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Monetary Indexation and Revenues from Money Creation: The Case of Iceland

Prepared by Peter K. Cornelius 1/

Authorized for Distribution by Duncan M. Ripley

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Abstract

This paper discusses the effects of monetary indexation on the revenues from monetization in Iceland. The paper starts by showing that monetization revenues fell sharply after indexation was introduced in 1979 and evaluates the different and partly ambiguous factors behind this development. The fiscal consequences are then examined in light of the fact that revenues from monetization have traditionally made up a substantial part of Government revenues in Iceland. Different policy options are simulated using the framework of the public finance approach to inflation. The simulations focus on the relation of fiscal deficits to inflation, output growth, and internal and external debt.

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Summary

The Icelandic financial system has undergone substantial changes in the last decade. Probably the most important reform was the introduction of monetary indexation. Bank deposits and loans were linked to price developments, while the Central Bank indexed the corresponding portion of required reserves. This policy had significant effects on the authorities' revenues from money creation. With a substantial part of base money insulated from price rises, the authorities' ability to derive revenues by eroding assets through inflation diminished. Thus, inflation tax revenues declined sharply. This was not fully balanced by increased revenues from seignorage owing to the public's greater willingness to absorb money.

A decrease in monetization revenues has important budgetary consequences, especially for countries like Iceland where revenues from money creation via transfers from the Central Bank form a substantial part of overall government revenues. This paper studies these effects in greater detail. In the framework of the public finance approach to inflation, different policy options are simulated. The investigations primarily focus on the relations of fiscal deficits to inflation, output growth, and internal and external debt, with and without indexation. The paper concludes that monetary indexation considerably raises the need for fiscal adjustment.

I. Introduction

With the passage of the Economic Management Act in 1979 Iceland introduced a comprehensive system of monetary indexation. Bank deposits and loans were linked to price developments, while the Central Bank indexed the corresponding portion of required reserves. This policy had important effects on revenues from money creation, a source of Government revenues on which the Icelandic authorities had heavily relied. With a substantial part of base money now being insulated, the Government's ability to derive revenues by responding to the inflation-induced demand for base money diminished. The tax base on which the inflation tax could be levied shrank substantially, as currency in circulation remained the only part of base money that was an interest-free liability of the public sector, and which could cover real expenditure through the issue of nominal liabilities. However, as a result of the indexation of financial assets in the banking sector, real interest rates increased significantly. With relatively higher opportunity costs of holding cash, the demand for currency decreased, thus further diminishing the inflation tax base.

On the other hand, the greater willingness of the public to absorb broad money and the subsequent increase in financial savings in the domestic economy meant a higher amount of seignorage for the authorities. However, since the inflation tax effect exceeded the seignorage effect, total revenues from money creation declined.

This decrease in monetization revenues has important consequences for fiscal policy which will be studied in greater detail in this paper. This will be done in the framework of the public finance approach to inflation. While, in principle, monetary indexation can affect the economy in various ways, 1/ the analysis will be carried out under restrictive assumptions. For example, the implication that monetary indexation might have for the Government's costs of nonbank borrowing--which could well aggravate the fiscal deficit--will be ignored. Insofar as profits in the banking sector may increase as a result of higher yields on required reserves and this effect leads to higher income tax revenues, this offset will also be neglected. 2/

These limitations should be kept in mind especially with regard to the policy simulations presented in the last part of this paper. These simulations are preceeded in section II by a description of the evolution of monetary indexation and of the present situation. In section III the measurement of revenues from money creation will be

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1/ See, for example, Baer, Beckerman (1980); Kapur (1982); World Bank (1989, pp. 63-68).

2/ The income tax effect also depends on whether the tax system includes corrective mechanisms for inflation. See Tanzi (1976) and (1989, pp. 647-651). For a description of the Icelandic tax system see Kolbeinsson (1982) and OECD (1988).

discussed. In section IV the analytical framework will be presented. Finally, section V provides empirical results on the effects of indexation on the demand for money.

II. The Evolution of Monetary Indexation in Iceland

Monetary indexation in its present comprehensive form was institutionalized by the Economic Management Act of 1979, although there had been some moves in this direction in earlier years. In fact, the origins date from the mid-1970s when a policy of generally raising the cost of credit and revenues from monetary assets was introduced. In 1976, special interest premium accounts--with interest premiums to be regularly considered in view of price developments--were initiated, and, since 1977, a price compensation factor based on the cost of living and building cost indices had been added to bank lending and deposit rates. However, since these arrangements only provided for partial ad hoc adjustments of interest rates to inflation which started to accelerate at the end of 1977, bank deposits continued to decline in relation to GDP while the demand for credit rose unabated.

In order to diminish the disincentives to save associated with negative real interest rates, the Government announced in April 1979 a system of general price indexation of savings and credit to be implemented before the end of 1980. While earlier legislation explicitly prohibited the general use of indexation, the Economic Management Act of 1979 provided for full and automatic adjustment of interest rates to inflation.

The first steps toward positive real interest rates were taken during the remainder of 1979 when nominal interest rates were raised three times. 1/ Banks were given permission to grant fully indexed loans carrying a positive real rate of interest with the loan principal indexed to the credit terms index. 2/ The minimum loan maturity was initially set at four years, shortened to 2 1/2 years in early 1981, and to six months in 1983. The real interest rate on indexed loans was initially set at 2 1/2 percent. On the deposit side, banks began to offer fully indexed two-year time deposits carrying a real interest rate of 1 percent in 1980, and in 1981, the minimum maturity was reduced to six months. Three-month indexed deposits with a zero real interest rate were also made available in 1982.

1/ For details, see Appendix II.

2/ The credit terms index was calculated monthly on the basis of the cost of living index (with a weight of two-thirds) and the building cost index (one-third). However, more recently (February 1989), the composition of the index was changed by adding the wage index with a weight of one-third and reducing the weight of the cost of living index to one-third.

Real interest rates were initially set by the Central Bank (as were the nominal rates on nonindexed instruments), but since 1984 market forces have been given an increasing role in interest rate determination. To maintain competitiveness, the banks introduced "switching term deposits" in 1984, where the terms switched between ordinary and indexed rates according to which was more favorable to the depositor. With the new Central Bank Act of 1986, commercial banks were freed to set practically all their own interest rates. The deregulation of interest rates caused deposit and lending rates to rise, as banks increasingly competed among themselves and with other institutions for financial savings (Chart 1). The ratio of total deposits to GDP increased considerably in response to higher real interest rates, with switching terms deposits proving to be particularly popular (Chart 2).

Overall, indexation has had predictable effects. Depositors responded to the more favorable terms by increasing their financial savings. 1/ Index-linked borrowing has also gained in popularity. At end-1988, 56 percent of all bank deposits were linked to the credit terms index, 7 percent were foreign-exchange linked, 2/ and 37 percent were non-indexed. On the credit side, 35 percent of bank loans were linked to the credit terms index and about 31 percent were foreign-exchange linked, leaving about 34 percent nonindexed. For the financial system as a whole, only about 15 percent of loans are nonindexed. Moreover, almost all treasury bonds are indexed, as are most private sector bonds.

However, recently the Government has attempted to reduce financial indexation. In July 1988, it decided to ban direct indexation of the principal value of financial instruments with maturities shorter than two years, and to set the minimum maturity for indexed bank deposits at six months. In June 1989, the Central Bank announced that indexation of switching term deposits would only apply to the unused amount in each savings account in each six-month period.

When indexed time deposits were introduced, similar accounts were opened in the Central Bank for deposit money banks' required reserves. While originally only the portion of required reserves corresponding to the banks' indexed deposits was indexed, 3/ in February 1987 it was

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1/ The deregulation of interest rates has also contributed to this development.

2/ In 1987, the Government considered using the exchange rate as an element in the credit terms index, but decided against it. Instead, exchange-rate based indexation has been authorized, allowing financial assets to be linked either to the credit terms index or to the SDR or the ECU.

3/ However, all required reserves earned interest.

decided to index all required reserves at a zero real rate of interest. 1/ However, since March 1988, required reserves have earned a real interest rate of 2 percent. 2/

III. The Measurement of Revenues from Money Creation

The Icelandic financial system has undergone substantial changes in the last decade. In response to the threat that the highly regulated system of financial repression could destroy itself (Eggertsson, 1989), successive Governments have introduced far-reaching measures to reform the financial and money markets. While these markets were still embryonic at the end of the 1970s (Eggertsson, 1982, p. 1), there have indeed been remarkable developments in some areas. The most important reform 3/--the introduction of monetary indexation--has generated predictable effects. Depositors have responded to more favorable terms, and domestic financial savings have increased.

If required reserves which have correspondingly increased had not been indexed, revenues from money creation would have become larger. In the steady-state, these revenues are equal to $(g + \pi)m$, where g denotes the growth rate of real income (assuming unitary income elasticity), π the inflation rate and m real base money. While gm can be interpreted as seignorage, that is, the steady-state increase in the real value of base money, πm represents the inflation tax, i.e., the amount of nominal balances that needs to be accumulated just to keep the real value of base money constant (Anand, van Wijnbergen, 1988, 1989). Assuming that the Central Bank pays no interest on its liabilities and issues monetary assets at a rate equal to the inflation rate, it taxes money holders (the DMBs which pass the loss on their depositors) at that rate (Fischer, 1982). 4/ However, in the case of Iceland this assumption cannot be maintained. As noted above, all required reserves earned interest before 1979, while after the introduction of indexation that portion of required reserves corresponding to the DMBs indexed deposits was also indexed. 5/ From February 1987 to February 1988, all required reserves were fully indexed but received zero real interest.

1/ The indexation adjustments are included in reserve money at the end of each month, but the banks have access to the funds only at the end of the year.

2/ The decision to pay real interest on required reserves was made in December 1988 to facilitate a reduction of interest rates in deposit money banks. This change was made retroactive to March 1988.

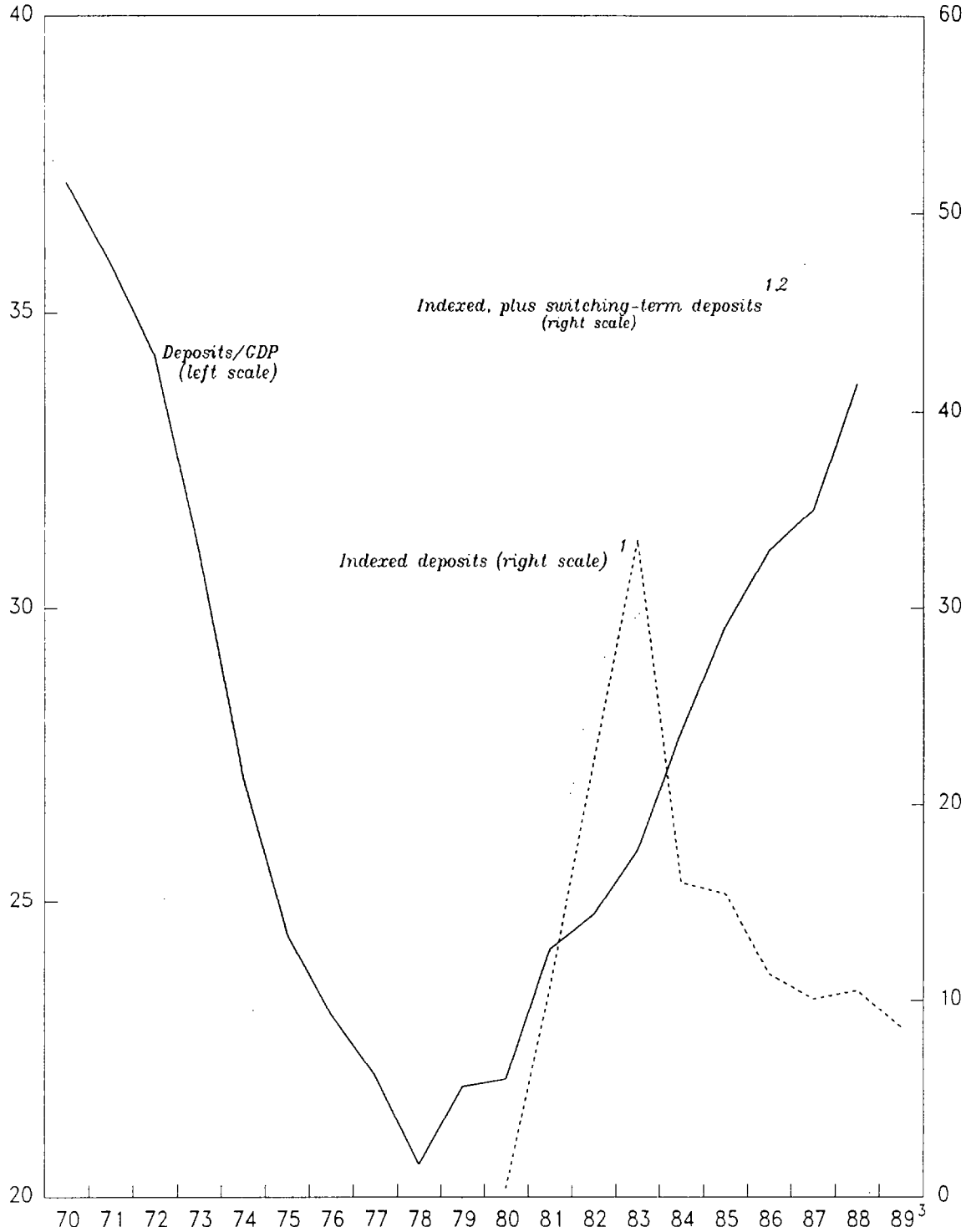
3/ For an overview of other reforms see Nordal (1988) and various issues of the Annual Report of the Central Bank of Iceland.

4/ With positive real interest rates on deposits and negative yields on required reserves, the spread between deposit and lending rates would be considerable.

5/ Interest was paid on the nonindexed portion of required reserves corresponding to the DMBs nonindexed deposits.

CHART 1

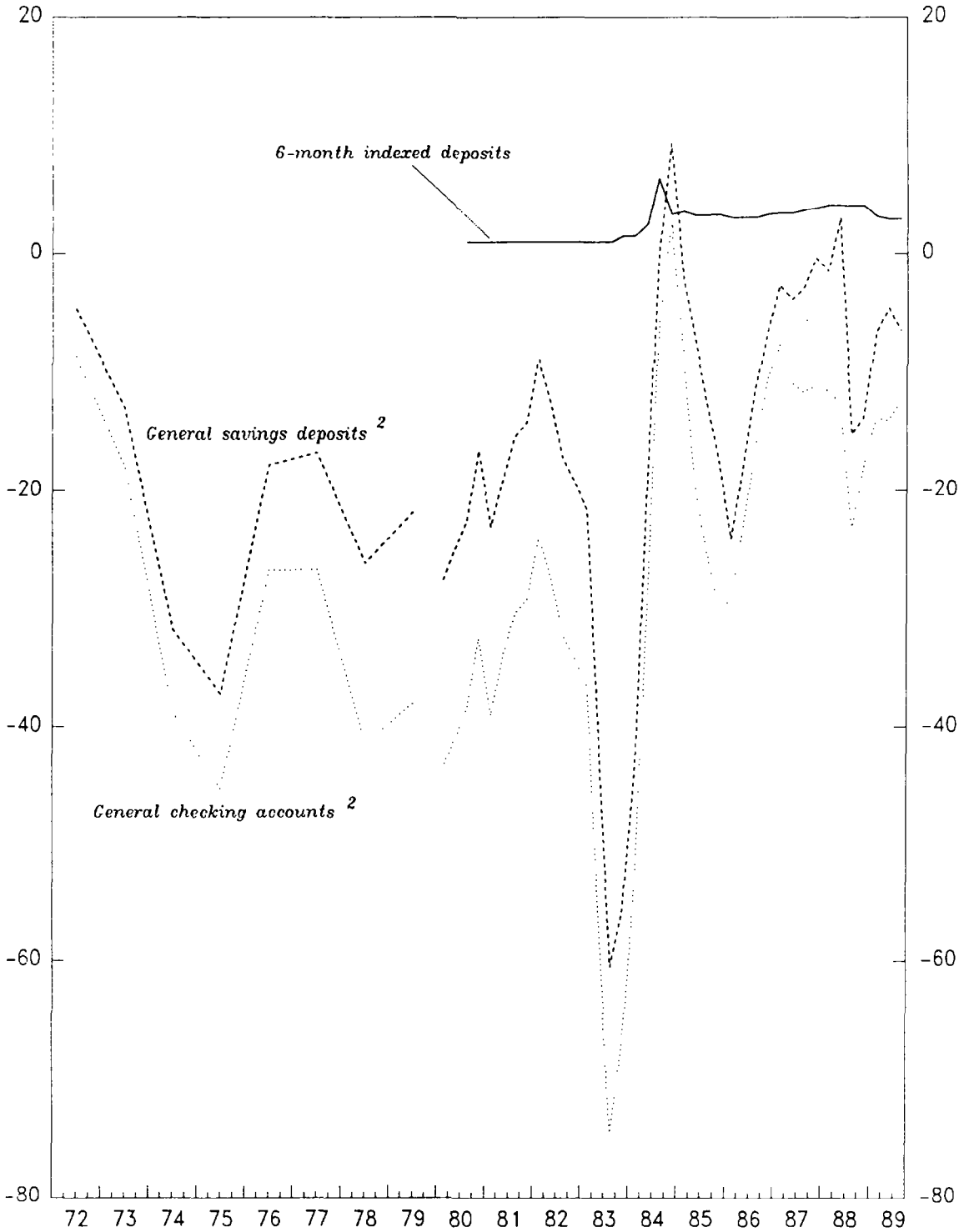
DEPOSITS IN DEPOSIT MONEY BANKS
(In Percent)



Source: Information provided by the Icelandic authorities.
1/ In percent of total deposits.
2/ Switching-term deposits, introduced in 1984, are deposits where the terms switch between ordinary and indexed rates according to which is more favorable to the depositor.
3/ End of June data.

CHART 2

REAL INTEREST RATES [1]



Source: Central Bank of Iceland, Economic Statistics Quarterly.
1/ 1972-79 data points refer to annual series, and 1980-89 are quarterly.
2/ Deflated by the change in the credit terms index during past 12 months.

Since March 1988, real interest of 2 percent has additionally been paid. Taking this into account, it appears more appropriate to use the following measure of revenues from money creation (RM): 1/

$$(1) \qquad RM = [g + \phi\pi + (1 - \phi)(\pi - i)]m$$

Equation (1) follows an approach suggested by the OECD (1988, p. 65), where revenues from money creation in Iceland were calculated by the (negative of the) real interest rate paid by the Central Bank: $(i - \pi)m$. However, this approach does not take into account that interest is paid only on a fraction of base money, namely required reserves $(1 - \phi)m$, whereas currency in circulation, ϕm , is indeed an interest-free liability of the Central Bank.

Calculations show that revenues from money creation have substantially decreased in the period of indexation. According to Table 1 the average annual revenues were 2.96 percent of GNP in the pre-indexation period from 1971 to 1980, whereas the period from 1981 to 1987 the average revenue was 1.49 percent.

There are several reasons for this, the most important being the move to non-negative real interest rates on required reserves. As discussed, the bulk of base money in Iceland is not an interest-free liability of the Central Bank. While in the 1970s interest was paid on required reserves at a rate equivalent to the interest rate paid by the DMBs on deposits plus a certain premium, the real interest rate on required reserves was still negative. To the extent that the inflation rate exceeded the nominal interest rate, the Central Bank received inflation tax revenues (in addition to revenues arising from the issue of bank notes and coins). When indexation was introduced, however, the portion of required reserves corresponding to the DMBs indexed deposits was also linked. Thus, the base on which the inflation tax could be levied shrank, irrespective of the increase in deposits in DMBs and hence in required reserves. When it was decided in February 1987 to index all required reserves, currency in circulation remained the only source of inflation tax revenues.

When indexed deposits were introduced, the opportunity cost of holding cash rose. While financial savings in bank deposits increased, currency in circulation (in relation to GNP) declined from 2.17 percent in the period form 1972 to 1980 to 1.25 percent in the period 1981 to 1987. This substitution effect has also diminished the inflation tax base, leading to a decline in revenues from monetization. Two further effects should be mentioned. One is the reduction of the (average) reserve requirement ratio by 10 percentage points in April 1985 and by

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1/ For a discussion of alternative measures of revenues from monetization see Barro (1982) and Gros (1989).

Table 1. Revenues from Money Creation

(In percent of GDP)

	Seignorage	Inflation tax revenues	Revenues from money creation
1971	1.45	0.64	2.09
1972	0.60	1.58	2.19
1973	0.57	2.50	3.07
1974	0.47	3.32	3.79
1975	0.03	2.80	2.83
1976	0.42	2.28	2.70
1977	0.78	1.63	2.41
1978	0.50	2.53	3.03
1979	0.47	1.87	2.34
1980	0.34	4.90	5.24
1981	0.22	2.16	2.38
1982	0.11	1.71	1.82
1983	-0.24	3.09	2.85
1984	0.23	0.90	1.13
1985	0.16	0.32	0.48
1986	0.47	0.72	1.19
1987	0.38	0.23	0.61

Source: Staff calculations.

5 percentage points in March 1987. 1/ The other noteworthy effect was the deregulation of interest rates in the 1980s. To the extent that increasing interest rates on deposits in DMBs also led to higher

1/ In the 1970s the (average) reserve requirement ratio was gradually raised from 20 percent to 28 percent where it remained until April 1985. More recently, the ratio was further lowered by 1 percentage point in August 1988 and in April 1989. For the development of required reserves at constant rates see Table 5 in Appendix 1.

interest rates on required reserves and hence to a smaller gap between nominal interest rates and the rate of inflation, the deregulation contributed to the decline of revenues from money creation.

As a consequence of this decrease in revenues from monetization total Government revenues have ceteris paribus been smaller than they would have otherwise been. This requires a cut in the deficit or else public debt will rise (Dornbusch, 1988, p. 12).

IV. Revenues from Money Creation in the Framework of the Public Finance Approach to Inflation

In this section, the analytical framework is presented in which the effects from decreased revenues from money creation can be studied in greater detail. Here, we follow the public finance approach to inflation mainly developed by Phelps (1973), Dornbusch (1977), Buiter (1983), Drazen and Helpman (1987). Without denying that, in the short run, demand pressures or cost-push factors may be more important determinants of inflation, this approach argues that the ultimate reason for the existence of high inflation rates lies in the Government's need for revenues. As Anand and van Wijnbergen (1988, 1989) have shown, the public finance approach provides a useful apparatus for deriving the implications of financial sector reforms for fiscal policies. While Amand and van Wijnbergen (1988) focused above all on changes in bank deposit rates, their model can easily be adjusted to take account of the effects of monetary indexation. In the following the analytical framework is presented which will later be applied to different questions.

In order to derive the fiscal consequences of monetary indexation we start from the following public sector deficit identity:

$$(2)\quad D + iB + i^{*}B^{*}E = \Delta B + \Delta B^{*}E + \Delta DC_{G}$$

On the left-hand side of equation (2) are the expenses of the public sector (net of tax revenues or transfers from the Central Bank): 1/ the noninterest deficit D, plus nominal interest payments on domestic and foreign debt. The variable i (i^{*}) is the nominal domestic (foreign) interest rate on domestic (foreign) debt B (B^{*}), E is the nominal exchange rate. On the right-hand side are the financing items, i.e., the issue of domestic or foreign debt plus Central Bank advances to the public sector.

1/ As mentioned above, tax revenues and other budgetary items are likely to be affected by monetary indexation.

Taking into account that the Government can shift a part of its deficit into the Central Bank accounts by simple changes of bookkeeping practices and that Central Bank credit to the Government represents a claim of one public entity on another, it seems useful to consolidate intergovernmental agencies' debt. According to equations (3) and (4) derived from a simplified Central Bank balance sheet

$$(3), (4) \quad M = DC_G + NFA^*E - NW = Cu + RR$$

base money is equal to currency in circulation (Cu) plus required reserves held by the DMBs at the Central Bank. It is issued to cover credit to the Government and the Central Bank's accumulation of net foreign assets (NFA^*E), insofar as this is not already covered by the Central Bank's accumulated profits of net worth (NW). 1/ Subtracting the Central Bank's profits (interest earnings on foreign reserves) from the budget deficit and the Central Bank profit's counterpart, i.e., the increase in net worth, from the public sector's increase in liabilities yields

$$(5) \quad D + iB + i^*(B^* - NFA^*)E = \Delta B + \Delta B^*E + \Delta DC_G - \Delta NW$$

By consolidating the change in the Central Bank's net foreign assets and the change in the Government's foreign debt we obtain

$$(6) \quad D + iB + i^*(B^* - NFA^*)E = \Delta B + (\Delta B^* - \Delta NFA^*)E + \Delta M$$

Taking into account that exchange rate changes imply capital losses or gains which are part of the cost of servicing foreign debt, and deflating all variables, equation (7) can be reformulated as follows:

$$(7) \quad d + rb + (r^* + \Delta e/e)(b^* - nfa^*)e = \Delta b + \Delta[(b^* - nfa^*)e] + \Delta m$$

1/ For simplicity we ignore excess reserves which are of secondary importance. Moreover, we ignore the fact that the Central Bank not only holds reserves from DMBs but also lends to them as well as to other private agents. Strictly speaking the monetary base would have to be adjusted as follows:

$$(4') \quad M_{Adj} = (Cu - DC_{PVT}) + (RR - DC_{CML}),$$

where DC_{PVT} and DC_{CML} denote Central Bank credit to other private agents and to DMBs, respectively.

where lower-case letters now denote real variables.

According to equation (7) the fiscal deficit, including the Central Bank's profit- and loss- account, but only counting real interest payments, equals changes in the real value of domestic and foreign debt and base money. If no nominal interest is paid on required reserves, Δm represents the Government's revenues from money creation, which is equal to $(g + \pi)m$ in the steady state. Since this assumption cannot be maintained in the case of Iceland, Δm has to be replaced by equation (1).

In order to evaluate different policy options it is important to know how the demand for money responds to changes in inflation and economic growth and whether these reactions are different, if monetary asets are indexed. In order to seperate effects on the demand for currency (C) and for deposits (D) the following partial adjustment money demand functions will be estimated: 1/

$$\text{(8a)} \quad \log (C_t/P_t) = \alpha_1 + \alpha_2 \log (Y^r_t) + \alpha_3 (i_t) + \alpha_4 (\pi_t) + \alpha_5 \log (C_{t-1}/P_{t-1}) + \varepsilon$$

$$\text{(8b)} \quad \log (D_t/P_t) = \alpha_6 + \alpha_7 \log (Y^r_t) + \alpha_8 (i_t) + \alpha_9 (\pi_t) + \alpha_{10} \log (D_{t-1}/P_{t-1}) + \varepsilon$$

where P is the GDP deflator of period (t), Y^r real GDP; i a weighted average of interest rates on demand, time, and savings deposits; π the inflation rate; and ε an error term.

Finally, it seems reasonable to assume that the alternative sources of financing a budget deficit are subject to certain limitations. Here, a particularly simple debt strategy is supposed, i.e., fixed debt-GDP ratios for both internal and external debt. 2/ Target values for these

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1/ Analysis of government revenue from monetary expansion frequently postulates an aggregate demand function for fiat money. Rarely is it recognized in these formulations that the demand for fiat money is composed of two distinct components: a direct demand for currency and an indirect demand for bank reserves derived from the public's demand for deposits and reserve requirements. However, in order to explore how bank regulations, especially reserve requirements, affect revenues from money creation it seems more appropriate to estimate the two components of base money separately. See Fry (1981), Siegel (1981), and Anand and van Wijnbergen (1988).

ratios imply that real domestic debt cannot grow faster than real output 1/ and real foreign debt cannot grow faster than the product of output times the real exchange rate:

$$(9a) b = nb$$

$$(9b) (b^* - nfa^*)e = (n - \Delta e/e)(b^* - nfa^*)$$

Inserting (9a) and (9b) in (6) yields (expressed as a percentage of GDP):

$$(10)\ [d + rb + r^*(b^* - nfa^*)e]/GDP = [nb + (n\ \Delta e/e)(b^* - nfa^*)]/GDP + \Delta m/GDP$$

According to equation (10) the noninterest deficit plus real interest payments on domestic and foreign debt cannot exceed what can be financed through debt issue at target debt-output ratios, plus the revenue from (steady-state) money creation.

V. The Demand for Money: Empirical Results

Using quarterly data 2/ the partial adjustment model given in equations (8a) and (8b) was estimated for the pre-indexation period 1972 (2) to 1980 (2). The regressions produced reasonable results which are reported in Table 2.

As far as the demand for cash is concerned, all coefficients have the expected sign and are significantly different from zero at least at the 10 percent level. All the diagnostic tests are satisfied at a significance level of 5 percent; neither residual autocorrelation, nor non-normality nor heteroscedasticity can be detected. Similarly

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2/ As a matter of course, more sophisticated debt strategies could be implemented. As far as external debt is concerned, a weighted average of the debt-output ratio and the debt-export ratio, for example, might be more appropriate. See Cohen (1988).

1/ If government debt were not indexed--contrary to the actual situation in Iceland--an increase in the inflation rate would lead, under certain circumstances, not only to higher revenues from money creation but also to a liquidation of outstanding debt. See Calvo (1989).

2/ Since quarterly data for GDP are not available for Iceland, annual data had to be interpolated. Moreover, seasonal dummies were included, but the results are not reported here.

Table 2. Regression Results 1/

Dependent Variable	Period	Independent Variables: Constant	Log Y_t^r	i_t	π	Log (C_{t-1}/P_{t-1})	Log (D_{t-1}/P_{t-1})	R^2	Durbin-Watson	ARCH(4) 2/	$AR(4)_1^4$ 3/	NORM(2) 4/
Log (C_t/P_t)	1972(2)-1980(2)	-3.481 (-1.370)*	0.4195 (1.543)*	-0.775 (-1.507)*	-0.204 (-1.609)*	0.666 (5.960)***	—	0.75	2.05	0.28 (0.884)	0.124 (0.328)	1.138 (5.991)
Log (D_t/P_t)	1972(2)-1980(2)	-7.509 (-3.171)***	1.069 (3.774)***	1.051 (2.289)**	-0.259 (-3.280)***		0.341 (2.583)**	0.84	1.89	0.58 (0.684)	0.0318 (0.0343)	1.123 (5.991)
Log (C_t/P_t)	1980(4)-1987(4)	-9.091 (-3.080)***	1.043 (3.186)***	—	-0.086 (-1.362)*	0.412 (2.618)**	—	0.86	1.95	0.51 (0.729)	0.124 (0.328)	0.59 (5.991)
Log (D_t/P_t)	1980(4)-1987(4)	-9.264 (-4.280)***	1.146 (4.541)***	0.593 (3.444)***	-0.121 (-1.925)**	—	0.4789 (4.056)***	0.97	2.02	0.27 (0.895)	0.60 (0.665)	2.71 (5.911)

Source: Staff calculations.

1/ t-statistics in parentheses; one asterik indicates that the coefficient is significantly different from zero on the 10 percent level, two asterisks indicate significance on the 5 percent level and three asterisks on the 1 percent level.

2/ Lagrange Multiplier Test for Auto Regression Conditional Heteroscedasticity; critical values at the 5 percent level in parentheses.

3/ Lagrange Multiplier Test for Residual Autocorrelation; critical values at the 5 percent level in parentheses; according to further tests the hypothesis of the non-existence of residual autocorrelation of different orders could not be rejected.

4/ Chi ^{2} - Test for normal distribution of residuals; criticical values on the 5 percent level in parenthesis

satisfying results were obtained with regard to the demand for deposits. Again, all coefficients show the expected sign while the t-values indicate a strong significance especially for real income and the inflation rate.

In order to evaluate the out-of-sample properties of the model, the estimations were used to forecast the demand for currency and deposits in the 1980s. The predicative accuracy was indeed poor. Supposing that the model has correctly been specified, then the predicative failure for the equations indicates that there has been a structural break in the demand for money. 1/ In fact, the Chow-test for parameter constancy rejected the hypothesis of parameter stability. 2/ The Chi^2-test 3/ was applied which confirmed the results of the Chow-test. As can be seen from Chart 3 the regression for the demand for currency implies a serious overestimation of the actual development in the indexation period, whereas the demand for deposits is heavily underestimated. This indicates that the introduction of monetary indexation has caused a significant shift in portfolio preferences.

Re-estimating the model for the indexation period 1980(4) to 1987(4) produced the results also reported in Table 2. Almost all of the coefficients are highly significant and all of them have the correct sign. The diagnostic tests do not indicate that the regressions suffer residual autocorrelation, non-normality, and heteroscedasticity. Two points are particularly worth noting: first, the interest rate variable which was used for the estimation of the demand for money in the pre-indexation period proved to be no longer significant. However, as far as the demand for deposits is concerned, a strong influence of the indexed interest rate on time deposits could be detected. 4/ In contrast, the opportunity costs of holding currency seem to be solely determined by the rate of inflation, whereas the return on alternative assets appears to play no longer a significant role. Experiments with different interest rates did not meet with success so that the interest variable was consequently omitted. Second, the (semi-) elasticity of the demand for money with respect to inflation has decreased significantly, both in the case of the demand for currency and for

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1/ As far as the demand for broad money is concerned, such a structural break was detected by Rodlauer (1984).

2/ As far as the demand for currency is concerned, the Chow-test value (31,27) was 2.73 against the critical value (at the 5 percent level) of 0.0048; with regard to the demand for deposits the value was 1.67 against 0.0963.

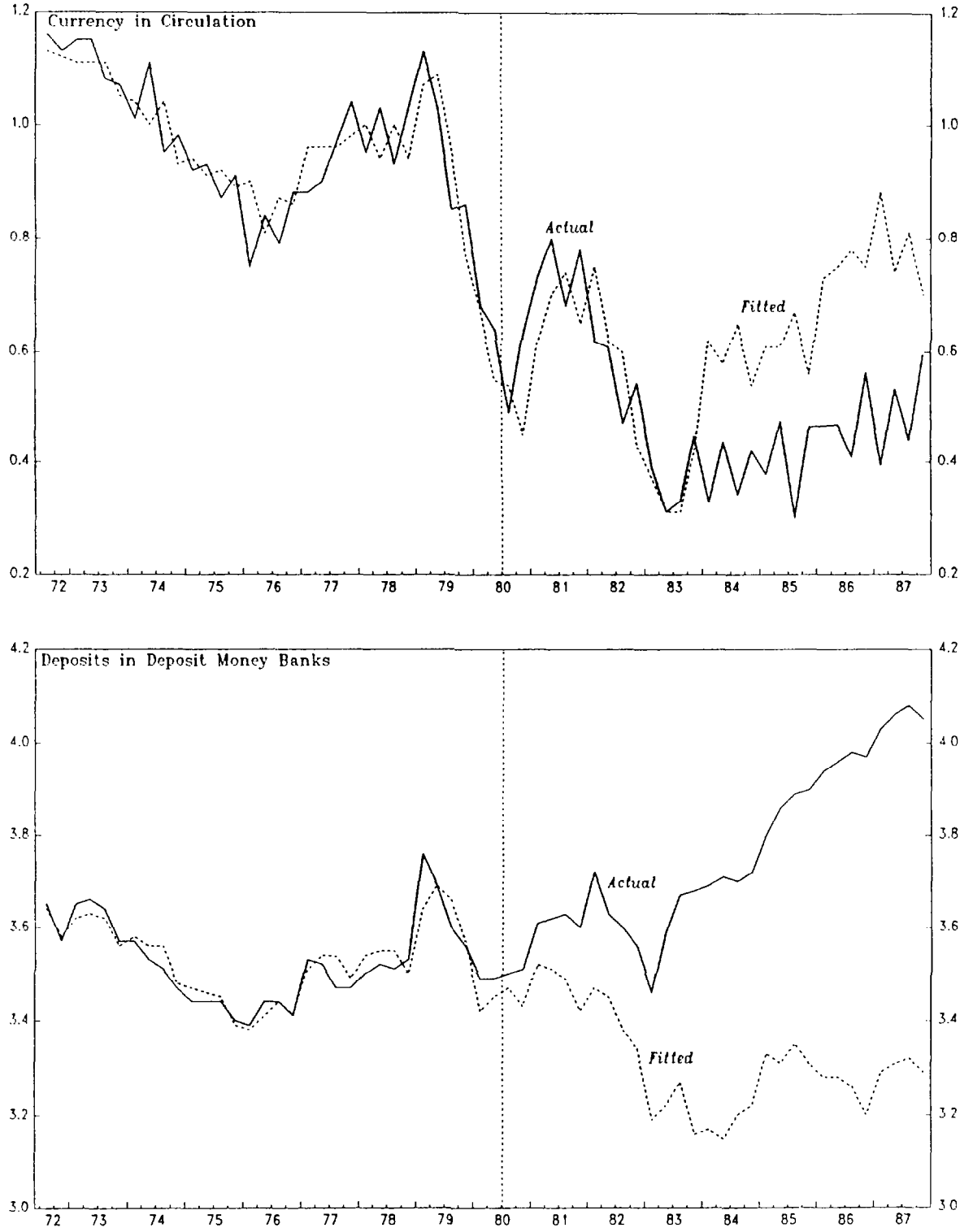
3/ The Chi^2-test of whether the model parameters remain constant in the forecast period is calculated as Chi^2 (N)N which yields an approximate F-test. The test values significantly exceeded the critical value of 2 (in the case of the demand for currency the value was 9.07, in the case of the demand for deposits 144.68). For the methodology see Hendry (1989).

4/ In the regression, the implicit nominal return was used.

CHART 3

DEMAND FOR MONEY: ACTUAL AND FITTED VALUES[1]

(In Logs)



Source: Staff calculations.
1/ In real terms (deflated by the GDP deflator).

deposits. On the other hand, the elasticity with respect to real income has increased considerably, especially in the case of the demand for currency.

In the final part of the paper, the regression results obtained are used to estimate the demand for money and hence the revenues from money creation with and without indexation. This is done under alternative macroeconomic scenarios in order to evaluate different policy options.

VI. Some Policy Simulations

Because indexation of base money leads to lower revenues from money creation, the so-called financiable deficit, that is, the deficit which can be financed without jeopardizing target values for internal and external debt, becomes smaller. If the Government decides not to adjust fiscal policies and hence the actual deficit by cutting down expenditures or raising taxes, than those targets will not be attainable.

Since monetary indexation leads to a smaller base on which the inflation tax can be levied, one obvious possibility is to increase the tax rate, i.e., the inflation rate. In order to evalue this option in greater detail let us suppose that in the indexation scenario all required reserves are fully indexed, whereas in the nonindexation scenario required reserves do not even earn interest. These assumptions while somewhat unrealistic, help highlight the implications of indexing base money.

Under those assumptions a policy of raising inflation rates would have the following outcomes in 1985 (Table 3) 1/

With money demand relatively inelastic to the opportunity cost of holding money, increased inflation generates increased revenues from monetization. 2/ However, the marginal increase in revenues gradually falls as inflation rises because the demand for real balances

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1/ The year 1985 seems particularly appropriate for our purposes, since variables like GNP growth, inflation, and the budget deficit did not show those extreme values as in other years when external shocks took place. So to speak, 1985 can be regarded as an "average" year.

2/ For dynamic considerations see Auernheimer (1974).

falls. 1/ Under indexation, an inflation rate of even 100 percent would cause revenues from money creation of only 1.4 percent of GDP. 2/ In contrast, in the nonindexation scenario where base money is an interest-free liability of the Central Bank, revenues from money creation achieve this level at an inflation rate of only 30 percent. At an inflation rate of 100 percent total revenues are more than 2 1/2 times larger than in the case of indexation. This difference would of course be even larger if required reserves received a positive real rate of interest as it has actually been the case since March 1988.

Revenues from money creation are only one source of financing. In addition there is domestic debt issue and foreign borrowing 3/ In order to estimate the financiable deficit, all three sources have to be combined. Thus calculated, the financiable deficit can then be compassed with the actual deficit, with the difference between the two

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1/ If the actual rate of inflation is higher than the rate at which revenues reach their maximum, an effective money demand increasing policy might allow the Government to maintain the size of its present budget deficit while reducing inflation. The policy problem, however, is to find the combination of expectations-changing policies sufficient to create the jump from the "high-inflation trap" where real money demand is lower to the "efficiently" financed deficit where money holdings are higher (Blejer, Cheasty, 1988, p. 870). It should be stressed that the inflation rate where revenues from money creation are maximized must not be interpreted as the "optimal" inflation rate. From the perspective of the theory of optimal taxation, the optimal inflation tax rate equates the marginal cost of distortions per currency unit of revenue from the inflation tax and from other distorting taxes. See, for example, Mankiw (1987) and Grilli (1989). Recent empricial studies have cast some doubt that from this point of view a positive inflation rate can be justified. See Garfinkel (1989, p. 10).

2/ Bomberger and Makinen (1980) have argued that in the case of Hungary indexation of financial assets was mainly responsible for the hyperinflation in 1945/1946. Since index-linking reduced substantially the tax base on which the inflation tax could be levied, higher inflation rates were needed to derive a given amount of revenues from money creation.

3/ See Section 4; domestic debt issue and foreign borrowing are calculated in the following under the assumption of fixed debt-output ratios.

Table 3. Revenues from Money Creation at Alternative Inflation Rates

(In percent of GDP)

Inflation Rate	Scenario I: Nonindexation	Scenario II: Indexation
10	0.6	0.4
15	0.8	0.5
20	1.0	0.5
25	1.2	0.6
30	1.4	0.6
35	1.6	0.7
40	1.8	0.8
50	2.1	0.9
60	2.5	1.0
100	3.6	1.4

Source: Staff calculations.

measures indicating the required deficit reduction (RDR). 1/ This has been done in Table 4 whereby the analysis focuses not only on changes in the inflation rate, but also on changes in economic growth and the real exchange rate.

As Table 4 shows, required deficit reductions are considerably higher in the case of indexation. Assuming that real economic growth is 3 percent and that the real exchange rate does not depreciate, fiscal adjustment would still be necessary at an inflation rate of even 30 percent. In contrast, if required reserves are not indexed, the financiable deficit would be equal to the actual deficit at an inflation rate of only slightly more than 10 percent. However, if economic growth accelerates, the need for fiscal adjustment decreases. At a growth rate of 4 percent the financiable deficit exceeds the actual deficit even in the case of indexation (under the assumption that the inflation rate is

1/ Because of the lack of consolidated data the actual deficit refers to the socalled A-Budget of the Government, which covers only the Treasury relatively narrowly defined. To take into account revaluations of indexed debt, monetary corrections have been made for accruals from those revaluations see Tanzi, Blejer, and Teijeiro (1987), pp. 727-729. Thus defined, the actual deficit was 5 percent in 1985.

Table 4. Required Deficit Reductions for Consistency with Various Macroeconomic Targets

(In percent of GDP)

	No Real Depreciation, Real GDP Growth of 3 Percent		
Inflation rate	10	20	30
RDR			
Nonindexation	0.1	-0.3	-0.7
Indexation	0.4	0.3	0.2

	No Real Depreciation, Inflation Rate of 10 Percent		
Growth target	2	3	4
RDR			
Nonindexation	0.8	0.1	-0.5
Indexation	1.1	0.4	-0.3

	Real GDP Growth of 3 Percent, Inflation Rate of 10 Percent		
Real depreciation target	--	2	4
RDR			
Nonindexation	0.1	0.9	1.8
Indexation	0.4	1.3	2.2

Source: Staff calculations.

only 10 percent.) In turn, the need for fiscal adjustment increases, if economic grwoth decelerates, whereby the required deficit reduction is relatively greater in the case of indexation. 1/

For the Icelandic economy, which is subject to severe shocks from its heavy reliance on fisheries, these results are of great interest. Suppose, for example, that as a result of an exogenous shock there is a decline in the rate of economic growth. Such a decline will, ceteris paribus, necessitate a compensating increase in the steady-state rate of inflation in order to keep the Government's revenues from money creation unaffected. The required increase in the rate of inflation is however substantially larger in the case of indexation than with non-indexation. As it has been shown by Melnick and Sokoler (1984), a decline in the growth rate may not only call for an increase in the rate of inflation (an increase greater than the decline in the rate of growth), but it may also imply that the necessary compensating increase in the rate of inflation is a positive function of the existing rate of inflation. This will be the case if the demand for real balances is a semilogarithmic function of the expected rate of inflation, or in other words, if the elasticity of the demand for money with respect to the expected rate of inflation increases as the rate of inflation rises. 2/

In order to prevent a deceleration of economic growth, the authorities might try to pursue an export strategy that relies on real

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1/ It should be noted that the sensitivity of required deficit reductions with respect to economic growth critically depends on the assumed debt strategy. One might argue that fixed debt-output ratios as assumed here are too restrictive, at least on an annual basis, and that in the light of the supply shocks the Icelandic economy periodically receives a medium-term strategy would seem to be more appropriate. However, the difficulty with this option is that variations in the fish catch are irregular in their amplitude and timing. Therefore, it is not possible to know how much can safely be borrowed in the slump without first knowing how much can be repaid in the boom that follows. In light of Iceland's foreign debt that has already reached critically high levels, one could, in turn, also argue that foreign debt (in relation to GDP) should decrease in any case. This would be the case, for example, if the absolute level is held constant despite an acceleration in economic growth. However, the required deficit reductions would then be higher than reported in Table 4.

2/ Such a function proposed by Cagan (1956) is normally used when the demand for money is studied in countries which experienced high rates of inflation. See, for example, Leiderman and Marom (1988), If, on the other hand, the elasticity of the demand for money with respect to the expected rate of inflation is constant, i.e. if demand for money is a linear logarithmic function of the expected rate of inflation, then the required compensating increase in the rate of inflation is a decreasing function of the existing rate of inflation.

exchange rate depreciation. However, such a policy would imply a greater need for fiscal adjustment by raising the ratio of foreign debt to GDP. Because of Iceland's high external debt, the required deficit reduction increases remarkably with the rate of real depreciation. Assuming real economic growth of 3 percent and an inflation rate of 10 percent, real depreciation of 4 percent would cause a gap of 1.8 percent of GDP between the financiable deficit and the actual deficit even in the case of nonindexation. If required reserves are fully indexed, the necessary fiscal adjustment would be even larger.

Further simulations are conceivable, for example, to explore the consequences of changes in reserve requirements 1/ or in bank interest rates. 2/ However, it should already have become sufficiently clear that monetary indexation has important budgetary implications.

VII. Conclusions

As has been shown in this paper, monetary indexation has significant budgetary consequences which are all the more important for countries like Iceland, where revenues from money creation represent a substantial part of total Government revenues. Starting from the observation that revenues from money creation declined sharply after indexation was introduced, a simple framework has been presented in which the consistency of fiscal deficits with other macroeconomic targets could be assessed. This framework based on the public finance approach to inflation allowed us to consider the relations of fiscal deficits to other targets including output growth, real exchange rate developments and internal and external debt with and without indexation. By simulating different policy options it can be shown that, ceteris paribus, monetary indexation considerably raised the need for fiscal adjustment.

1/ In principle, reserve requirements serve to control the means of payments in the economy and to secure stability in the aggregate price level but if carried to far, they may become self-defeating as an instrument of monetary control and seriously interfere with the banking system's intermediary role in allocating the economy's scarce resources (McKinnon, 1980, p.106). As Eggertsson (1989) argues Iceland has drastically reduced reserve requirements exactly because of this reason. As mentioned earlier, this has also contributed to a decline in monetization revenues. However, if Iceland as a member of the European Free Trade Association wants to follow the steps toward financial integration in the EC to be achieved by 1992, further reductions may be required. Otherwise, foreign banks operating under lower reserve requirements would have a competitive advantage against Icelandic banks. See Drazen (1989) and Folkerts-Landau, Mathieson (1989, p.9).

2/ See, for example, van Wijnbergen (1985).

This would not have been the case, if only financial assets in the banking system were indexed. On the contrary, due to the increase in seignorage associated with larger bank deposits and required reserves, required deficit reductions, would have been comparatively lower. However, in the absence of base money indexation the spread between deposit and lending rates would probably increase significantly.

In the recent past, steps have been taken to reduce the extent of monetary indexation. As an alternative to linking monetary assets to the price development, deposits have been introduced where assets are linked to the exchange rate. These schemes may provide not only an alternative to deposits indexed to the credit terms index but also an alternative to foreign exchange deposits. While foreign exchange linked deposits do not require the use of actual foreign currency, foreign exchange deposits normally lower the base on which the inflation tax can be levied -- insofar as they provide a liquid alternative to domestic money. 1/ However, in Iceland foreign currency deposits are nevertheless subject to reserve requirements so that this potential effect is of no importance. 2/

1/ If the rate of interest on domestic currency deposits falls below the (expected) total rate of return from foreign currency holdings (including exchange rate changes), people may satisfy at least some of their demand-for-money requirements by holding foreign currency. Apart from the fact that interest rate -induced currency substitutions may weaken monetary control, a reduction in the real stock of domestic money will in principle reduce the level of real revenues that the government can raise through deficit financing and money cration. See Tanzi and Blejer (1982, p. 783).

2/ However, insofar as foreign currency accounts may encourage currency substitutions, they can affect the optimal inflation tax. See Vegh (1989).

Table 5. Monetary Indicators

(Annual changes; in percent)

	Narrow Money	Broad Money	Currency in Circulation	Required reserves: At constant rates 1/	Required reserves: At current rates	Monetary Base	Inflation: Consumer price index	Inflation: Credit term index 2/
1971	23.9	19.8	27.3	20.0	20.0	17.4	7.4	...
1972	22.8	18.8	23.8	17.6	17.6	24.6	14.4	...
1973	38.6	32.8	26.0	30.3	43.4	39.3	24.7	...
1974	27.8	27.6	28.2	26.2	26.2	26.8	42.2	...
1975	37.9	28.9	28.6	27.1	33.3	34.1	50.2	...
1976	21.6	32.5	28.5	28.2	39.4	36.3	33.5	...
1977	47.1	43.9	56.8	41.5	41.5	55.0	30.5	...
1978	40.2	48.8	40.0	46.3	46.3	55.3	44.5	...
1979	47.3	56.2	29.4	44.8	62.2	47.7	45.5	43.6
1980	61.6	65.0	36.9	76.4	76.4	75.4	59.1	57.5
1981	60.4	70.6	80.0	89.0	89.0	67.0	50.6	51.8
1982	29.0	58.0	30.8	70.9	70.9	48.9	51.1	49.8
1983	77.1	78.5	46.5	83.7	83.7	73.6	85.7	79.4
1984	43.2	33.5	24.5	27.9	27.9	29.1	30.3	33.8
1985	25.7	47.3	29.7	51.5	-2.6	24.6	32.7	30.6
1986	45.3	35.3	37.9	31.9	31.9	33.0	20.6	24.6
1987	31.7	35.3	29.3	49.0	7.6	10.5	18.9	17.4
1988	17.9	24.0	16.9	15.5	6.6	11.2	26.4	23.4

Source: Central Bank of Iceland, Economic Statistics Quarterly (various issues).

1/ In 1971 the reserve requirement was 20 percent of all deposits in commercial banks.
2/ Until February 1989 the credit term index was composed of the cost of living index (two thirds) and the building cost index (one-third). At present, the cost-of-living index, the building cost index, and the wage index have a weight of one-third each.

Table 6. Iceland: Monetary Indexation: Chronology of Major Steps

1976	Introduction of special premium accounts, with interest premiums to be reconsidered regularly in view of the development of inflation.
1977	Bank lending and deposit rates are divided into two factors--basic rates and a price compensation factor subject to discretionary changes at regular three-month intervals with a view to price developments (moving average of past and projected inflation rates). The reference indices of the price compensation factor are the cost-of-living index (weight of two thirds) and the building-cost index (one third).
1979	Passage of the "Economic Management Act." The new law stipulates that a system of general price indexation of savings and credit shall be implemented before the end of 1980. It replaces the earlier legislation which only provided for partial adjustments of interest rates to inflation on an ad hoc basis but prohibited the general use of indexation.
June 1979	Implementation of first adjustment of interest rates according to the Economic Management Act's provisions. Banks are given permission to grant fully indexed loans carrying a real interest rate of 2 percent. Full indexation of the loan principal follows a credit terms index which is calculated monthly on the basis of the cost-of-living index (with a weight of two thirds) and the building-cost index (one third).
July 1980	Introduction of new two-year time deposits, fully index-linked (credit term index) with a real interest rate of 1 percent. Similar accounts with a real interest rate of 2 1/2 percent are opened in the Central Bank for deposit money banks.
Dec. 1980	The program of new economic measures issued by the Government stipulates that, inter alia, the adjustment period for the implementation of full indexation of deposits and lending laid down in the Economic Manangement Act of April 1979 is extended for one year to the end of 1981. Moreover, deposit money banks are required to offer fully indexed savings accounts in which deposits are blocked for six months instead of two years previously.
Feb. 1981	New six-month time deposits are introduced. The deposits are index-linked and the rate of interest is 1 percent per

annum. The previous two-year time deposits are automatically changed to six-month time deposits.

April 1981 Deposits can be transferred from 12-month interest premium accounts to the new six-month index-linked accounts. At the same time, the minimum maturity period of indexed loans is shortened, from 4 years to 2 1/2 years.

June 1981 The old six-month, 12-month, 10-year time deposits are abolished as such. Interest premium deposits are simply referred to as time deposits, and the interest rate on premium loans and mortgages are harmonized, thus abolishing interest premium loans as a special category.

April 1982 Deposit money banks begin to offer fully indexed three-month savings accounts, without interest. With the introduction of these accounts the implementation of the stipulations of the 1979 Economic Management Act is completed.

Sept. 1984 After the Central Bank decided on August 11, 1984 that it would no longer regulate all interest rates (except for general savings deposits, penalty rates on overdue payments, and rediscountable produce loans) the deposit money banks introduce "switching term deposits" where the terms switch between ordinary and indexed conditions according to which is more favorable to the depositor during a certain "comparison" period.

Jan. 1985 The Central Bank resumes control of interest rates on indexed loans. Indexed loans with a maturity under six months are prohibited.

Nov. 1986 The new Central Bank Act comes into effect. After interest rates on general savings accounts had already been deregulated in March 1986, the new Act liberalizes all other interest rates (including those on indexed loans and deposits) except penalty rates and interest rates on Central Bank deposits. The Central Bank can, however, interfere if domestic real interest rates are excessive compared to foreign interest rates, or interest rate margins are excessive.

Feb. 1987 The commercial banks' required deposits with the Central Bank are all merged into one account which is indexed but carries no interest.

March 1987 The Central Bank offers the deposit money banks three-month deposit certificates with alternative interest terms, i.e., either indexation and 6 percent interest or nonindexation with 20 percent interest, whichever proves higher on maturity.

Dec. 1987	Banks are authorized to receive foreign exchange-linked deposits in special accounts for a period of at least six months and re-lend such funds at the same time with a foreign exchange clause. The foreign exchange reference will be the SDR or the ECU.
July 1988	The Government bans the direct indexation of the principal of financial instruments with maturities of less than two years. An exception is made for the switching term deposits with banks and other indexed deposits with a minimum maturity of six months. The exception for the switching term deposits is made provided that the so-called comparison period for the terms of the deposits will be no less than six months as of January 1, 1989.
Nov. 1988	The Central Bank decides to pay 2 percent real interest on required reserves. In order to facilitate a reduction of interest rates in deposit money banks, this change is made retroactive to March 1988.
Jan. 1989	The composition of the credit terms index is changed. While previously it was calculated on two-thirds the cost of living index and one-third the building cost index, it is now one-third the building cost index, one-third the cost of living index, and one-third the wage cost index.
June 1989	The Central Bank announces that the indication of switching term deposits only applies to the untouched amount in each savings account in each six-month period.

Source: Central Bank of Iceland, National Economic Institute.

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