under full capital mobility.[39]

6.3. Euro-peg

There are three degrees to an euro-peg, i.e. a traditional unilateral peg, a bilateral peg and a currency board.

The *traditional unilateral peg* suffers from all the drawbacks of unilateral pegs with free capital movements. There are no obvious benefits in terms of credibility and the gain in terms of a lower interest rate differential will be small, non-existent or even negative if markets perceive the peg to be more vulnerable than the present one due to the risk of misalignment as the peg would not reflect Iceland's trade patterns. Hence, it would be particularly problematic for Iceland to peg to the euro so long as the euro area only accounts for a third of Iceland's foreign trade. The Asian experience shows clearly that "wrong" pegs can be dangerous when countries are faced with significant changes in the exchange rates of major trading partners. This option can thus be excluded.

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breaking the stronger half of the old ±6% band on 19 April 2000. Recently, the króna has depreciated and by the end of 2000 was about 5% into the weak part of the band.

[38] See Pétursson (2000b) for a discussion on central bank independence, with respect to Iceland.

[39] Gerlach (1998) uses a probit model to identify structural factors that influence the probability that countries will adopt an explicit inflation target. These seem to be low central bank independence prior to the introduction of the inflation target, relatively low degree of openness and relatively few export goods, but those countries are more likely to be subject to external shocks and changes in the equilibrium real exchange rate. The fitted (out-of-sample) probabilities that Iceland and Norway are using an explicit inflation target are both practically unity.

The *bilateral peg* is a more promising option, as credibility will be enhanced to the extent that the ECB would be willing to defend the peg. The gain in terms of a lower interest rate differential could therefore be significant. But it is difficult to evaluate this possibility at present, as exchange rate relations of the euro area with close third countries have not been defined. The EEA agreement does not cover monetary and exchange rate arrangements, but article 46 of the agreement opens up the possibility of exchanging information and viewpoints on these issues, though without any commitment. But it is somewhat contradictory to claim that monetary union is a very important complement to the internal market (some say even a necessary addition) while, at the same time, accepting that those countries, which, through the EEA agreement, are part of that market, could in principle have very flexible exchange rates towards the euro area. The legal provisions in the Maastricht Treaty seem to indicate that ERM2 will not be open for non-EU countries. Formal exchange rate arrangements involving non-EU currencies will be governed by article 109(1) of the Maastricht Treaty, which makes it clear that it will be the responsibility of the Council, acting on recommendations from the ECB and the Commission, after having consulted the ECB and the European Parliament, to conclude such agreements. This process of making a bilateral agreement of supporting a peg of the Icelandic króna to the euro is somewhat cumbersome, although such an agreement cannot be excluded. An agreement with the ECB on limited intervention support is another and possibly an easier variant. It is though not clear if it would enhance credibility to the same degree.

This raises the question as to why insiders should be interested in providing institutional arrangements for bilateral pegs for outsiders. Honohan (1997) argues that the existence of outsiders that are strongly integrated with certain insiders and face similar kind of shocks could make the problem of asymmetric shocks even worse for these insiders and thus be a potential threat to a monetary union. He goes on to propose soft target zones with a flexible intervention support from the ECB in these cases.

A *currency board* is of course a unilateral peg, but with a much stronger internal commitment mechanism. It is therefore likely that it will bring benefits in terms of the interest rate differential.[40] The problems are possible strains on the banking system and the absence of the lender-of-last-resort function of the Central Bank. It is also to be considered that currency boards have usually been adopted by colonies, newly independent countries in the process of establishing their own currency, or countries

[40] The interest rate differential need not disappear due to credit and equity risks as Argentina's experience shows.

that have very severe problems with inflation, financial instability and a lack of credibility. Currency boards have, to our knowledge, not been adopted by relatively successful and independent developed countries.

6.4. Unilaterally adopting the euro as a legal tender

The unilateral use of the euro as a legal tender involves the full euroisation of the economy as in Panama vis-à-vis the US dollar and as has been contemplated by Argentina and recently adopted by Ecuador and El Salvador.[41] The practical arrangement of such a transition has not been fully thought out and there is a question as to what degree a consent of the euro authorities is necessary and advisable.[42] It is also an open question whether lender-of-last-resort facilities for the banking system would be available and who would be providing those. In any case, it is hard to see that a full euroisation of the Icelandic economy would be practical until such time as euro notes and coins come into circulation.[43]

The main benefits of full euroisation would be reduced transaction costs, smaller exchange rate risk and a lower interest rate differential. There will, of course, be no scope for an independent monetary policy but, at the same time, there is no exchange rate vulnerability. The vulnerability of the financial system is, however, likely to increase. From the standpoint of sovereignty it is problematic that the country will have no say in monetary policy decisions. Moreover seigniorage will accrue to other countries and the country in question will loose if notes and coins get lost or destroyed although, by the same token, the country will not bear the cost of producing notes and coins. Therefore, the same applies as regarding the currency board, that this is not a road that has been taken by relatively successful and independent developed countries.

6.5. Participation in EMU

Finally, we want to compare the options we have discussed so far with the option of joining EMU. This is not, of course, an available option to Iceland at present as it is not a member of the EU. It seems to us that EMU membership would be preferable to both a currency board arrangement and the unilateral use of the euro as a legal tender.

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[41] See Hanke and Schuler (1999) for an interesting discussion.

[42] It is though clear that it would involve using the foreign exchange reserves of the Central Bank to swap the monetary base into euros. As the numbers were at the end of 1998 it is a viable option as the monetary base was 20.6 bn.kr. (of which 6.3 bn.kr. are notes and coins) but gross reserves of the Central Bank were 29.8 bn.kr. and net foreign assets of the Central Bank stood at 26.1 bn.kr.

[43] Icelandic residents are free to open foreign exchange accounts in domestic banks. At the end of 1998 such accounts stood at 15 bn.kr. or 6.7% of total deposits.

All benefits of the latter concerning exchange rate risk and interest rate differential will accrue. It will also be superior in terms of vulnerability and sovereignty. But the issue of the role of the ECB as a guardian of the stability of the financial system and as a lender-of-last-resort is presently unresolved. The country would get its share of the seigniorage of the euro and what is more important, it would be part of the decision process on monetary policy. On policy flexibility in the face of shocks, it can be argued that EMU membership is inferior to the unilateral use of the euro as a legal tender as fiscal policy would be subject to the strictures of the Stability and Growth Pact.[44] Finally, this alternative seems to be superior to euroisation in terms of the cost of the transition. In the case of euroisation, Iceland would have to use its foreign exchange reserves to swap the monetary base for euros. By joining EMU only a part of the foreign exchange reserves would be handed over to the ECB. Hence it may be unwise to adopt the euro as a legal tender if participation of EMU might be on the agenda in the not too distant future.

6.6. Comparison of the options

We conclude this section by attempting to rank the options we have discussed above in terms of the five criteria. In Table 11 we try to put signs on the net benefits relative to the current arrangement. It goes without saying that this is very far from being an exact science and some of the signs (or question marks) are debatable. Some of the signs flow from the discussion above but further explanations are also called for. Most of the question marks are in the column for vulnerability. At first sight it might seem that a bilateral euro peg should clearly be less vulnerable than the current arrangement as it would be defended by the ECB as well as the Central Bank of Iceland. But it would be more vulnerable to exchange rate fluctuations of the major international currencies than the current arrangement so long as Iceland has a significant trade with the US, the UK and Asian countries. These fluctuations could in that case cause fluctuations in the effective exchange rate and/or the terms of trade. The currency board and euroisation options have question marks in the vulnerability column for the same reasons, but also due to more exposure of the financial system. The question marks in the interest rate differential column were explained in the text above.

[44] This drawback might be less than it seems as the bigger room of manoeuvre for fiscal policy is not necessarily always used wisely.

Table 11. Options for exchange rate policy – Net benefits relative to the current arrangement

Exchange rate arrangement	Interest rate differential	Flexibility	Vulnerability	Transaction costs	Sovereignty
Inflation target	?	+	+	–	0
Unilateral euro peg	?	0	–	0	0
Bilateral euro peg	+	–	?	0	0
Currency board	+	–	?	+	0
Euroisation	+	–	?	+	–
EMU	+	–	+	+	–

In Table 12 we try to assess the relative ranking of selected options in terms of the five criteria. No attempt is made to weigh the various aspects. We leave out three options, i.e. the current arrangement, a unilateral euro peg and the currency board. The current arrangement is left out, as we want to assess its main alternatives. But it is clear that the current arrangement would not be the most favoured option on any of the criteria, except regarding sovereignty, where it has an equal rank with a bilateral euro peg, the currency board and the inflation target. It clearly emerges from Table 11 that a unilateral euro peg is inferior to all the other options and therefore of no interest for the exercise in Table 12. The currency board option is left out in order to simplify the table, but it is a weaker case of the more theoretically interesting euroisation, with a small probability of being adopted. The currency board option is not the most favoured option on any of the criteria, except sovereignty.[45]

Table 12. Relative ranking of selective options in terms of net benefits

Criteria	Statements	Results
Interest rate differential	IT < BEP < ELT = EMU	ELT or EMU are preferred
Flexibility	EMU < ELT < BEP < IT	IT is preferred
Vulnerability	IT – ? – EMU; BEP & ELT < IT & EMU	IT or EMU preferred
Transaction costs	IT < BEP < ELT < EMU	EMU is preferred
Sovereignty	ELT < EMU < BEP = IT	BEP or IT preferred

IT = inflation target, BEP = bilateral euro peg, ELT = euro as a legal tender (euroisation), EMU = Economic and Monetary Union.

The inflation target is preferred in three cases and EMU membership in three, but the other two options only in one case each. But if EMU membership is excluded then inflation targeting would be preferred in three cases and euroisation in two, thus, making the inflation target the most favoured option.

[45] The currency board option would be ranked below euroisation in terms of the interest rate differential, but it is not clear whether it would be better than a bilateral euro peg. It would rank between euroisation and a bilateral euro peg on flexibility, would be inferior to an inflation target, EMU membership and euroisation on vulnerability, between a bilateral euro peg and euroisation on transaction costs and equal to a bilateral euro peg and an inflation target on sovereignty.

We have seen that there is no single answer concerning the optimal exchange rate regime that is given for all times. Rather, the optimal exchange rate regime for a country depends on the options that are open in any given period, which in turn depend on the historical development of the economy and the economies of its trading partners (see Frankel, 1999 for similar arguments). The same will apply in the future. We can therefore think of several scenarios for the development of the framework for monetary policy. One scenario, which seems though rather unlikely at the moment, is that the possibility of Iceland's membership in EU and later EMU opens up relatively soon. In that case it is conceivable that Iceland could live with the current arrangement until it enters a bilateral euro peg (ERM2) and then eventually becomes a full member of EMU. Another scenario is that Iceland moves to an inflation target in the near future. That does not though preclude that it could, at a later date, become a member of EMU if Iceland was to decide to enter the EU (as was done in Spain and Finland).

The question of moving to an inflation target raises the issue of what is called the exit problem in the literature (see Eichengreen, 1999). It seems that countries do not usually move to increase the flexibility of their exchange regimes until forced to do so by crises. It is clearly optimal to move before. It also seems desirable to move gradually, and when the currency is not under any strong downward pressure. In Iceland's case the first steps have already been taken with the gradual widening of the bands from ±2¼% to ±9%, the more extensive use of the width of the bands and more explicit reference to price stability in the conduct of monetary policy. The final step would then be the removal of the fluctuation bands and an adoption of a transparent inflation target regime as the nominal anchor of monetary policy. That then leaves the final question of whether the Icelandic economy is really large enough to make it optimal for it to sustain an independent monetary regime.[46]

7. Conclusions

This paper analysis the appropriate exchange rate arrangement for Iceland, given its structural characteristics, on the one hand, and the need for a framework for monetary policy that enhances the credibility of the goal of low inflation, on the other. It also discusses the rationale for the choice of the current regime of a currency peg, and how successful it has been in achieving its goals. The paper then tries to explain how the apparent conflict between the exchange rate arrangement suggested by the structural

[46] In this connection it is interesting that a discussion seems to have begun in the New Zealand economic establishment about the drawbacks of monetary independence and the possible benefits of entering a monetary union. See Coleman (1999).

characteristics of the economy and the arrangement actually chosen, has been resolved. Finally, the paper suggests and analyses alternative options that are available for future arrangement of monetary policy.

The findings suggest that the structural characteristics of the economy all support a flexible exchange rate regime. The economy is not so open that the transaction costs of keeping an independent currency are overwhelmingly large, nor is trade with the potential currency area large enough to warrant pegging the króna to the euro. The main sources of aggregate fluctuations in Iceland are persistent, real supply shocks that are largely uncorrelated with business cycles in other countries. Finally, it is argued that wage flexibility and labour mobility cannot be expected to take the burden completely off monetary policy in the face of external shocks. It seems therefore that Iceland fails to fulfil all, or most, of the optimal currency area (OCA) criteria for a successful euro-peg. That is not to say that joining the euro is necessarily a bad idea. That depends on whether the extra room of manoeuvre provided by a flexible exchange rate regime will be used wisely or not. Furthermore, if exchange rates are excessively volatile, an independent currency may have destabilising effects on the economy, in which case a monetary union membership might be welfare improving.

It is one of the conclusions of the paper that there is no single time independent answer to the question of the optimal exchange rate regime. Although historical evidence suggests that Iceland may not fulfil the OCA criteria, it might be that increased trade with the EU area following EU membership will lead to increased business cycle symmetries. Hence, Iceland may fulfil the OCA criteria *ex post* even when not *ex ante*.

The paper also discusses possible future monetary policy options for Iceland. Considering the long-run vulnerability of the current regime (and other unilateral pegs) and the fact that any forms of bilateral agreement with EMU or full EMU membership are rather unlikely at present, it is argued that an inflation target offers more flexibility and credibility than the current regime and is more consistent with the structural characteristics of the Icelandic economy. But the more general question about the optimality for Iceland of sustaining an independent monetary regime is still unanswered.

Appendix A. A Simple Open Economy Growth Model

To motivate the number and structure of the long-run relations in Section 3.2, a simple open economy extension of the real business cycle model in King *et al.* (1991) is used, containing output (y_t), consumption (c_t), investment (i_t), fish catch (a_t) and the terms of trade (q_t). This model follows Mellander *et al.* (1992) but allows for two types of productivity shocks: a domestic productivity shock and a resource shock.

As in Mellander *et al.* (1992) the analysis is conducted in a steady state where all stationary disturbances in the system are equal to their expected, zero, values. The first steady state relationship states that along a balanced growth path the output-investment ratio should be constant.

To show this, assume that the home country's output, *y*, is produced by means of a Cobb-Douglas technology with constant returns to scale. There are three factors of production, labour and two types of goods: one produced at home and abroad and one that is only produced abroad. The capital stocks for these two goods are denoted as k_h and k_f, respectively. Normalising labour input to unity, the production function can be written as

$$y = (\lambda k_h)^{\alpha} k_f^{\beta} \tag{A.1}$$

where λ is total factor productivity, which consists of two independent trends

$$\lambda = \lambda_d^{\phi} \lambda_r^{1-\phi} \tag{A.2}$$

where λ_d is a domestic productivity trend and λ_r is a resource trend. Letting the price of the *h*-good act as numeraire, maximisation of (A.1) subject to costs yields the following first-order condition for the allocation of the two capital stocks

$$k_f = q(\beta / \alpha) k_h \tag{A.3}$$

where *q* is the terms of trade. Under a zero-profit condition, *y* is given by

$$y = \upsilon \left[\left(\lambda_d^{\phi} \lambda_r^{1-\phi} \right)^{\alpha} q^{\beta} \right]^{1/(1-\alpha-\beta)} \tag{A.4}$$

where υ is a constant. Output is therefore driven by the two trends in λ and the terms of trade trend, *q*.

Total investment is given by

$$(A.5) \quad i = i_h + i_f / q = (\gamma + \delta)(k_h + k_f / q)$$

where γ is the average growth rate of output and δ is the rate of depreciation. The steady-state value for investment is thus

$$(A.6) \quad i = \varphi\left[\left(\lambda_d^{\phi}\lambda_r^{1-\phi}\right)^{\alpha} q^{\beta}\right]^{1/(1-\alpha-\beta)}$$

where φ is a constant. Thus, the three trends that drive output are also driving investment. Equations (A.4) and (A.6) further imply that

$$(A.7) \qquad \ln y - \ln i = \ln(\upsilon / \varphi)$$

i.e. the output-investment ratio is constant along a balanced growth path. As deviations from this steady state value must be stationary, the output-investment ratio will be stationary.

The second steady state relation implied by the open economy growth model is between output and consumption. The consumer maximises utility $U(c)$, where c denotes aggregate consumption $c = (c_h, c_f)$, subject to a budget constraint. The consumption index c is given as

$$(A.8) \qquad c = c_h^{\theta} c_f^{1-\theta}$$

where θ denotes the share of the h-good in aggregate consumption. The solution to the consumer maximisation problem is given as

$$(A.9) \qquad c = \vartheta\left[\left(\lambda_d^{\phi}\lambda_r^{1-\phi}\right)^{\alpha} q^{\beta}\right]^{1/(1-\alpha-\beta)} q^{1-\theta}$$

where ϑ is a constant. It therefore follows that

$$(A.10) \qquad \ln y - \ln c + (1-\theta)\ln q = \ln(\upsilon / \vartheta)$$

Thus, in steady state the output-consumption ratio, adjusted for the terms of trade, should be stationary. Note that this degenerates to the closed economy case analysed in King *et al.* (1991) when $\theta = 1$ or if q is stationary.

Accordingly, this simple model suggests that output, investment and consumption are all driven by the three common stochastic trends λ_{dt}, λ_{rt} and q_t with two cointegrating relations given as (using the ordering $(\ln a_t, \ln q_t, \ln y_t, \ln c_t, \ln i_t)$)

$$\text{(A.11)} \qquad \beta' = \begin{pmatrix} 0 & 0 & 1 & 0 & -1 \\ 0 & 1-\theta & 1 & -1 & 0 \end{pmatrix}$$

Appendix B. Identification of Permanent and Transitory Shocks

The structural VAR model

To identify the permanent and transitory shocks and the main sources of these shocks, a structural VAR approach is used. This approach can briefly be explained as follows.

Let x_t denote a $n \times 1$ vector of variables of interest at time *t*. Assume that the true underlying structural relationship between the growth rates of x_t, Δx_t, can be given a vector moving average representation

$$\text{(B.1)} \qquad \Delta x_t = \rho + C(L)\varepsilon_t$$

where L is the lag operator, $C(L) = C_0 + \sum_{j=1}^{\infty} C_j L^j$ and ε_t is the vector of the n structural shocks, with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t') = I$.[47] There are assumed to be two types of structural shocks, $k \times 1$ "permanent" shocks, ε_t^P , and $r \times 1$ (with $k + r = n$) "transitory" shocks, ε_t^T , with $C(1)$ formulated such that ε_t^T only affects real variables in the short run but both types of shocks can effect nominal variables in the long run.

If there are fewer permanent shocks than variables, the variables in x_t are cointegrated. Hence, there will be a reduced number of independent trends driving the system, with the number of cointegrating vectors determining the number of these trends. Thus, $C(1)$ will have reduced rank k and $\beta' C(1) = 0$ where β is a $n \times r$ matrix containing the r cointegrating vectors.

[47] The important assumption here is that of a diagonal covariance matrix which makes it meaningful to interpret the innovations as structural disturbances. The assumption of an identity covariance matrix is simply an immaterial normalisation.

By recursive substitution, the structural model in (B.1) can be rewritten in a common trends form (see King *et al.*, 1991) [48]

(B.2) $x_t = C(1)\xi_t + C^*(L)\varepsilon_t$

where $C^*(L) = \sum_{i=1}^{\infty} C_i^* L^i$ and $C_i^* = -\sum_{j=i+1}^{\infty} C_j$. The *n*-dimensional vector ξ_t is a random walk with drift given as

(B.3) $\xi_t = \delta + \xi_{t-1} + \varepsilon_t$

where $\delta = C(1)\rho$.

The reduced rank property of $C(1)$ makes it possible to write $C(1)$ as a product of two rectangular matrices, a $n \times k$ matrix Ψ and a $k \times n$ matrix J, satisfying $\Psi J = C(1)$, with J constructed such that it picks out the permanent shocks from ε_t, $J\varepsilon_t = \varepsilon_t^P$. The *k* permanent trends driving the system can then be written as

(B.4) $\tau_t = \mu + \tau_{t-1} + \varepsilon_t^P$

where $\mu = J\delta$ and $\tau_t = J\xi_t$. The structural model can then be written as

(B.5) $x_t = \Psi\tau_t + C^*(L)\varepsilon_t$

Estimation and identification

To estimate and identify the structural shocks a corresponding reduced form model is used to calculate the $n \times k$ values of Ψ

(B.6) $x_t = A(1)\zeta_t + A^*(L)e_t$

where e_t is the vector of one-step-ahead linear forecast errors in x_t given information on lagged values of x_t, with $E(e_t) = 0$ and $E(e_t e_t') = \Sigma$, and the *n*-dimensional vector ζ_t is a random walk with drift given as

(B.7) $\zeta_t = \alpha + \zeta_{t-1} + e_t$

[48] Initial values are set to zero to simplify the notation.

First note that cointegration imposes $(n - k)k$ restrictions on the nk elements of Ψ since $\beta'\Psi=0$. This leaves k^2 restrictions left to just identify Ψ. These can be derived from

$$\text{(B.8)} \qquad \Psi JJ'\Psi' = \Psi\Psi' = A(1)\Sigma A(1)'$$

Given $A(1)$, which has rank k, and Σ, equation (B.8) gives $k(k + 1)/2$ additional restrictions on Ψ. Hence, to just identify Ψ additional $k(k - 1)/2$ restrictions need to be imposed. These are analogous to the identifying assumptions in standard structural VAR models, such as Sims (1986), except that they are imposed on the long-run rather than on the contemporaneous correlations and have to be consistent with the pattern of cointegration.

To impose these final restrictions, King *et al.* (1991) suggest writing Ψ as $\Psi_0\pi$, where Ψ_0 is a $n \times k$ matrix with parameters chosen such that $\beta'\Psi_0 = 0$, and where the free parameters of Ψ are lumped into the $k \times k$ matrix π. To determine the remaining $k(k - 1)/2$ parameters they suggest using a Choleski decomposition of π, which will give the remaining restrictions to just identify Ψ.

A simple bivariate model of permanent and transitory shocks

The simple bivariate model used by Bayoumi and Eichengreen (1993) uses output growth and inflation to identify permanent and transitory shocks, by imposing the restriction that permanent shocks are those which only affect output in the long run. This model is based on the long-run restrictions approach suggested by Blanchard and Quah (1989).

This can also be framed in the identification scheme suggested by King *et al.* (1991), by assuming that $x_t = (\ln y_t, \Delta \ln p_t)'$, implying that output and prices are non-stationary and that inflation is stationary.[49] In this case the cointegration vector is simply $\beta' = (0, 1)$ and $\Psi_0 = (\psi, 0)'$. The structural common trends model is therefore given as

$$\text{(B.9)} \qquad \begin{pmatrix} \ln y_t \\ \Delta \ln p_t \end{pmatrix} = \begin{pmatrix} \psi\pi \\ 0 \end{pmatrix} \tau_t + C^*(L) \begin{pmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{pmatrix}$$

$$\tau_t = \mu + \tau_{t-1} + \varepsilon_t^P$$

[49] These assumptions are supported by unit root tests. The results are available upon request.

Identifying the sources of permanent shocks

In the simple open economy growth model in Appendix A, $n = 5$ and $r = 2$. There are therefore $k = 3$ common trends driving the model. The cointegrating vectors are given as in (A.11), imposing $(n - k)k = 6$ restrictions on the $nk = 15$ elements of Ψ. The estimate of the long-run covariance matrix of x_t gives $k(k + 1)/2 = 6$ additional restrictions, having 3 additional restrictions to be imposed.

Since the stochastic trends are assumed to represent a resource trend (τ_{rt}), a terms of trade trend (τ_{qt}) and a domestic trend (τ_{dt}), it seems natural to assume that shocks to the domestic trend do not have long-run effects on the two other trends and that shocks to the terms of trade trend do not have long-run affects on the resource trend. This provides the three additional restrictions needed for identification. The three common trends thus affect x_t according to

$$\begin{pmatrix} \ln a_t \\ \ln q_t \\ \ln y_t \\ \ln c_t \\ \ln i_t \end{pmatrix} = \begin{pmatrix} \pi_{11} & 0 & 0 \\ \pi_{21} & \pi_{22} & 0 \\ \pi_{31} & \pi_{32} & \pi_{33} \\ (1-\theta)\pi_{21} + \pi_{31} & (1-\theta)\pi_{22} + \pi_{32} & \pi_{33} \\ \pi_{31} & \pi_{32} & \pi_{33} \end{pmatrix} \begin{pmatrix} \tau_{rt} \\ \tau_{qt} \\ \tau_{dt} \end{pmatrix} + C^*(L) \begin{pmatrix} \varepsilon_{rt}^P \\ \varepsilon_{qt}^P \\ \varepsilon_{dt}^P \\ \varepsilon_{1t}^T \\ \varepsilon_{2t}^T \end{pmatrix}$$

(B.10)

$$\begin{pmatrix} \tau_{rt} \\ \tau_{qt} \\ \tau_{dt} \end{pmatrix} = \begin{pmatrix} \mu_r \\ \mu_q \\ \mu_d \end{pmatrix} + \begin{pmatrix} \tau_{rt-1} \\ \tau_{qt-1} \\ \tau_{dt-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{rt}^P \\ \varepsilon_{qt}^P \\ \varepsilon_{dt}^P \end{pmatrix}$$

where ε_{1t}^T and ε_{2t}^T are the two transitory shocks.

Appendix C. The Data

Table C.1. Data description and sources

Data	Description	Period	Source	Most recent data
Consumption	Total private consumption at 1990 prices	A: 1950-1998	*Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Current account	Trade of goods and services, excluding transfers	A: 1980-2000	*Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Effective exchange rate	Trade weighted average of króna price of foreign currency	A: 1961-2000	CBI	*Hagtölur mánaðarins*
Export revenue	Exports of goods and services in current prices, deflated by import prices	A: 1961-2000	*Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Fish catch	Volume index of fish catch at constant prices	A: 1950-1998	*Sögulegt yfirlit hagtalna*	*Hagtölur mánaðarins*
Foreign variables	Consumer prices and GDP at constant prices	A: 1961-1998	OECD	OECD 1991/1
Gross domestic product	At current and 1990 prices	A: 1945-2000	*Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Immigration	Net emigration per 1,000 inhabitants	A: 1961-1997	*Landshagir*	
Prices	Annual averages of the consumer price index	A: 1961-2000	CBI	*Hagtölur mánaðarins*
Investment	Total private investment at 1990 prices	A: 1950-1998	*Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Official exchange rate	Trade weighted average of króna price of foreign currency	M: 1/90-11/00	CBI	*Hagtölur mánaðarins*
Population	Total population	A: 1950-1998	*Sögulegt yfirlit hagtalna*	
Real exchange rate	Relative price levels. Index, 1980 = 100	A: 1914-2000	1914-69: Nordal and Tómasson (1995) 1970-00: CBI	*Hagtölur mánaðarins*
Terms of trade	Terms of trade of goods and services	A: 1950-1998	*Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Unemployment rate	Unemployment as a percentage of total workforce	A: 1960-2000	1960-69: *Tölfræðihandbók 1974* 1970-00: *Sögulegt yfirlit hagtalna*	*Þjóðarbú-skapurinn*
Vacancy rate	Number of vacancies as a percentage of total workforce	A: 1985-2000	*Fréttabréf Þjóðhagsstofnunar*	
Wages	Weighted average of hourly earnings of skilled and unskilled production workers	A: 1962-1998	*Fréttabréf Kjara-rannsóknarnefndar*	

Hagtölur mánaðarins is published by the CBI. *Sögulegt yfirlit hagtalna*, *Þjóðarbúskapurinn* and *Fréttabréf Þjóðhagsstofnunar* are published by the NEI. *Tölfræðihandbókin 1974* and *Landshagir* are published by SI. *Fréttabréf Kjararannsóknarnefndar* is published by the Institute of Labour Market Research. Abbreviations: CBI: Central Bank of Iceland, NEI: National Economic Institute, SI: Statistics Iceland, A: Annual data, M: Monthly data.

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