



The Circulation of Deutsche Mark Abroad

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Foreword

The present study entitled "The Circulation of Deutsche Mark Abroad" is the first in a series of discussion papers to be produced by the Economic Research Group of the Deutsche Bundesbank. This new research unit will publish further papers in future at irregular intervals.

Monetary policy makers have to adapt to a process of accelerated change in the overall operational setting which owes much to the monetary integration process in Europe and the globalisation of the financial markets. This change increases the need to underpin practical monetary policy by means of theoretical-empirical investigations; the Economic Research Group, which was set up in October 1994, is expected, among other things, to play its part in providing such underpinning. To that end we are releasing four members of staff in rotation from their normal duties on a kind of sabbatical leave, which will generally last for six months, thus enabling them to perform concentrated research work; this includes an exchange of ideas with other experts at the Bundesbank, at other central banks and at research institutes. Dr Robert Fecht has been put in charge of the Research Group. The results of the work in the group will be presented in discussion papers in the course of this series.

Professor O. Issing

The Circulation of Deutsche Mark Abroad

Summary

Since the fifties, the DM-denominated currency in circulation outside the banking system has increased both in nominal and in real terms, and the growth rates have shown a tendency to increase for about three decades. Even simple statistical ratios and charts indicate that this trend cannot be explained on the basis of domestic transactions alone. Cash holdings of enterprises, domestic hoardings, the shadow economy and lost cash taken together are not the main reasons for this either. Thus the foreign demand for Deutsche Mark is the only possible remaining explanation. This paper attempts to analyse this phenomenon in theoretical and empirical terms. This venture presents difficulties particularly since only the total amount of currency in circulation outside domestic banks is known and not the geographical breakdown of that total.

First of all, the study presents some stylized facts on Deutsche Mark in circulation (for example, the per capita cash holdings or the velocity of circulation of cash). Both international cross-sectional comparisons and purely national conditions indicate that there are certain inconsistencies. One would expect, for example, that, owing to financial innovations, the per capita amount of currency in circulation would decrease over time. However, in statistical terms, this has not happened in Germany since the seventies.

These first empirical indications of inconsistencies in the demand for Deutsche Mark are given more concrete shape in the following chapter by attempting to sift out external influences in the context of an econometric estimation of a currency demand function. This is done on the basis of the DM-US dollar exchange rate. On the one hand, this reflects the international strength of the Deutsche Mark. On the other hand, the Deutsche Mark (in countries in which it is used) is also a potential substitute for the US dollar. By means of an error correction approach, the study distinguishes between short-term influences which are associated with currency substitution and the relevance of the argument in the long-term equilibrium relationship (cointegration equation), as a measure of the cocirculation of Deutsche Mark. In both cases, it emerged that foreign variables had a statistically significant influence.

Subsequently the study describes a theoretical model with microeconomic foundations for deriving the determinants of foreign demand for Deutsche Mark. In this model, there are two types of currency, the domestic one and the foreign "DM". Particular attention is paid to the opportunity costs of the currency holdings concerned. It was found that the exchange rate and the inflation trend emerge as the main determining factors. If in this context a second currency, such as the Deutsche Mark, has established itself in a particular country, this process cannot easily be reversed (hysteresis effect).

On the basis of the analyses described so far, no statements can be made on the extent of foreign DM holdings. This is the subject of the following section, which is also the main part of the paper. Here, a distinction is made between direct and indirect approaches.

Among the former are the results of surveys and statistically recorded banknote outflows and return flows. Both are probably not appropriate for mastering the complexity of the problem. The currency in circulation abroad is characterised by the very fact that it cannot be recorded accurately in statistical terms. For that reason, the direct approaches were rejected in principle. They should be used as a back-up, at most. At the end of 1994, an external circulation of little more than DM 12 billion was recorded statistically.

In this respect, the indirect approaches seem to hold out greater prospects of success. Under these approaches, the study looks for variables which are influenced by the demand from abroad, and/or evaluates a priori information on parts of the currency in circulation. In many cases the study tries initially to determine the domestic part and then, in a second step, calculates the foreign part, as a residual.

The only method which is probably generally unsuitable for quantifying the currency in circulation abroad is that which relies on figures on foreign currency deposits of countries which use Deutsche Mark. These figures should be resorted to as additional information only. The other four approaches seem to be more promising. Although they do not exhibit a uniform temporal pattern, they all indicate that similar orders of magnitude apply at the current margin (end of 1994). Between 30% and 40% of the total currency in circulation is likely to be abroad. In absolute terms, this amounts to DM 65 billion and DM 90 billion, respectively.

The first model is based on the assumption that the foreign demand for Deutsche Mark has a dampening effect on the seasonal factor of the entire currency in circulation. A point of reference is needed for separating the domestic from the foreign component. Here, two

alternatives are used: the seasonal figure of the currency of a suitable foreign country and the seasonal figure of a domestic transactions variable. In the second model, the "shock of unification" is used for comparing the old Federal area with the new Federal area and the new Länder. If the "surge in cash" in mid-1990 is attributed to eastern Germany alone, it is possible, given certain assumptions, to calculate notional per capita currency holdings in Germany. These may be used as a basis for establishing the DM holdings abroad. A third major category is represented by the approaches based on an estimation of currency demand. For this purpose, the first two sub-models specify a domestic money demand function. At first, the "best fit" of this function is sought on the basis of the maximum of the log-likelihood. By contrast, in the second sub-case this function is estimated for a period in which it was assumed that the issue of foreign holdings was still of secondary importance. Currency demand is then "forecasted" up to the current margin. By means of the prediction error, it is possible, under certain assumptions, to infer the foreign holdings. The last sub-model examines the trend in the currency ratio. By comparing the entire German trend with other periods and another country, it is possible, in turn, to calculate the foreign DM circulation. As a final model, the study carries out an analysis of the age of German banknotes. Comparisons of the actual average life with the "normal" life of small notes (DM 5 to DM 50) make it possible to derive information on the movements of the corresponding notes abroad.

The section following these detailed empirical analyses deals with the consequences for monetary policy of the DM circulation abroad. In the first place an increased currency demand (irrespective of where it originates) strengthens the ties of the commercial banks with the Bundesbank, which potentially increases the impact of the Bundesbank's interest rate policy. It further increases the seigniorage, and thus the Bundesbank profit. However, no major impairment of monetary targeting based on a broad monetary aggregate such as M3 is to be expected. Problems might arise only if the foreign holdings are subject to major annual fluctuations. Owing to various uncertainties and problems, however, a correcting factor for the money stock should not be used.

The last section summarises the results and gives a short account of further possible research geared towards gauging foreign holdings of Deutsche Mark. It reiterates, in particular, that the foreign demand refers to large and small banknotes and that the entire complex of problems can be adequately dealt with only if the analysis is not confined to the past few years and to eastern Europe, but instead covers the entire period since the Deutsche Mark came into existence and all unstable countries.

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*What we know not, of that our need is dire,
And what we know lacks application.*

(J.W. von Goethe, Faust I)

The Circulation of Deutsche Mark Abroad*

I. Introduction

Virtually every international definition of the money stock takes as its point of departure domestic non-banks, the domestic banking system and the transactions function of money. For example, the Bundesbank's official indicator and intermediate target variable M3 is defined as the amount of currency in circulation and the sight deposits, time deposits for less than four years and savings deposits at three months' notice held by domestic non-banks - other than the Federal Government - at domestic credit institutions. Such a definition focuses on the potential purchasing power for the domestic economy. The various types of deposits can unambiguously be broken down by residents and non-residents and by domestic and foreign banks, using the banking statistics. By contrast, all that we know for currency in circulation is the aggregate amount circulating in the hands of non-banks. It is not possible to distinguish between holdings in Germany and holdings abroad. With the US dollar and the Deutsche Mark especially (these being international investment and reserve currencies), there is some evidence that part of the currency is being used for transactions or hoarding purposes in countries with unstable conditions, and hence is perhaps being withdrawn from the domestic economy for a prolonged period.¹ In the case of the Deutsche Mark huge amounts may have accumulated since 1948.

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¹ In the United States attention was drawn to this at an early stage, see Kimball (1981). In the case of the Japanese yen, this phenomenon does not yet appear to be very pronounced, and seems to be confined mainly to south-east Asia. At any rate, the length of time during which Japanese banknotes remain abroad is fairly short (Bank of Japan, 1994, p. 117). Since the end of the seventies there has also been an increase, albeit at a low level, in the amount of pounds sterling circulating abroad (Bhattacharyya, 1990, p. 710). The Bank of England even includes figures on foreign holdings of pounds sterling, as calculated by the Central Statistical Office, in the balance sheet counterpart of M4. According to information from the Banque de France, the French franc circulates only in the Maghreb countries on a relatively small scale. It appears that the Swiss franc is used abroad solely for hoarding purposes, but to an unknown extent.

In the present study an attempt is being made to track down the amount of DM currency in circulation abroad. It is the first more detailed study of this topic. Following the presentation of some stylized facts on currency in circulation, an attempt is made to sift out evidence of external influences with the help of estimating currency demand functions. This is followed in turn by a theoretical model to explain the circulation of Deutsche Mark abroad. The main part of the paper is concerned with gauging foreign DM holdings using different approaches. As nearly all existing analyses relate to the US dollar, it is not possible to make comparisons with other estimations. The final part of the study looks at the monetary policy implications of the holdings of Deutsche Mark abroad.

One of the aims of this paper is to provide an answer to the question "Should we tolerate, ignore or try to curb the circulation of Deutsche Mark abroad?"

II. Some stylized facts

Before coming to the analytical part proper, I would like first to consider some international comparisons as well as certain conspicuous and specific features of currency in circulation during the past few decades.²

Fig. 1 shows currency in circulation in Germany since 1950.³ It has been growing exponentially since around the end of the sixties. Since that time, too, larger fluctuations in the absolute annual change in the amount of currency in circulation have been evident, whereas before the trend was fairly steady (fig. 2). At the end of 1994 approximately DM 225 billion and about 2.4 billion banknotes were in the hands of non-banks. The bulk of this was in DM 100 and DM 10 notes, the denominations used most frequently in transactions, while the smallest share was made up of DM 200 and DM 500 denominations.⁴ Table 1, which gives a breakdown of currency holdings, shows that in 1994 - in a statistical sense - each household in Germany held on average approximately 25 DM 100 notes. But each household also held two DM 1,000 banknotes. It is unlikely that holdings of this magnitude can be explained by (domestic) transactions alone.

² The term of reference throughout this study is the entire amount of currency outside the German banking system, i.e. it is assumed that the value of lost banknotes is negligible, see also Boeschoten (1992), p. 108 f., Laurent (1974).

³ In interpreting this figure it should be noted that the Bundesbank has always accommodated the demand for currency; hence the amount of currency in circulation should be viewed as an endogenous variable.

⁴ Hitherto the notes in circulation have always made up at least 90% of the total currency in circulation (see fig. 3).

Table 1: Number of denominations per household

Total denominations in 1994		No. of DM 1,000 notes per head/household	
DM 5	2.0	1984:	0.31 / 0.70
DM 10	13.4	1988:	0.65 / 1.45
DM 20	10.9	1991:	0.59 / 1.33
DM 50	11.3	1993:	0.75 / 1.74
DM 100	24.7	1994:	0.87 / 2.00
DM 200	1.6		
DM 500	1.4		
DM 1,000	2.0		

If all German currency were held in Germany, each person would have had to have held DM 2,780 at the end of 1994, which means a total of DM 11,120 per four-person household. Both nominal and real per capita currency holdings have increased since 1960 (fig. 4).⁵ These phenomena cannot be adequately explained merely by reference to the shadow economy (see, in the case of the United Kingdom, Beenstock (1989), p. 472). Even if the size of the shadow economy were estimated at 10% of GNP (Pommerehne/Kirchgässner (1994), p. 852), and if a velocity of circulation of currency of about 10 were assumed, it would account for no more than about DM 30 billion of the total currency in circulation. The corresponding figure for Germany in table 2 would then still come to almost US\$ 1,360.

The table lists per capita currency holdings in countries with different levels of development. The numbers vary greatly, even between countries that are similar. For example, the gap of US\$ 2,700 between Finland and Switzerland certainly cannot be explained simply by reference to differing payment habits and rates of inflation. Germany, Japan and Switzerland are the countries with the highest figures. The less developed countries tend to have a lower average level of currency holding. As these countries also often have an unstable environment, this is probably not attributable solely to their lower state of development but also to the holding of Deutsche Mark and US dollars.

⁵ In interpreting the German figures, the "jump" caused by German unification in 1990 should always be borne in mind.

Table 2: International comparison of per capita currency holdings (1993, in US\$)

Australia	665	Sweden	985
Canada	607	Switzerland	3,060
Japan	2,944	Turkey	78
New Zealand	187	United Kingdom	492
United States	1,271	Argentina	299
Austria	1,386	Brazil	70
Belgium ¹⁾	1,276	Chile	98
Denmark	766	Congo	79
Finland	358	Egypt	94
France	746	India	30
Germany	1,579	Iran	68
Greece	651	Israel	309
Iceland	222	Kenya	. 13
Ireland	648	Morocco	149
Italy	987	Thailand	123
Malta	2,568	Czech Republic	196
Netherlands	1,323	Hungary ²⁾	336
Norway	1,169	Poland	143
Portugal	475	Romania	61
Spain	1,307		

1) 1992

2) 1991

Theoretically one would expect that the holding of currency for use in transactions (measured, say, by private consumption) would decline over time as a result of cashless payments and other financial innovations (Stekler, 1991, Daniels/Murphy, 1994). Fig. 5, however, suggests that this proposition has not been generally valid since the sixties. Germany, Japan and, to a certain extent, the Netherlands have shown a contrary tendency since the beginning of the eighties, the United States since the mid-eighties and Italy since the early nineties. As fig. 6 shows, the outcome is not basically different if GDP is taken as the reference variable.⁶ A particularly marked feature in Germany since the seventies has

⁶ This surprising outcome for Germany, especially from the mid-eighties onwards, is also referred to by Holtham et al. (1990), p. 215 f.

been the holding of large-denomination banknotes. But the small denominations, too, have shown a rising trend since the mid-eighties.

The movement of the reverse relation to this, the velocity of circulation, corroborates these findings (fig. 7). For the most part, coins likewise display a declining trend. If the figures are broken down by denomination, a clear distinction between large and small banknotes is apparent. For denominations up to DM 50 a rising trend is discernible, and for notes of DM 500 and DM 1,000 a falling trend is evident (fig. 8). This suggests that part of the currency - the large-value notes - are not only held in Germany for transactions purposes, but that other factors are involved as well. Apart from currency holdings abroad, domestic non-banks' portfolio considerations may play a role in this, i.e. domestic cash holdings may be asset-determined to some extent.⁷ The ratio of currency to households' financial assets has been fairly constant since the beginning of the eighties (fig. 9).

Within the denomination range, it has been the circulation of DM 10, 20, 100 and 1,000 notes that has increased at an exceptional pace in recent years (fig. 10). The surging growth rates of the DM 1,000 banknote were also in evidence, however, at earlier times (fig. 11). It is likewise apparent that the (positive) growth rates of currency have shown a declining trend since the end of the eighties (see the moving averages in fig. 11). The share of currency in circulation in M3, M1 and sight deposits has shown a slightly rising tendency since the seventies. It now makes up around 12%, 33% and 45%, respectively, of those aggregates (fig. 12). This is remarkable, since, in general, the interest-bearing components increase automatically as a result of interest payments. The share of DM 1,000 notes in M3, and that of the two largest notes in currency in circulation, has been growing continuously since that time (to approximately 5% and 43%, respectively, at present). By contrast, the percentage shares of the other denominations have gone down steadily (in nominal terms) (fig. 13). The large denominations have probably been mainly responsible - at least until the mid-eighties - for the interest elasticity of the demand for currency. Since then, however, the relationship has been far less marked (fig. 14). The fact that domestic transactions provide only an incomplete explanation of the above trends is also shown by the seasonal fluctuations (e.g. around the turn of the year), which are principally caused by transactions. These show a rather varied pattern for the different currency components (see fig. 15, in which the seasonal movements can be traced in a number of examples).

⁷ For explanations of different trends in the velocity of circulation, see Bordo/Jonung (1987), chapters 2 and 3. The argument for including portfolio considerations in the analysis of currency demand also appears in Beenstock (1989), p. 471 f. and Boeschoten (1992). It follows that theoretical analyses based purely on the transactions function of currency, such as the recent search-theoretical models (e.g. Trejos/Wright, 1995), are likely to be misspecified for many countries.

Many of the inconsistencies or "currency puzzles" described above could be explained by holdings of Deutsche Mark notes abroad. An increasing number of commentators have pointed this out of late (e.g. Schütte, 1994, p. 35, Gillies, 1993, Balzer et al., 1990, Deutsche Sparkassenzeitung, 1991, Süddeutsche Zeitung, 1994, Frankfurter Allgemeine Zeitung, 1993, Kolendic, 1994). The purpose of this paper is to deal with this phenomenon both theoretically and empirically. The problem of counterfeit money, which has been gaining in importance since the start of the nineties, in particular, has not been addressed. A large proportion of counterfeit money, too, is presumably circulating abroad. For example, not only has the absolute number of counterfeit DM notes detected in and outside payment transactions increased, but the amounts coming from abroad have likewise risen noticeably.

III. First empirical indications of external influences in the demand for currency

"What is and what should never be"

(Led Zeppelin, II)

Following these simple statistical correlations and graphical illustrations, an attempt will now be made to capture the external influence on currency in circulation more concretely. For this purpose, domestic and foreign determinants are included in an econometrically estimated currency demand function. For the sake of simplicity, the external variables are confined to various exchange rates. It is difficult empirically to capture or construct other external variables for a country whose currency is used in many other countries.

A simple comparison of currency in circulation and the effective external value of the Deutsche Mark against 18 industrial nations already reveals the suspected connection. At times of an (expected) appreciation of the Deutsche Mark, the demand for the German currency rises, too (see fig. 16).⁸ The exchange rate elasticity seems to derive principally from the large-value bills. From the second third of the eighties, however, a break in the relationship apparently occurred which cannot be attributed (solely) to German unification.⁹ If the analysis is confined to the bilateral relations between the Deutsche Mark and the US dollar, a similar correspondence is found. This is unlikely, however, to stem from any direct substitution between these two currencies in Germany or in the United States,

⁸ In the case of the Deutsche Mark, which in the past has appreciated nearly continuously, it does not appear implausible to take the actual exchange rate trend as a yardstick of the expected trend.

⁹ This statement is underpinned in fig. 16, in which a "currency series" has been statistically adjusted for the unification leap.

but rather from the fact that Deutsche Mark or US dollars are being held in weak-currency countries instead of the domestic currency.

To determine more precisely the foreign impact on currency in circulation, the demand for Deutsche Mark was estimated using the Johansen procedure (Johansen, 1988, Johansen/Juselius, 1990). This approach explicitly distinguishes between long-term equilibrium relationships (cointegration relationships) and short-run dynamics without limiting the number of cointegration equations to one from the outset.¹⁰ This improves the statistical properties of the regression.

Seasonally adjusted quarterly data were used. The estimation period runs from the first quarter of 1960 to the second quarter of 1994 (N = 138); in the Vector Error Correction Model (VECM) the sample period was correspondingly adjusted by taking account of the lags and differencing. Overall, this more or less countered the bias in the long-run estimates stemming from too small a sample range (Banerjee et al., 1986). From the third quarter of 1990, data for unified Germany were used. An estimate was made of the real demand for currency (cur).¹¹ Real private consumption (cr) represents the transactions variable.¹² Accordingly, the deflator of private consumption was used for deflating. The three-month money market rate (i) was used as a measure of the domestic opportunity costs. In addition, the (nominal) DM/US dollar exchange rate (e\$) was included as a regressor to capture the (trend in) potential external influences.¹³ The aim of this was, firstly, to capture the relative strength and attractiveness of the Deutsche Mark and, secondly, to trace the substitution relationship between the Deutsche Mark and the US dollar in countries predestined for cocirculation. All the variables, except the interest rate, are in natural logarithms. The changes (Δ) relate to one period before, i.e. they are first differences.

¹⁰This assumption is made, for example, in the two-step approach of Engle/Granger and the one-step analysis of Stock, see Engle/Granger (1987) and Stock (1987).

¹¹By estimating a real equilibrium relationship, a price homogeneity of one is assumed, so that freedom from money illusion is assured.

¹²As an alternative, real retail turnover (rtr) and its sub-groups "food, drink and tobacco" (rtfdr) and "textiles, clothing, shoes and leather goods" (rttsr) were used. The dependent variable was then denoted cur1, cur2 or cur3, respectively. Attempts to derive the transactions financed by cash are made in Cramer (1986), Dotsey (1988) and Feige (1987).

¹³Alternatively, use was made of the weighted external value of the Deutsche Mark against 18 industrial countries (ev). For currency estimates using an exchange rate argument, see also Langfeldt/Lehment (1980), Gross (1989), Holtham et al. (1990).

Table 3: Stationarity tests

Variable	Test specification	t-value (absolute)
cur	C,3	1.05
Δ cur	C,3	3.98***
cur1 ²	C,4	0.92
Δ cur1	C,4	3.53***
cur2 ³	C,4	0.80
Δ cur2	C,4	3.16**
cur3 ³	C,4	1.36
Δ cur3	C,4	3.15**
cr	C,4	0.93
Δ cr	C,4	3.97***
i	4	1.36
Δ i	4	5.34***
e\$	C,4	1.05
Δ e\$	C,4	4.69***
ev ¹	C,4	1.61
Δ ev	C,4	4.37***
rtr ²	C,3	2.39
Δ rtr	C,3	3.78***
rtdr ³	C,T,3	1.52
Δ rtdr	C,T,3	4.21***
rttsr ³	C,T,2	3.16
Δ rttsr	C,T,2	5.88***

Estimation period 1960,1-1994,2, unless stated otherwise.

Comparison of the t-values with the critical values of MacKinnon (1991).

***/**: significant at the 1%/5% level.

C=constant, T=deterministic trend; 4/3/2: number of lags in the test equation.

1) 1973,1 to 1994,2; 2) 1962,1 to 1994,2; 3) 1968,1 to 1994,2

Statistical breaks have only a minor bearing on currency in circulation. It is therefore not necessary to produce a break-adjusted time series in order to exclude illusory correlations and to avoid the danger of deriving economic effects (such as structural breaks) or causalities from purely statistical phenomena. There are thus no obstacles on that account to the existence of meaningful cointegration results (Lane/Poloz, 1992, p. 7, Deutsche Bundesbank, 1995, p. 45).

Under the Johansen approach, the number of cointegration vectors has to be determined first. Then a VAR model is estimated, taking into account the established cointegration relationship(s). The basic condition for the applicability of this method is that the variables are integrated of order one (I(1)). Therefore, the order of integration is first tested. As indicated by the stationarity tests listed in table 3, the Augmented Dickey-Fuller (ADF) statistic ensures, at least at a significance level of 5%, that the variables used are (I(1)). That means that simple differencing ensures the stationarity of the time series.

With the aid of the Johansen test, the number of cointegration equations (CE) can now be determined (see table 4). Based on the selection criteria of Akaike and Schwartz (with a maximum of four lags), the number of lags considered was confined to two here and in the VECM. The likelihood ratio test then applied (maximum eigenvalue) indicates the existence of exactly one long-run relationship between cur_t , cr_t , i_t and $e\$_t$.¹⁴ The exact specification was selected on the basis of an economically meaningful interpretation of the relationship.

Table 4: Determination of the number of cointegration relationships

Eigenvalue	Likelihood ratio	5 per cent critical value	1 per cent critical value	Hypothetical number of CE's
0.249653	55.34024	47.21	54.46	none **
0.068422	16.27842	29.68	35.65	at least 1
0.040595	6.63936	15.41	20.04	at least 2
0.007350	1.00327	3.76	6.65	at least 3

*(**) indicates the rejection of the null hypotheses at the 5%(1%) significance level

The cointegration vector calculated on the basis of the normalised cointegration coefficients is

$$(1) \quad cur_t = 14.77 + 4.82cr_t - 1.00i_t - 0.65e\$_t + \varepsilon_t,$$

where ε_t denotes the stationary residual.

The parameters can be interpreted as elasticities and have the theoretically expected signs. Both the interest rate and the transactions elasticity have relatively high values. The latter yields a falling trend in the velocity of circulation, which points to the asset quality of currency (see also the comments in connection with the stylized facts). This may be caused primarily by the large denominations and their predominance. A foreign influence via the DM/dollar exchange rate is likewise discernible over the long run: when the Deutsche Mark appreciates against the US dollar, the demand for currency rises. As this influence obtains in the long-run relationship, this would seem to reflect the long-term use of

¹⁴Hence, given exogeneity of the regressors, it would also be possible to proceed further using the two-step approach of Engle/Granger.

Deutsche Mark in other countries (such as in eastern Europe as a parallel currency).¹⁵ For analytical reasons, this long-run and, in part, irreversible nature of the cocirculation of two or more currencies needs to be differentiated from the more short-run effect of currency substitution (Krueger/Ha, 1994, Kamin/Ericsson, 1993, Sahay/Végh, 1994).

The order of magnitude of the elasticities was raised very sharply, or even distorted, by German unification and the opening-up of eastern Europe. If these factors are excluded from the analysis and the estimation is carried out only up to the second quarter of 1990 (N = 122), the following cointegration equation is obtained:

$$(1') \quad \text{cur}_t = 1.17 + 1.30\text{cr}_t - 0.20\text{i}_t - 0.11\text{e}\$, + \varepsilon_t$$

All elasticities are distinctly smaller and are more in line with a priori beliefs. To that extent, the equations for currency in circulation imply a changed long-run relationship, but suggest that the continued existence of such a relationship is assured.¹⁶ The transactions elasticity result could be interpreted as suggesting that hoarding problems in Germany and/or the currency in circulation abroad have increased since German unification.

Subsequently, a VECM for the short-run dynamics can be estimated. This enables currency substitution effects to be captured as well. Complementary to the above variables two shift-dummies are taken into account: one (dum) is designed to capture the withholding tax effects and takes the value one from the fourth quarter of 1987 to the first quarter of 1989, and is otherwise zero. The other (dume) serves to represent German unification and the opening-up of eastern Europe; it takes the value one as from the third quarter of 1990, and before that zero. The equation for the entire period investigated (1960,3 to 1994,2) is as follows:¹⁷

¹⁵A similar argument can be found in Langfeldt (1989), p. 54 f. For some countries in which a second currency circulates, it was found that a long-run money demand relationship exists only in conjunction with an exchange rate argument, see Choudhry (1995).

¹⁶By contrast, if the foreign influence is captured via the weighted external value of the Deutsche Mark, no economically meaningful cointegration relationship exists between the four variables.

¹⁷The absolute t-values are given below the coefficients. This equation, too, confirms the cointegration relationship through the magnitude of the t-value of the error correction term, see Kremers/Ericsson/Dolado (1992).

The following apply: R²: coefficient of determination, Std: Standard error of the regression, SSR: sum of squared residuals, AIC/SC: Akaike/Schwartz selection criterion.

$$(2) \quad \Delta \text{cur}_t = \underset{(5.00)}{-0.04} - \underset{(5.49)}{0.001} \text{ECT}_{t-1} + \underset{(5.80)}{0.30} \Delta \text{cr}_t - \underset{(2.43)}{0.002} \Delta i_{t-1} \\ - \underset{(3.80)}{0.07} \Delta e\$_{t-1} + \underset{(2.39)}{0.01} \text{dum}_t + \underset{(2.79)}{0.007} \text{dume}_t + u_t$$

$R^2=0.49, \text{Std}=0.009, \text{SSR}=0.01, \text{AIC}=-9.33, \text{SC}=-9.18, \text{N}=136$

The residuals u_t are

$$u_t \sim \text{IN}(0, \sigma_u^2), t = 1, \dots, T,$$

i.e. the residuals are identically and independently normally distributed with zero mean and constant variance. In particular, they are "white noise".

The residuals of the long-run regression (ε_t) are included in the error correction model as (lagged) equilibrium errors. The coefficient of this error correction term (ECT_{t-1}) displays the negative sign required for a stable equilibrium. Adjustment to the long-term equilibrium is, however, relatively slow. The two dummy variables are significantly positive. A clear and significant external influence is discernible in the short-run equation, too. This suggests that DM currency in circulation is likewise characterised by currency substitution.¹⁸ The short-run elasticities are (as one would expect) lower throughout than the long-run elasticities. Overall, the test statistics show acceptable statistical properties for the regression.

In the short run there is little qualitative change in the results if the estimation period is only taken up to the second quarter of 1990. Only the adjustment to long-run equilibrium speeds up perceptibly. The relationship is as follows:

$$(2') \quad \Delta \text{cur}_t = \underset{(1.33)}{-0.002} - \underset{(6.03)}{0.01} \text{ECT}_{t-1} + \underset{(3.07)}{0.22} \Delta \text{cr}_t - \underset{(2.49)}{0.002} \Delta i_{t-1} \\ - \underset{(1.99)}{0.04} \Delta e\$_t - \underset{(2.99)}{0.06} \Delta e\$_{t-1} + \underset{(3.57)}{0.01} \text{dum}_t + u_t$$

$R^2=0.49, \text{Std}=0.009, \text{SSR}=0.008, \text{AIC}=-9.48, \text{SC}=-9.31, \text{N}=120$

Altogether, therefore, the long-run equilibrium relationship for currency - unlike M3 - displays greater changes since 1990 than the short-run dynamics. This phenomenon may possibly stem from the fact that currency in circulation is more heavily influenced by developments in eastern Europe than is the monetary aggregate M3, for which the short-term changes arise principally from other factors like German unification.

¹⁸Fröhlich (1989), p. 35, draws attention to the short-run effect of an increased foreign demand for German currency for speculative reasons at times of currency appreciation. Within the EMS, by contrast, no currency substitution effects are discernible in the case of currency (Deutsche Bundesbank, 1995).

Alternatively, retail turnover or its sub-categories could be used as transactions variables as they are perhaps more closely related to the use of cash. As no reliable and comparable figures are available so far for eastern Germany, west German data must continue to be used even after the third quarter of 1990, or else the estimation has to be confined to the period prior to German unification. In the case of the first alternative, currency in circulation has to be adjusted in such a way that the unification leap no longer occurs. It can be sifted out such that the increase in currency circulation due to German unification is fictitiously already taken into account for the period preceding the third quarter of 1990. The above a priori hypothesis could not be confirmed using this approach, with reference neither to west German retail turnover as a whole nor to the latter's sub-categories food, drink and tobacco or clothing and footwear. Either no economically informative long-run relationship was detectable or its existence had to be denied in the light of the statistical tests. Hence private consumption would seem to be the best transactions variable for Germany as a whole at present.

For the period before reunification, on the other hand, it was possible to construct a cointegration equation using aggregate retail turnover, though not its sub-groups. The friction which has obtained since the beginning of the nineties has apparently led to a collapse of the long-run relationships. The complete error correction model is presented in (1'') and (2'') (sample: 1962,1 to 1990,2):

$$(1'') \quad \text{cur } l_t = 6.91 + 2.18 \text{rtr}_t - 0.43 i_t - 0.21 e\$_t + \varepsilon_t$$

$$(2'') \quad \begin{aligned} \Delta \text{cur } l_t = & \frac{-0.07}{(5.68)} - \frac{0.005}{(6.24)} \text{ECT}_{t-1} + \frac{0.09}{(2.02)} \Delta \text{rtr}_t - \frac{0.002}{(2.19)} \Delta i_t - \frac{0.002}{(2.44)} \Delta i_{t-2} \\ & - \frac{0.03}{(1.78)} \Delta e\$_t - \frac{0.06}{(3.26)} \Delta e\$_{t-1} + \frac{0.01}{(3.73)} \text{dum}_t + u_t \end{aligned}$$

$$R^2=0.54, \text{Std}=0.008, \text{SSR}=0.007, \text{AIC}=-9.61, \text{SC}=-9.42, N=113$$

The equations show properties similar to those of (1') and (2'). Thus it would appear that cash-related transactions in the former Federal area prior to German unification can be adequately represented either by private consumption or by retail turnover. This suggests that, as soon as consistent data on retail turnover are available for Germany as a whole, these should again yield meaningful results in currency demand functions.

Although holdings of Deutsche Mark abroad cannot be derived from the above cointegration analysis based on error correction models, the analysis undoubtedly shows a pronounced external influence on currency in circulation, both from a short-term view and a long-term perspective, which is presumably attributable above all to unstable countries.

IV. A theoretical model explaining foreign demand for Deutsche Mark

In developed countries with free market economies there is little evidence of any marked cocirculation (Pentecost, 1995, p. 5). Intuitively, however, it seems quite plausible that the population of unstable countries may be eager to acquire hard currencies (Deutsche Mark, US dollars). To improve our understanding of this process and of the microeconomic considerations which lie behind it, this section presents a theoretical model based on Lane (1990). In contrast to this setup, I model a free market economy (e.g. a current east European variant) without rationing. Accordingly, all prices are market prices. The representative household can choose between two currencies, the foreign currency (Deutsche Mark) and the domestic one (e.g. the zloty) to finance its purchases of goods. There are no other financial assets, neither interest-bearing ones (e.g. foreign currency deposits) nor other currencies (e.g. US dollars) and barter is not allowed.¹⁹

The household maximises its expected utility EU as a function of the chosen consumption path cr over an infinite time horizon

$$(3) \quad EU = E_0 \sum_{t=0}^{\infty} \beta^t u(cr_t)$$

E is the expectations operator, β the discount factor of the utility flows u . It is assumed that there is only one consumption good which can be purchased using either domestic currency (x^i) or foreign currency (x^a), i.e.

$$cr_t = x_t^i + x_t^a$$

The budget constraint of the household in local currency (4) implies that, within any given period, purchases of goods during the period ($p_t x_t$) plus currency holdings at the end of the period (cu_t) must equal initial holdings of currencies (cu_{t-1}) plus nominal income (y_t). The prices p_t are not affected by the choice of currency. Foreign units of currency are converted into domestic ones using the exchange rate in price quotation e_t .

$$(4) \quad p_t(x_t^i + x_t^a) + cu_t^i + e_t cu_t^a = cu_{t-1}^i + e_t cu_{t-1}^a + y_t$$

¹⁹The important role of the credit market in the reform process of the east European countries in transition is therefore excluded, see Calvo/Kumar (1994).

In addition to this budget constraint there are two cash-in-advance constraints: purchases with zlotys have to be financed from the initial holdings of zlotys (equation (5)), and the total purchases of goods are limited by the available stocks of the two currencies (equation (6)).

$$(5) \quad p_t x_t^i \leq cu_{t-1}^i$$

$$(6) \quad p_t x_t^i + p_t x_t^a \leq cu_{t-1}^i + e_t cu_{t-1}^a$$

The non-negativity conditions apply to currency holdings (equation (7)) and the purchases of goods (equation (8)):

$$(7) \quad cu_t^i, cu_t^a \geq 0$$

$$(8) \quad x_t^i, x_t^a \geq 0$$

The household's objective is to maximise (3) with respect to $x_t^i, x_t^a, cu_t^i, cu_t^a$ subject to the constraints (4) to (8). In order to solve this problem it is possible to define a value function $J(cu_t^i, cu_t^a)$, which in this concrete case is the expected maximised present value of the utility from $t+1$ onwards as a function of the cash holdings carried over from period t . The Lagrangean for each period t (λ_i are the Lagrange multipliers) then reads:

$$\begin{aligned} L_t = & u(x_t^i + x_t^a) + \beta J(cu_t^i, cu_t^a) \\ & - \lambda_{1,t} (p_t x_t^i + p_t x_t^a + cu_t^i + e_t cu_t^a - cu_{t-1}^i - e_t cu_{t-1}^a - y_t) \\ & - \lambda_{2,t} (p_t x_t^i - cu_{t-1}^i) - \lambda_{3,t} (p_t x_t^i + p_t x_t^a - cu_{t-1}^i - e_t cu_{t-1}^a) \\ & - \lambda_{4,t} cu_t^i - \lambda_{5,t} cu_t^a - \lambda_{6,t} x_t^i - \lambda_{7,t} x_t^a \end{aligned}$$

The first question to be addressed is how many units of goods can be bought with the respective currency. The two first-order conditions for the optimum values of x_t^i and x_t^a are given by

$$(9a) \quad u_t^i \equiv \frac{\partial u}{\partial cr_t^i} = p_t (\lambda_{1,t} + \lambda_{2,t} + \lambda_{3,t}) + \lambda_{6,t}$$

$$(9b) \quad u_t^a \equiv \frac{\partial u}{\partial cr_t^a} = p_t (\lambda_{1,t} + \lambda_{3,t}) + \lambda_{7,t}$$

Assuming that x_t^i and x_t^* are positive in every period, (8) is no longer binding ($\lambda_{6,t}=\lambda_{7,t}=0$) so that, according to (5), $\lambda_{2,t}=0$, i.e. not only are positive stocks of local currency (zlotys) definitely held, but the stocks are also larger than are necessary for goods purchases. By holding local currency the household has the option, so to speak, of acquiring goods or the foreign currency. This is also based on the perception that zlotys are needed in any case for certain transactions.

The conditions for the optimal holdings of Deutsche Mark (cu_t^*) and zlotys (cu_t^i), and hence the corresponding demand functions, can be derived from (10):

$$(10a) \quad \beta J_{i,t} = \lambda_{1,t} + \lambda_{4,t}$$

$$(10b) \quad \beta J_{a,t} = e_t \lambda_{1,t} + \lambda_{5,t}$$

where $J_{n,t} = \partial J(\cdot) / \partial cu_{t,n}$, $n=i,a$. Using the definition of the value function, this gives

$$(11a) \quad J_{i,t} = E_t [\lambda_{1,t+1} + \lambda_{2,t+1} + \lambda_{3,t+1}]$$

$$(11b) \quad J_{a,t} = E_t [e_{t+1} (\lambda_{1,t+1} + \lambda_{3,t+1})]$$

Thus holding both currencies eases the budget constraint (λ_1) and the cash-in-advance constraint for the total goods purchases (λ_3). In addition, the holding of zlotys eases the other cash-in-advance constraint (λ_2).

Below, only those solutions are considered in which the Deutsche Mark is also used as a long-term store of value, so that not all of the available amount of Deutsche Mark is converted into goods in each period. In this case, neither the cash-in-advance constraint (6) nor the non-negativity condition of the DM holdings from (7) has a binding effect, i.e. $\lambda_{3,t} = \lambda_{5,t} = 0$. From (9) to (11) the savings (in Deutsche Mark) can then be determined on the basis of equation (12).

$$(12) \quad u_t^i = \frac{\beta E_t [u_{t+1}^i (1 + a_t)]}{1 + \pi_t},$$

where a_t is the rate of appreciation of the Deutsche Mark $[(e_{t+1} - e_t) / e_t]$ and π_t denotes the inflation rate $[(p_{t+1} - p_t) / p_t]$ from t to $t+1$. If a depreciation of the Deutsche Mark or an increased erosion of the value of the domestic currency is expected, the demand for

Deutsche Mark declines for store-of-value reasons (but not necessarily for transactions purposes). In the relevant countries it is usually found that $Ea_t \gg 0$ and $E\pi_t \gg 0$. Analogously, the demand for domestic currency is derived from (13).

$$(13) \quad BE_t \left(\frac{a_t}{1 + \pi_t} \right) u'_{t+1} = p_t \lambda_{4,t}$$

On the left-hand side of (13) is the expected utility-weighted real return on DM holdings relative to that of zlotys. The lower this return, the greater is the demand for domestic currency. This shows that the influence of economic stabilisation programmes on the expectations of private market participants is a crucial factor in using more than one currency. And such stabilisation efforts can be triggered by the pressure emanating from an increased use of Deutsche Mark (or of any other second currency) (Sturzenegger, 1994).

By means of a Taylor approximation of (13) and after taking due account of (4), the determinants of the two currency demand functions can be analysed more closely (see also Lane, 1992, p. 832 ff. and Lane, 1990). In a simplified form (with the plus or minus signs of the partial derivatives placed above the arguments), the corresponding relationships are as follows:²⁰

$$(14) \quad cu_t^i = f^i \left[y_t^+, p_t^+, e_t^+, E\bar{a}_t, E\bar{\pi}_t, \text{Var}(\bar{\pi}_t), \text{Var}(\bar{a}_t), \dots \right]$$

$$(15) \quad cu_t^a = f^a \left[y_t^+, p_t^+, e_t^+, E\bar{a}_t, E\bar{\pi}_t, \text{Var}(\bar{\pi}_t), \text{Var}(\bar{a}_t), \dots \right]$$

At first, both demands depend positively on nominal income, prices and the DM-zloty exchange rate. Whether used in transactions or as a store of value, the relative return on holding Deutsche Mark vs zlotys in both cases depends on the expected exchange rate movement. If an appreciation of the Deutsche Mark is expected, the demand for Deutsche Mark rises. Fluctuations in the rates of inflation and appreciation, captured via the variance terms, have an ambiguous effect on the demand for Deutsche Mark. On the one hand, demand increases owing to the possible fall in value of the domestic currency; on the other hand, fluctuations in the external value render the zloty more attractive. Even if a depreciation of the domestic currency is expected, the demand for it need not necessarily fall to zero. This depends crucially on the co-movement of cr_{t+1} with a_t and π_t , i.e. the above-mentioned covariance terms (cov). The conditions $\text{cov}(cr_{t+1}, a_t) > 0$, $\text{cov}(cr_{t+1}, \pi_t) < 0$ and

²⁰The ambiguous covariance terms are disregarded. They are represented by the dots in (14) and (15).

$cov(a_t, \pi_t) > 0$ are conducive to a positive demand for zlotys. In the event of a negative supply shock which lowers cr and increases π and a , the last two conditions are met, and in the event of a positive demand shock which increases cr , π and a , the first and the third conditions are met. Such (exogenous) disruptions could and can be observed, particularly in eastern Europe, with varied timing.

This model can be used to trace the demand for currency for transactions, precautionary and store-of-value purposes in market-oriented but unstable countries. Political risks are included only in the sense that they have repercussions on the determinants of the demand for currency considered here (they are taken into consideration explicitly in Ortiz, 1983). Similar demand functions, expressed in terms of ratios (cu^i/cu^a) - in a less ambitious theoretical framework, but including deposits and bonds, and taking specific account of eastern Europe - can be found in Brand (1993), chapter VI,3. The demand functions may display hysteresis or irreversibility effects, i.e. once a second currency such as the Deutsche Mark has established itself, this process reverses only very slowly, even if the factors which have caused it have ceased to apply (Guidotti/Rodriguez, 1992, Brand, 1993, chapter VI, Kamin/Ericsson, 1993). These effects could be captured with different speeds of adjustment upon the raising or lowering of a_t or π_t .

V. Methods of capturing currency in circulation abroad

*"There are some men live in darkness
While the rest have light for free
You can spot those in the limelight
those in darkness you don't see."*

(Bertholt Brecht, Dreigroschenoper)

The following conclusions can be drawn from the analysis so far:

- ◆ There are some inconsistencies in the temporal trend of currency in circulation which could be largely explained by substantial holdings abroad.
- ◆ The estimation of currency demand functions provides evidence of a significant external impact on Deutsche Mark currency in circulation.
- ◆ In certain circumstances it is rational for potential foreign users to substitute their domestic currency for Deutsche Mark.

It is not yet possible, however, to give concrete figures on the amount of Deutsche Mark held by foreign non-banks. Various quantification approaches are to be examined below.²¹

1 Direct methods

1.1 Survey results

It is theoretically possible to obtain information on the currency in circulation abroad through surveys made in Germany and foreign countries.

For example, households and enterprises in countries with supposedly large stocks of Deutsche Mark could be asked about their holdings of that currency. As far as I know, this has not been tried so far. This same method could also be used in an analogous manner at home. In that case, residents' holdings of Deutsche Mark for transactions and hoarding purposes would be the focus of attention. This information would then yield the level of holdings abroad as a residual (total currency in circulation less the amount held by domestic non-banks). The surveys carried out by the Dutch central bank (Boeschoten, 1992, chapters 2 and 3, Boeschoten/Fase, 1992) and by the Federal Reserve (Avery et al., 1986, 1987) may be interpreted in this way. Both come to the conclusion that households require or hold only about 10% of the total currency in circulation for the sake of transactions.

Apart from the costs and specific individual problems, there are a number of fundamental objections to surveys of this kind:

- ◆ The results very much depend on the phrasing of the questions.
- ◆ Identifying a representative sample is probably difficult.
- ◆ The surveys would have to be repeated at regular intervals so that different periods could be compared.
- ◆ The willingness to answer questions on cash truthfully is not likely to be very great, since it is precisely for reasons of anonymity and individuality that currency is held.
- ◆ The "missing money" traced by studies of this kind need not necessarily be abroad.

²¹From the point of view of the object under investigation, the optimum solution would be to recall all banknotes at a particular juncture or to have comprehensive statistics on the life-cycle of banknotes, as described, for example, in Feige (1994).

Consequently, this method of ascertaining the amount of currency held abroad has to be rejected.

1.2 Analysis of the statistically recorded outflows and return flows of notes

If all cash transactions with non-residents were settled through official channels, in particular the banking system, it would be possible, in principle, to obtain a reliable record of the currency held abroad by means of the statistics on net outflows of banknotes. Simple addition of the flows from a given starting point would yield the appropriate stocks. Statistics on such officially recorded transactions constitute the basis, for example, of the item "Deutsche Mark notes abroad", which is part of the external asset position drawn up by the Deutsche Bundesbank, and for the purposes of the balance of payments statistics.²² In the case of Germany, it would be ideal if these records were available since the introduction of the Deutsche Mark in 1948, as it would be possible to start from (plausible) initial holdings of zero. An increase in the holdings of Deutsche Mark abroad would then be reflected in outflows of notes abroad over and above the corresponding returns. These data may then be used as the basis of more detailed econometric analyses (see, e.g., Gross (1989) for Switzerland, Kamin/Ericsson (1993) and Feige (1993) for the United States).

The transactions on which these flows are based can be seen from table 5, which shows the transactions in Deutsche Mark notes with non-residents statistically recorded by the Bundesbank. Most of the data for these statistics, too, have to be estimated.

I shall deal first with the outflows of Deutsche Mark notes. By virtue of an agreement with some European central banks, the Deutsche Bundesbank receives information on purchases of Deutsche Mark notes by foreign commercial banks which are probably associated with foreign travel. Denmark, Norway, Sweden, France, the Netherlands, Austria, Portugal and Spain are currently participating in this reporting procedure. The Deutsche Mark carried by commuters are estimated with the help of data from the Federal Labour Office on the number of commuters working in Germany, although these data do not include seasonal and loan workers. Data on notes taken abroad as a result of border merchandise transactions are available only from the Dutch central bank and from Denmark. The estimate of currency carried by foreign workers is based on a survey of foreign workers carried out annually by the Marplan Institute on behalf of the Bundesbank. Transfers of capital in the form of cash are estimated on the basis of the DM 500 and DM 1,000 notes

²²As far as I know, the United Kingdom is the only country other than Germany which includes currency transactions with non-residents in the balance of payments.

returned from Austria, Switzerland and Luxemburg.²³ Finally, outgoing consignments of notes by domestic banks are recorded through the banks' reports on their external position.

Table 5: Statistically recorded cross-border flows of DM banknotes

DM million

Year	Outflows of DM notes abroad					Inflows of DM notes from abroad				Net outflows (+) and inflows (-) of DM notes	
	Foreign travel, commuters, etc.	Purchases of goods ¹⁾	Remittances from foreign workers ²⁾	Financial transactions ³⁾	Consignments of DM notes by domestic banks to other countries	Outflows of DM notes, total	Notes carried by travellers	DM notes returned to domestic banks from abroad	Inflows of DM notes, total	Net outflows (+) and inflows (-) of DM notes	
										in the period	cumulative value
1958	900	0	0	.	50	950	400	500	900	+ 50	50
1959	1 050	0	0	.	100	1 150	400	650	1 050	+ 100	150
1960	1 250	0	0	.	50	1 300	400	850	1 250	+ 50	200
1961	1 700	0	50	.	50	1 800	500	1 200	1 700	+ 100	300
1962	2 100	0	100	.	50	2 250	500	1 800	2 300	- 50	250
1963	2 150	0	200	.	100	2 450	600	1 750	2 350	+ 100	350
1964	2 500	0	300	.	100	2 900	500	1 900	2 400	+ 500	850
1965	2 900	0	450	.	100	3 450	800	2 300	3 100	+ 350	1 200
1966	3 250	0	550	.	100	3 900	900	2 850	3 750	+ 150	1 350
1967	3 400	0	600	.	150	4 150	1 000	2 500	3 500	+ 650	2 000
1968	3 550	0	550	.	250	4 350	1 150	2 550	3 700	+ 650	2 650
1969	4 200	0	800	.	200	5 200	1 300	3 200	4 500	+ 700	3 350
1970	5 200	0	1 400	.	150	6 750	1 550	4 850	6 400	+ 350	3 700
1971	7 050	0	2 100	.	150	9 300	2 000	7 200	9 200	+ 100	3 800
1972	8 350	0	2 300	.	150	10 800	2 300	8 150	10 450	+ 350	4 150
1973	9 450	0	2 400	.	500	12 350	2 750	9 850	12 600	- 250	3 900
1974	9 250	0	2 400	.	200	11 850	2 600	10 900	13 500	- 1 650	2 250
1975	10 400	100	2 550	.	200	13 250	2 700	10 400	13 100	+ 150	2 400
1976	10 550	250	2 800	.	300	13 900	3 300	9 650	12 950	+ 950	3 350
1977	12 500	250	2 600	50	300	15 700	3 650	10 550	14 200	+ 1 500	4 850
1978	13 600	300	2 600	250	300	17 050	3 800	11 050	14 850	+ 2 200	7 050
1979	14 900	450	2 200	700	350	18 600	4 050	13 350	17 400	+ 1 200	8 250
1980	15 600	350	2 900	1 050	550	20 450	4 450	15 200	19 650	+ 800	9 050
1981	15 300	550	3 400	1 100	300	20 650	4 400	17 200	21 600	- 950	8 100
1982	15 500	950	3 200	750	350	20 750	4 600	17 200	21 800	- 1 050	7 050
1983	15 350	950	3 000	750	200	20 250	4 800	16 400	21 200	- 950	6 100
1984	15 700	1 000	4 950	750	200	22 600	5 100	17 350	22 450	+ 150	6 250
1985	16 400	1 000	3 450	950	250	22 050	5 600	16 450	22 050	+ 0	6 250
1986	16 800	1 000	2 800	1 800	250	22 650	6 000	15 950	21 950	+ 700	6 950
1987	17 400	1 000	2 470	1 800	450	23 120	6 350	15 500	21 850	+ 1 270	8 220
1988	18 050	1 200	2 500	2 800	350	24 900	6 900	17 400	24 300	+ 600	8 820
1989	18 150	1 100	2 500	2 700	900	25 350	7 500	18 250	25 750	- 400	8 420
1990	20 400	1 050	2 600	3 150	2 500	29 700	8 050	19 600	27 650	+ 2 050	10 470
1991	22 250	1 600	2 500	4 000	1 600	31 950	9 350	22 250	31 600	+ 350	10 820
1992	24 130	2 030	2 400	13 600	1 030	43 190	9 650	33 210	42 860	+ 330	11 150
1993	25 670	2 370	2 600	8 540	1 130	40 310	10 060	29 460	39 520	+ 790	11 940
1994	25 460	2 380	2 600	5 540	3 570	39 550	9 880	29 040	38 920	+ 630	12 570

1) Primarily purchases by Germans in the Dutch border area, data on which are provided by the Dutch central bank.

2) Estimate based on the annual survey by Marplan.

3) Estimate based on information taken from the Swiss and Belgian-Luxemburg banking statistics.

The breakdown of the Deutsche Mark notes returned are given in columns 8 and 9 of table 5. The estimated volume of notes returned as a result of foreign travel is based, in turn, on data from various central banks on sales of Deutsche Mark notes to travellers by foreign

²³These countries are known to be traditional destinations for capital flight. They account for most of the statistically recorded return flows of Deutsche Mark to Germany (over 60% in the past few years) although only marginal amounts are sent there. These return flows include sums which, for example, other countries (possibly for reasons of cost) send back to Germany via Switzerland.

banks. The only other item mentioned is banks' reports on the notes returned by foreign banks.

The change in the stock of Deutsche Mark notes abroad is obtained by subtracting the return flows from the outflows.²⁴ Since the middle of the eighties a certain correlation has been found between these flows and changes in the currency in circulation (see fig. 17). However, the results are reliable only to the extent that the magnitude of the various subsections is adequately recorded. This is most likely to be the case where the amounts concerned pass through the domestic banking system. But even then it is unclear in most cases who has held the Deutsche Mark notes and through which channels they have been returned to German banks. Where the latter are not involved, that is to say, where the notes reach foreign non-banks or foreign banking systems in other ways, it is likely that substantial distortions will arise. Consequently, as a result of these unrecorded channels, an enormous error potential may have accumulated during the period of almost five decades since the Deutsche Mark was introduced.

By aggregating the net outflows since the end of the fifties, one would arrive at net foreign holdings of Deutsche Mark totalling just over DM 12 billion at the end of 1994, which is no more than approximately 5.5% of the total currency in circulation. Another conspicuous factor here is that since 1991 there have been only slight changes in net outflows. Surprisingly, if only the countries of central and eastern Europe were considered, nothing other than net inflows would have been recorded since 1987 (see table 6).²⁵ Therefore there must also still be a part that has not been captured.

In addition to the criticisms already mentioned either implicitly or explicitly, such a set of statistics is probably also problematical as a basis for estimating the currency in circulation abroad because it includes absolutely none of the Deutsche Mark notes taken abroad (at least initially) in connection with illegal business (such as drug-trafficking). The fluctuations in the circulation of Deutsche Mark abroad no doubt largely stem from those sectors which cannot be exactly documented statistically. However, the statistics may show underlying trends in the total amounts flowing abroad as long as the unrecorded part is always more or less in proportion to the rest. Besides, they have the advantage that the amounts

²⁴Judson/Porter (1994) suggest possible ways of calculating the link between (estimated) holdings abroad and return flows to Germany in Appendix B.

²⁵This may owe something to the better opportunities for money laundering in Germany as a result of German reunification. According to internal information from the Fed, the figures on "official shipments" of dollar banknotes to eastern Europe are also implausible. For example, no US dollars were sent "officially" to Russia until 1993.

they show are to a large extent actually held abroad. In certain situations they are therefore useful as an additional indicator of the cash held abroad but they should not be used as the principal means of deriving this.²⁶ Under no circumstances do they represent the full significance and extent of the foreign stock of Deutsche Mark.

Table 6: Consignments of DM notes to and from central and eastern Europe¹⁾

DM million

	Outward consignments (1)	Return consignments (2)	Net outflows (1)-(2)
1987	5	715.1	-710.1
1988	73.6	611.8	-538.2
1989	209.1	405.1	-196.0
1990	26.5	509.5	-483.0
1991	100.9	429.7	-328.8
1992	10.4	1,169.7	-1,159.3
1993	25.2	1,629.5	-1,604.3
1994 ²⁾	21.7	670.9	-649.2
1987-1994	472.4	6,141.3	-5,668.9

1) Albania, Poland, Hungary, (countries of the former) Soviet Union, Romania, Bulgaria, the former Czechoslovakia or the Czech Republic and Slovakia.

2) January to August.

Generally speaking, the conclusion of Judson/Porter (1994, p. 2 f.) in the case of the US dollar has to be underlined with respect to the direct methods of recording Deutsche Mark holdings abroad: "Indeed, in the light of the portability and concealability of currency, it is difficult to imagine a practical statistical system that could accurately and directly measure these aggregate flows."

2 Indirect approaches

Since the chances of directly recording the volume of Deutsche Mark circulating abroad are not very promising, the only alternative is to approach the task indirectly. Essentially, these methods consist of finding variables which are affected by the demand for Deutsche Mark abroad, so that conclusions can be drawn regarding the circulation of Deutsche Mark or of using a priori information on the internal and external use. Where international comparisons are made (as in sections 2.2.2, 2.4.3 and 2.5), they refer only to those countries whose

²⁶If only one side of the associated transactions which are relevant to the balance of payments is systematically recorded, this really ought to be reflected in the balance of statistically unclassifiable transactions. The correlation coefficient between this balance and the changes in currency in circulation is 0.32 for the period between 1948 and 1994, and rises to 0.37 for the shorter period between 1980 and 1994. Hence virtually no conclusions regarding cash holdings abroad can be drawn from this.

payment systems, and particularly the proportion of cashless payments, are not very different from one another and have gradually converged over time (see BIS, 1993).

2.1 Foreign currency deposits as an indicator

As data on the circulation of cash in foreign currencies generally do not exist, one could try to deduce foreign cash holdings of Deutsche Mark from information on foreign currency deposits in countries in which the Deutsche Mark is presumably in use. I would like to concentrate here on countries of the former eastern bloc.²⁷ Since foreign currency deposits in these countries were either prohibited or extremely limited prior to 1989, developments from the end of the eighties could provide some idea of the use of foreign currency (Deutsche Mark, US dollars). Moreover, cash in foreign currency is usually required in these countries in order to create the relevant deposits. Owing to lack of data, only Romania is analysed here.

It can be seen from table 7 that foreign currency deposits were virtually negligible in Romania up to and including 1989. It was not until the beginning of the nineties and the liberalisation of the financial system that they shot up and, from the end of 1993, actually exceeded the volume of lei in circulation. It may be assumed from this, and from the formation of certain ratios (e.g. currency to deposits in national and foreign currency), that there is a pronounced parallel currency circulation in Romania.

There are several reasons why an analysis of this kind is open to criticism:

- As long as there is no a priori information on which foreign currency is circulating in the form of cash, no distinction can be made between the various currencies (US dollars, Deutsche Mark). In principle, this is a problem in all countries in which the Deutsche Mark is potentially circulating (Brand, 1993, chapter IV). There is usually no information either on the currency composition of the foreign currency deposits in the countries where it is assumed that a parallel currency is in circulation. It is only from the foreign branches and subsidiaries of German credit institutions in the Czech Republic that we know that almost 100% of the foreign currency deposits there are denominated in Deutsche Mark.

²⁷The "proxy" of foreign currency deposits is also used frequently in econometric analyses to capture the existence of currency substitution in unstable and less developed countries. See, for example, Chopra (1994), El-Erian (1988), Mueller (1994) and Ortiz (1983). Wingender (1989), p. 85 ff., provides an overview of the use of western currencies in eastern Europe before it was opened up to the west.

Table 7: Foreign currency deposits and currency in circulation in Romania

Lei billion, end-of-year figures

Year	Foreign currency deposits	Currency in circulation
1973	0.2	17.6
1974	0.2	18.2
1975	0.2	21.1
1976	1.0	23.6
1977	1.4	27.0
1978	1.1	28.2
1979	2.1	34.1
1980	2.3	39.3
1981	3.0	41.3
1982	3.6	44.7
1983	2.7	44.9
1984	3.2	49.1
1985	3.7	54.8
1986	4.1	60.0
1987	5.4	60.6
1988	4.5	65.0
1989	3.9	74.7
1990	15.1	92.4
1991	40.4	176.5
1992	281.3	411.7
1993	1,324.6	1,048.1
1994	2,358.1	2,200.6

Source: IMF, International Financial Statistics.

- There is no reason to assume that there is a fixed ratio of foreign cash to foreign currency deposits. Cash is often held precisely because the banking system is not trusted. Foreign currency is frequently in use even when maintaining foreign currency deposits is prohibited (Melvin/de la Parra, 1989). Total foreign currency holdings (deposits and cash) may actually increase in these circumstances (Mueller, 1994, p. 12). Foreign currency deposits and cash holdings may also move in opposite directions, for example, in the event of successful stabilisation programmes (see Kamin/Ericsson (1993) for the case of Argentina).
- Preliminary information on how cash holdings in foreign currency and foreign currency deposits interact is available for only a few countries (Mueller, 1994, p. 5).
- No distinction is made between the motives for holding cash and for maintaining deposits.
- A survey of many countries would have to be undertaken over a fairly long period to establish the total holdings of Deutsche Mark abroad.

Accordingly, data on trends in foreign currency deposits should likewise be used only as supplementary information, at the most.

2.2 Comparison of seasonal factors

2.2.1 The model

The basic idea behind the analysis with seasonals is that foreign demand affects the seasonal pattern of the total amount of Deutsche Mark currency in circulation. It derives from a study by Sumner (1990), although he was concerned with the domestic hoarding of US dollars, and was applied to the problems associated with holdings abroad by Richard Porter of the Federal Reserve System (Porter, 1993, 1994, Judson/Porter, 1994). It is assumed in this specific case that the circulation of Deutsche Mark abroad has a dampening effect on the seasonality of total currency in circulation, and that the latter runs more moderately. If Deutsche Mark are used for transactions and hoarding purposes abroad, this probably has little to do with seasonal movements in Germany. Although cash transactions made abroad in the context of foreign travel have a countervailing impact here, their significance will probably have diminished considerably with time because the number of cash transactions abroad are becoming ever-smaller. And in a comparative analysis these transactions distort the results only in the event of a systematic deviation from the selected reference point. In addition, the amounts concerned are returned fairly quickly to Germany via banknote consignments of foreign banks in the traditional holiday areas. However, it is especially characteristic that in the case of the (longer-term) holdings of Deutsche Mark abroad (for instance in regions with fairly unstable conditions and currencies and for hoarding purposes of German residents) the relevant amounts are not returned (quickly).²⁸

The concrete specification is as follows:

A multiplicative seasonal adjustment process is assumed for the currency in circulation, where the total currency in circulation (CU_t) is composed of the product of a trend component (T_t) and a seasonal component (S_t) (t denotes a particular month or quarter in a year). Part of the currency is in circulation at home (indicated by "i"), and the rest abroad (indicated by "a").²⁹

²⁸In the first case either they do not enter the banking system of the countries concerned, or the cost of seasonal returns is too high for the banks.

²⁹It is assumed that calendar effects and the irregular components are either included in T or correspond to those of the selected reference variable. Alternatively, the components of CU_t could be specified as random walks. In the case of the United States, the basic results remained virtually unaffected by this modification.

$$(16) \quad CU_t = T_t S_t = T_t^i S_t^i + T_t^a S_t^a$$

If β_t represents the share in the entire trend that is held at home ($\beta_t \equiv T_t^i / T_t$) and, accordingly, $(1-\beta_t)$ the part which is circulating abroad ($1-\beta_t \equiv T_t^a / T_t$), this yields the following equation:

$$(17) \quad S_t = \beta_t S_t^i + (1 - \beta_t) S_t^a$$

If it is assumed that the foreign seasonal component does not fluctuate, that is to say, $S_t^a \equiv 1$ or $100 \forall t$, equation (17) can be solved for β_t .

$$(18) \quad \beta_t = \frac{S_t - 1}{S_t^i - 1}$$

It is then easy to calculate the part of the currency in circulation which is abroad $(1-\beta_t)$. The reasons why the Deutsche Mark are circulating abroad are irrelevant for deriving this formula.

S_t represents the seasonal component of the total Deutsche Mark currency in circulation (exception: section 2.2.3) and is either known or can be calculated fairly easily by the usual seasonal adjustment methods. On the other hand, S_t^i , the seasonal for the Deutsche Mark currency in circulation in Germany, is unknown. Various figures will be used for this variable in the following sections. Sumner (1990) suggests the seasonal component of small-denomination notes for this. As small-denomination Deutsche Mark notes are probably also circulating abroad for the purposes of transactions, however, this approach is not very suitable in the case of the Deutsche Mark.

The foreign holdings, however, cannot be calculated directly from equation (18). It was assumed when deriving that equation that, without the foreign component, the relative seasonal patterns will be the same in every month. However, that is unrealistic, and in some cases would also yield rather meaningless results for β_t . If, for example, $S_t^i = 1$, then β_t approaches infinity. Even if $\beta_t \neq 1$, (18) may yield misleading results if S_t is not consistently below S_t^i . This situation may occur inevitably, however, because the seasonal figures do not run exactly parallel in the course of a year.

To solve these problems, it is possible to exploit the fact that seasonal highs and lows are usually reached in the same periods of a year. In the case of currency in circulation, for

example, the maximum is normally reached at the end of the year. To estimate the seasonal fluctuation, one could take the difference between the maxima and the minima and calculate β from that. To be able to apply this to individual months, in other words, to derive β_t , the following moving average is devised:

$$(19) \quad \beta_t = \frac{\max_{s \in I2} S_s - \min_{s \in I2} S_s}{\max_{s \in I2} S_s^i - \min_{s \in I2} S_s^i}$$

where $s \in I2$ represents the months within a twelve-month span.³⁰ For this calculation we look six months ahead and five months back and calculate for each month the maximum and the minimum of the values observed in this interval for Germany and the reference case and then take the ratio.

Before this approach can be used empirically for Germany, attention should be drawn to a few inherent sources of error:

- ♦ The seasonal model stands and falls by the premise that the chosen proxy for the domestic component of currency in circulation is a sufficiently close approximation to currency demand in Germany.
- ♦ If significant amounts of currency are hoarded at home, this likewise has a dampening effect on the seasonal. As a result, the amount of Deutsche Mark circulating abroad is overestimated. It may be assumed, however, that the proportion which is permanently hoarded in cash at home has tended to fall over time (see also chapter VI). After all, there seems to be no clear evidence that it has anything to do with illegal activities (Boeschoten, 1992, p. 119 ff., Anderson, 1977). Furthermore, the difference between internal hoarding and circulation abroad is irrelevant to monetary policy because in each case the amounts in question are no longer available to finance domestic transactions. However, we encounter this lack of power with other approaches too.
- ♦ It is quite possible that a fairly large part of the foreign component is of a seasonal nature. For example, the (statistically recorded) return flows of Deutsche Mark notes from abroad - at least, those from western industrial countries and holiday areas - show

³⁰Alternatively, the formula

$$\beta_t = \sqrt{\sum_{s \in I2} S_s} / \sqrt{\sum_{s \in I2} S_s^i}$$

could be used. It has emerged that, in the case of the United States, this does not change the underlying results.

a seasonal pattern. Seasonal foreign workers who take Deutsche Mark home with them should also be mentioned here.

It is likely that, in the case of Germany, the first point is of particular relevance.

2.2.2 Country-specific comparison

It was Richard Porter of the Federal Reserve System (Porter, 1993, 1994, Judson/Porter, 1994) who devised the method of determining the proportion of currency circulating abroad from the relative seasonal patterns in the total currency in circulation and in a country of comparison.³¹ He found that, at the current margin, 60% to 70% of US dollars are held abroad, notably in South America and eastern Europe, and that larger-denomination banknotes predominate. Other studies using alternative methods have more or less confirmed this order of magnitude (Sprenkle, 1993, Porter, 1994).

In this approach S_i^j is represented by the seasonal of the currency in circulation in a reference country. Canada is a good choice in the case of the United States. For Germany, however, the choice of such a country poses problems. It should represent the situation in Germany in the event of no foreign demand for Deutsche Mark. Accordingly, the seasonal of the reference country would ideally correspond to that in Germany without the foreign component. That means, in the first instance, that the currency of the country concerned should be in little demand abroad, or in no demand at all. Furthermore, in order to compare the various denominations, its banknotes should have similar face values, and the various denominations should also be potentially comparable after exchange rate effects have been eliminated. Only then is it possible to make detailed and informative direct comparisons of the various denominations in the two currencies concerned. Excluding the DM 200 note, which was first issued in October 1990 and must therefore be left out of the analysis, there are seven different denominations circulating in Germany. In this respect the Netherlands is a good choice as a reference country in Europe. The range of its denominations is similar, and the denominations are also comparable in terms of their face values. Moreover, the proportion of notes circulating abroad is estimated to be only about 1% of the total volume of currency in circulation (Boeschoten, 1992, p. 66).³² Unfortunately, however, the Netherlands has an internal hoarding problem, particularly with respect to Hfl 1,000, Hfl 250 and Hfl 100 notes (Boeschoten, 1992, chapter 4). This likewise has a dampening effect

³¹Melvin/Ladman (1991) investigated seasonal fluctuations in connection with illegal activities and their impact on the "dollarisation" process through the informal credit market.

³²For this reason Switzerland, which likewise has seven different denominations, is unsuitable for comparison purposes.

on the seasonality of the currency in circulation. It is actually more moderate than in Germany, both overall and with respect to the large-denomination notes, with the result that the methodology with seasonal factors can in principle only be applied to small denominations. However, we can take Austria as a second-best solution. In terms of the payment habits and mentality of its people, Austria is certainly just as comparable with Germany, if not even more so. Foreign demand for Austrian schillings is probably also negligible. On the other hand, the range of denominations is smaller than in the case of the Deutsche Mark (S 20, S 50, S 100, S 500 and S 1,000 notes)³³ and, with a rate of exchange of 1:7, not all the denominations are compatible either, and uncertainties occur. It must also be remembered that in summer and winter our southern neighbour has a highly developed tourist, and thus seasonal, trade. Despite these reservations, Austria will be used as a reference country below for those cases which are not covered by the Netherlands. This means that S_t^i is known and that β_t or $1-\beta_t$ can be calculated.

In order that the Austrian or Dutch seasonal can indicate which seasonal pattern would have been "normal" for currency in circulation in Germany in the absence of foreign demand for Deutsche Mark, it is necessary first to compare the determinants of the demand for currency and their seasonality in Germany with those in the reference country. With similar seasonals for these determinants, the seasonality of the currency in circulation should also show a similar pattern if the foreign demand for Deutsche Mark is disregarded. Normally, a money market rate is used as an opportunity cost variable of cash holdings, and private consumption or retail turnover is used as a scale variable. As interest rates have no seasonality, one can concentrate on comparing transactions variables (see also Becker, 1975, p. 63 f., Cagan, 1958, p. 306 f., Galli, 1980, p. 3, Kimball, 1981, p. 44 f.).

A comparison of the relevant quarterly seasonal factors of private consumption is given in figs. 18 and 19. Even if differences are discernible in the details, the general pattern - up to a scale factor or level effect - is fairly similar.³⁴ This statement applies in particular to the comparison of Germany and Austria, especially during the eighties. The seasonal components in both of these countries are declining over time. However, the seasonal effects apparent in Germany are not consistently less pronounced than in the two reference countries. Given - relatively speaking - similar seasonal figures and assuming similarities in the scale elasticities of currency demand, the seasonal demands for currency ought to be pretty much the same. From that point of view, there is no reason why the methodology with seasonal factors cannot be applied. In other words, as the seasonal factors of the

³³S 5,000 notes did not exist until October 1989.

³⁴The same applies to Belgium and France, which are therefore also potential candidates for comparison.

determinants of the demand for currency in Germany and in the countries of comparison are broadly the same, the difference in the seasonal component of the Deutsche Mark in circulation and of the reference currency should be reflected in the foreign demand for Deutsche Mark if the other premises of the seasonal approach apply.

In figs. 20 - 26 the **monthly** seasonal factors of the circulation of Deutsche Mark as a whole, and by denomination, are compared with the corresponding figures for Dutch guilders and Austrian schillings. As already mentioned, a comparison was made with Austria (with the S 1,000 note) with respect to the total currency in circulation and the DM 1,000, DM 500 and DM 100 notes, and with the Netherlands in the case of the remaining denominations. As both a DM 5 coin and DM 5 banknote exist and as distortions therefore arise as a result of substitution effects, the DM 5 note is not included in the analysis. Owing to restrictions in the availability of the data, the analysis begins in 1970 and ends in 1994. The same seasonal adjustment technique was used in each case, namely the Deutsche Bundesbank's own modified version of the Census Method developed by the US Bureau of Census.³⁵ In the patterns shown, the absolute deviations from 100 are to be interpreted as seasonal fluctuations.

Generally speaking, the graphs for the Deutsche Mark show a more compact pattern for the monthly seasonal factors. The fluctuations over the entire time-horizon are less pronounced in the case of the Deutsche Mark.³⁶ They reflect only in part the seasonal pattern of the transactions variables, but nevertheless more markedly than in the case of the United States. In principle, the seasonal peak occurs at the end of the year (November and December) and the trough at the beginning (January and February). In the case of the Deutsche Mark, the seasonal swings within a given year do not increase or decrease as consistently as in the case of the Dutch guilder or Austrian schilling. This is probably why the holdings of Deutsche Mark notes abroad do not point clearly in any one direction either. They may vary in trend according to the denomination concerned, and even within a given denomination amounts will tend not to rise or fall monotonically.³⁷ It is also possible to infer from these observations that the seasonal transactions elasticities differ for the various banknote components.

³⁵This method is described in Deutsche Bundesbank (1987). It has emerged in the case of the United States that the results are not sensitive with respect to the seasonal adjustment method. A uniform procedure only should be used in both cases.

³⁶December is an exception in a few cases; but even then at least the seasonality overall in Germany runs at rather a lower level. The DM 1,000 notes do not consistently fit into the general picture, either. That could indicate domestic hoarding of that note.

Figs. 27 and 28 show the unsmoothed and smoothed percentages of the various notes abroad, as calculated by equation (19). Owing to the course of the maximum and minimum values of the numerator and the denominator when additional months are added, smoothing is essential. Contrary to a widely-held belief, the proportion of Deutsche Mark notes abroad, according to this analysis, has been falling consistently since the beginning or the middle of the eighties.³⁸ This applies equally to the small denominations, which are rarely hoarded at home. This result is consistent with the data on the net return flows of notes from eastern Europe (see item V, 1.2). Previously the percentage of foreign holdings had increased; by the end of 1994 it had fallen to amounts between 30% and 40% of the currency in circulation. The actual amounts involved were somewhere between DM 65 billion and DM 85 billion.³⁹

Developments over the past few years are not altogether in line with expectations. This is perhaps due to the fact that the hoarding of notes within Germany is also included in this approach.⁴⁰ To test for this possibility, by means of a simple econometric model, the proportion of currency held abroad between 1973 and 1994, calculated using equation (19) for the total amount of notes in circulation, was regressed on the money market rate, retail turnover and the Deutsche Mark-US dollar exchange rate using monthly observations.⁴¹ The final variable was again included to capture the foreign influence. It enters the equation with a significantly negative coefficient (t-value: 2.8). The foreign part increases when the Deutsche Mark appreciates. The long-term transactions elasticity is about 1.2. This reflects the falling trend in the velocity of circulation and could be associated with domestic hoarding or the asset character of currency, but also with foreign demand. If the estimation period is reduced to the time-span between 1980 and 1994, the significance of the exchange rate term is completely lost (t-value: 1.2). This result could be interpreted to mean that since the eighties the decline in $(1-\beta_1)$ has been primarily due to the decrease in domestic hoarding. Conversely, however, it then logically has to be concluded that foreign holdings have not necessarily diminished. The increase in the transactions elasticity to 1.4

³⁷This is in contrast to the results for the US dollar, which clearly indicate an increase in the proportion held abroad from the seventies onwards.

³⁸This is also true when comparisons are made with Belgium or France. The current proportions are also within the bounds of the values reached so far (see fig. 29).

³⁹When the individual denominations are added, smaller amounts result. Owing to the inaccuracies in the present comparison, however, it is better to use the total amount of notes or currency in circulation.

⁴⁰Under an approach which is based on the life of banknotes (see also section 2.5), Boeschoten (1992), p. 169, also refers to the problems which arise in the case of the Deutsche Mark both from domestic hoarding and from holdings abroad.

⁴¹This constitutes a Goldfeld estimate in differences adapted to take account of first-order autocorrelation of the residuals.

could also be interpreted in this way. The temporal patterns should at least be interpreted with caution.

2.2.3 The seasonal of the transactions variable

Domestic demand for currency is probably adequately described by a transactions and an interest rate variable. As it is only the transactions variable that exhibits seasonality, this ought to be reflected in the currency in circulation. One could therefore try to represent S_t^i by the seasonal of private consumption.⁴²

However, this poses problems, as the seasonal fluctuations in private consumption (or in other transactions variables such as retail turnover, the national product or domestic absorption) are so pronounced by comparison with those of currency in circulation (see fig. 30) that the foreign element calculated using equation (19) would yield quite implausible values (for example, over 99% at the end of 1994). However, since not only currency but also sight deposits are relevant to transactions at home, one could apply the methodology of seasonal factors to M1. This monetary aggregate shows seasonal fluctuations which are more pronounced than those of currency in circulation. In keeping with the model, one would then argue that the seasonality of M1 is weakened by the currency tied up abroad, as a result of which the seasonal factor of M1 differs from that of the transactions variable. Accordingly, S_t would be the seasonal factor for M1, and S_t^i the seasonal for private consumption.

Fig. 31 shows the currency holdings abroad calculated in this way since 1970. A falling trend - interrupted between the late seventies and the early eighties - is discernible. This finding again contradicts the economic hunch that a rise in foreign demand is more likely over time. At the end of 1994, figures similar in size to those of the last chapter emerge: just under 35% of the total amount of currency in circulation is to be found abroad. From 1990 to 1991 (opening-up of eastern Europe) this proportion rose for a short time, but then declined steadily again.

⁴²To calculate (19), we now look two quarters ahead and one quarter back.

The analysis with seasonal factors is an elegant way of indirectly estimating the currency in circulation abroad.⁴³ However, the informative value of the results is impaired by the necessary assumptions and makeshift solutions.

2.3 Analysis of data on German unification

Between June and August 1990 the amount of currency in circulation in Germany rose by just under DM 10 billion (see fig. 32). If this rise is ascribed to eastern Germany alone and if the population at that time is taken to have been approximately 16 million, there was a per capita currency provision of DM 625.⁴⁴ This amount was probably used exclusively for transactions. After adjustment, using the "gap" of 50% in real per capita consumption, to take account of the difference in living standards between western and eastern Germany, there is a notional transactions amount of approximately DM 1,235. Assuming that domestic currency hoardings are only of minor importance, and after taking account of the average rate of inflation, a sum of just under DM 1,700 is calculated for the end of 1994. This represents a per capita "currency gap" of about DM 1,100. In absolute terms, the amount of currency held abroad thus amounts to just over DM 70 billion (about 35% of the total currency in circulation). This figure more or less confirms the findings hitherto. But here, too, the amounts would be distorted upwards if domestic hoardings existed to any appreciable extent.

2.4 Approaches in the context of an econometric estimate of currency demand

2.4.1 Search for the "best fit" of domestic demand for money

In economic theory there is relatively little controversy about what the domestic demand for money depends on: a transactions variable and an opportunity cost variable. This information could be used in an attempt to extract the part of a specific monetary aggregate which remains at home. To keep the problem of hoarding as small as possible, reference will be made in the following to the money stock components sight deposits (sd) and currency (cu), which are relevant mainly for transactions purposes. It is assumed that part

⁴³Another possibility would be to use the seasonality of a reference period, when the foreign demand for Deutsche Mark was known to be negligible. The fifties, for example, would be suitable for this. The trend at that time of the monthly seasonal factors is then extended up to the margin and the resulting time series inserted for S_t^i . As a result of this trend approximation, however, the seasonal factor is fairly smooth. Furthermore, choosing a "foreign-free" estimation period poses problems if the Deutsche Mark was used abroad relatively soon after its introduction in 1948. Consequently, a simple application of this method does not yield any useful results (negative foreign component or values approximating to 90%).

⁴⁴It is assumed here that the holdings of Deutsche Mark in the former GDR were negligible.

of the currency is held abroad, and an attempt is made to identify the best statistical fit of the approach adopted.

The money demand function to be estimated is again specified in real terms. Private consumption (cr) acts as the transactions variable. In contrast to chapter III, opportunity costs, for technical reasons, are not included in a relative form as a nominal interest rate, but in absolute form. This means an explicit decomposition is made into the inflation rate (π), as measured by the cost-of-living index, and an (expected) real interest rate (ir). To calculate this expected variable, the expected rate of price rise, captured via the actual movement in the following period, is subtracted from the three-month interest rate.⁴⁵ All the variables, except for the interest rate and the inflation rate, are in logarithms. To eliminate random fluctuations and their disruptive potential, annual data are used (see Laidler (1993), pp. 118-120), with the result that no sub-samples can be examined in an estimation period which extends from 1970 to 1994 only.

In Germany, sight deposits are defined in such a way that they must be held by domestic non-banks in the German banking system. In the case of currency in circulation, on the other hand, it is not known how much is held in Germany and how much abroad. To determine the domestic component, the following money demand function is estimated (p is the deflator of private consumption):⁴⁶

$$(20) \quad \frac{sd_t + \theta cu_t}{p_t} = \alpha + \beta cr_t + \gamma ir_{t-1} + \delta \pi_t + u_t$$

$$\beta > 0, \gamma < 0, \delta < 0$$

The unknown value of θ stands for the (constant) proportion of the currency which is held at home during the estimation period. It is added to sight deposits to establish the total available money stock at home. All that is initially known about θ is that $0 \leq \theta \leq 1$. For $\theta = 0$, all cash is held abroad; for $\theta = 1$, all cash is held at home. An attempt is now made to establish the value $\theta = \theta^*$, for which (20) is statistically the most suitable, in the sense that it yields the maximum of the log likelihood function (LL).⁴⁷ For this purpose, θ moves in

⁴⁵If the current inflation rate is subtracted, there is no change in the ultimate findings, but in some cases there are insignificant parameters.

⁴⁶A similar methodology was applied by J. Ha to a currency-importing country (Swaziland) see Ha (1994), Krueger/Ha (1995), pp. 15-17.

⁴⁷LL is defined as , $LL = \frac{N}{2} + \left(\frac{N}{2}\right) \log(2\pi) + \left(\frac{N}{2}\right) \log\left(\frac{SSR}{N}\right)$,

where N is the number of observations and SSR the sum of squared residuals.

steps of 0.1 between 0 and 1. The domestic portion θ^* is determined from the maximum of LL. $(1-\theta^*)$ is then equivalent to the share of foreign holdings.

Figure 33: The log likelihood function for various values of θ

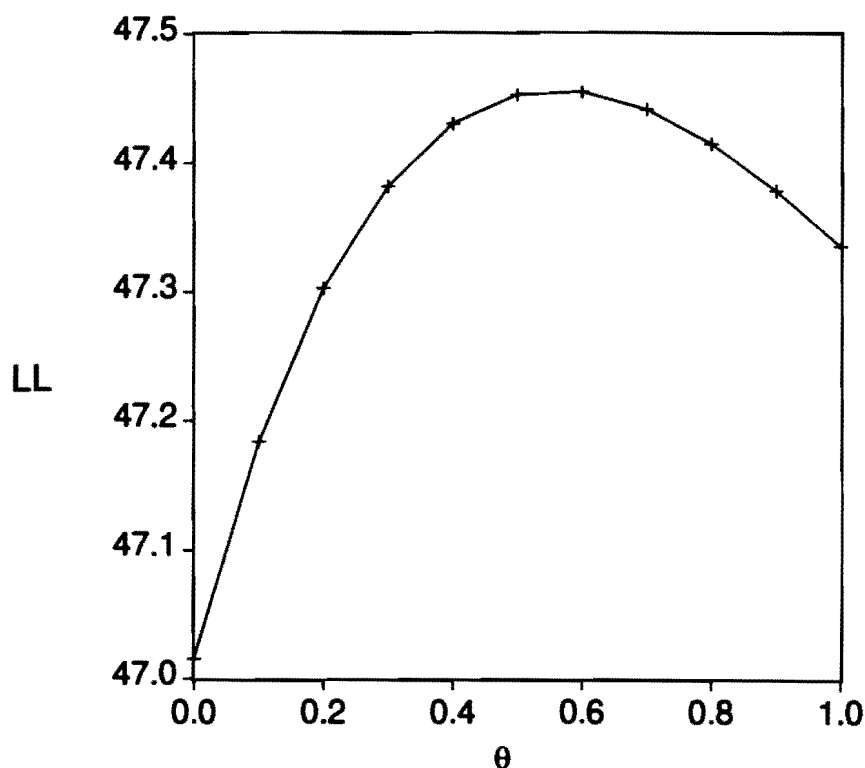


Fig. 33 shows the curve of the log likelihood function. It reaches its maximum at $\theta^* = 0.60$. That means that 40% of the currency is held abroad. The corresponding equation is:

$$(20') \quad \frac{sd_t + 0.6cu_t}{p_t} = \underset{(14.4)}{-2.15} + \underset{(52.8)}{1.13}cr_t - \underset{(2.2)}{0.01}ir_{t-1} - \underset{(2.7)}{0.01}\pi_t + u_t$$

$R^2 = 0.99, LL = 47.45$

The problem posed by this approach is that it assumes that the proportion of currency held abroad is constant. It is neither time-variable nor dependent on economic variables (e.g. exchange rate trends). For that reason, 40% should be interpreted as the average level over the past 25 years. However, the figure is roughly consistent with the estimated results so far obtained. Moreover, it must be borne in mind that the log likelihood function fluctuates only between values of 47.0 and 47.5 in the relevant interval $0 \leq \theta \leq 1$, that is to say, it moves within a very narrow range. Moreover, there is no ex ante guarantee that the maximum of LL is at all within this range. A corner solution ($\theta = 0$ or $\theta = 1$), which is not impossible, would likewise be difficult to interpret.

This type of analysis can be applied to a country importing Deutsche Mark only if it is certain that only Deutsche Mark and not, say, US dollars as well are in circulation.

2.4.2 Analysis of the residuals of a currency demand function

Another means of establishing the currency circulating abroad focuses on a period in which the foreign impact was still insignificant. A currency demand function with "good" statistical properties is estimated for that period. This allows us to identify that part of the currency which circulates in the home country.

In this context, changes in the currency in circulation could initially be examined more closely. According to fig. 2, greater fluctuations in the currency in circulation occur from the second third of the sixties onwards. A possible reason for this could be a lack of foreign demand up to that point. The "basis regression" would then have to be confined to the period prior to that. However, if the fluctuations are not due to the foreign element and/or the foreign demand had existed beforehand as well, the results which follow would be distorted accordingly. The regression equation is⁴⁸

$$(21) \quad \Delta c u_t = 0.04 + 0.35 \Delta c_t - 0.008 \Delta i_t + u_t$$
$$R^2 = 0.60, SE = 0.01, SSR = 0.002, ARCH(2) = 0.63$$

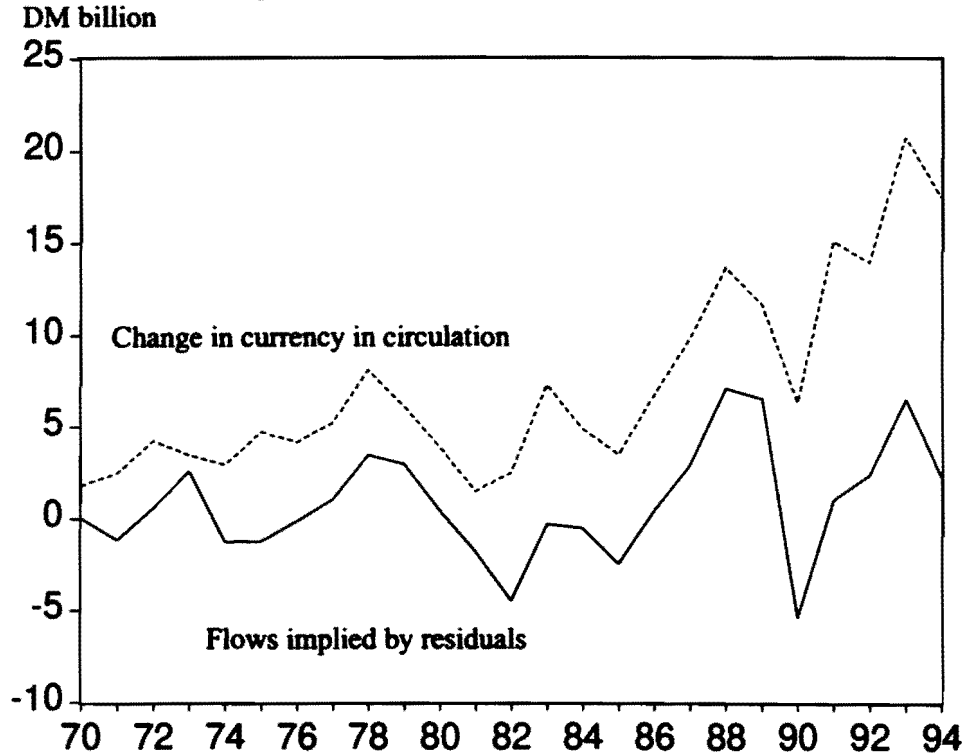
This equation is then used to simulate up to the end of the series, enabling us to derive the net flows abroad as the difference between the actual and the forecasted currency in circulation, i.e. the forecast error.⁴⁹ As the residual or the forecast error of this flow model covers **all** unrecorded (positive and negative) factors and changed relationships between the included variables currency, interest rate and private consumption over the corresponding time-horizon, and because of the general assumptions of the OLS method, it makes no sense to try to derive foreign holdings by this method. Also - principally because of the limited period for the original estimation -, the absolute changes should be interpreted only in terms of their movements relative to the actual fluctuations in the currency in circulation. These flows are compared in fig. 34. It turns out that the actual turning points of the changes in currency in circulation show a fairly strong similarity to the "implied foreign component" (especially during the eighties). The correlation coefficient

⁴⁸The estimation period runs from the first quarter of 1960 to the fourth quarter of 1966 and is duly adjusted by means of the differences used. The changes (Δ) refer to fourth differences. All variables are nominal, and, with the exception of the interest rate, in logarithms. If the specification is in real terms, poorer statistical properties emerge, but there is no change in the basic results.

⁴⁹Regarding this method, see Judson/Porter (1994), p. 25 f. and IMF (1994), p. 29 ff.

between the two time series is 0.67. If the simulation error does in actual fact capture the foreign demand for Deutsche Mark, this would mean that the fluctuations in the amount of currency in circulation are largely due to the foreign element and to some extent can indeed be forecasted by it.

Figure 34: Actual and implied changes in currency in circulation



These results provide initial indications that the approach using the residuals of a currency demand function yields reasonably plausible results. The fact that, as fig. 1 shows, the exponential curve of currency in circulation started approximately at the beginning of the seventies can be used in deriving the stocks. If the relevant (logarithmic) variables for estimating the currency demand in a previous period are stationary in their levels, an estimate of the levels may be undertaken and, using the above method, the foreign component thus derived.

Table 8: Stationarity tests for the sixties

Variable	Test specification	t-value (absolute)
cu	C,3	3.37**
c	C,2,T	6.80***
i	C,4	3.37**

Estimation period 1960,1-1969,4.

Comparison of the t-values with the critical values of MacKinnon (1991).

***/**: significant at the 1%/5% level.

C=constant, T=deterministic trend; 4/3/2: number of lags in the test equation.

According to table 8, the nominal amount of currency in circulation, the money market rate and private consumption are stationary variables from 1960 to end-1969. Estimates can therefore be undertaken in levels. The equation reads as follows:

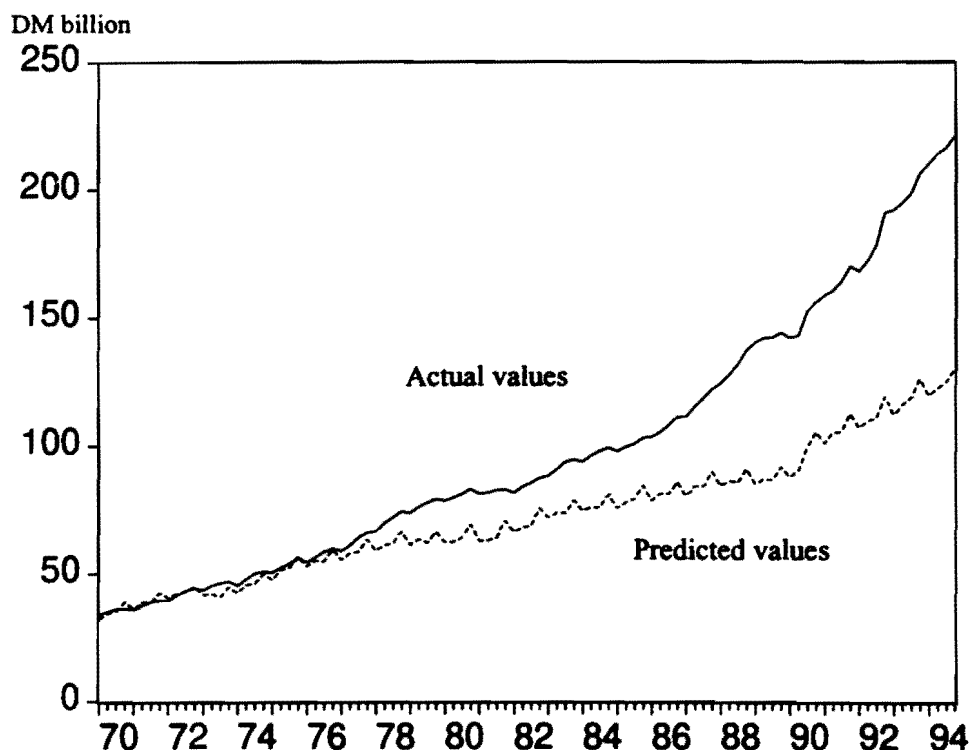
$$(22) \quad cu_t = 0.31 + 0.74c_t - 0.01i_t + u_t$$

(2.24) (20.22) (1.83)

$$R^2 = 0.93, SE = 0.045, SSR = 0.076, DW = 2.05$$

The currency in circulation abroad can be calculated as the forecast error for the period between 1970 and 1994 (see fig. 35). Accordingly, there was an increase in the foreign demand for Deutsche Mark from the middle of the seventies onwards. From this point, the forecasted and the actual currency trends show increasing divergences. The foreign component shows additional surges in the middle of the eighties and at the beginning of the nineties. At the end of 1994 the foreign holdings totalled approximately DM 90 billion, or just over 40% of the currency in circulation. The trend over time is in contradiction to the estimated results hitherto and should always be viewed with the restrictions of the underlying model in mind. The current holdings abroad, on the other hand, are only slightly above the figures calculated so far.

Figure 35: Actual and forecasted movements of currency in circulation



2.4.3 Trend in the currency ratio

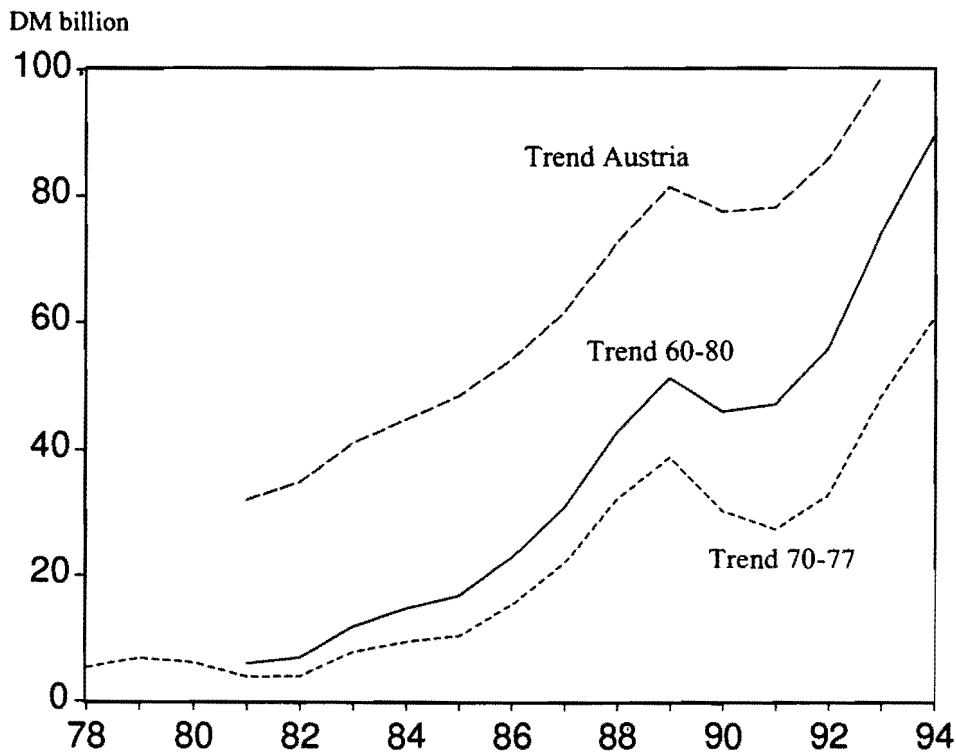
In theory one might expect the currency ratio (currency in circulation relative to a transactions variable) to decrease over time as a result of cashless payments and other financial innovations. According to figs. 5 and 6, however, this is evident in Germany in a pronounced form only until the beginning of the seventies, and in a weaker form until the end of the seventies, relative to both private consumption and to GDP. The trend since then could be explained by an increase in foreign demand (Stekler, 1991, p. 5). The falling trend could be extended up to the current margin, or the trend in the currency ratio of a country with comparable payment practices could be used to derive the holdings of Deutsche Mark abroad as the difference from the actual currency ratio in Germany. Here the basic assumption is, of course, that the reversal in the trend is due entirely to countries abroad.

Since the foreign holdings, calculated in this way, depend crucially on the assumed trend, three alternative calculations will be made below. The following reference trends are taken as a basis:

- ◆ the trend in the currency ratio in Germany from 1960 to 1980,
- ◆ the weaker trend in Germany from 1970 to 1977,
- ◆ the consistently decreasing trend in the currency ratio in Austria (see fig. 5).

Fig. 36 shows the Deutsche Mark holdings abroad, as derived by this model. The currency ratio is related to private consumption in each case.⁵⁰ The simulation with the Austrian trend was taken from the beginning of the eighties onwards.

Figure 36: Currency holdings abroad, as derived from the trend in the currency ratio



As in the last chapter, the result is a rising curve. The curves hardly depend on the assumed reference trend. At the end of 1994, amounts of between DM 60 billion and almost DM 100 billion are obtained, i.e. between about 30% and 45% of the total Deutsche Mark in circulation outside the German banking system. The relatively high figures calculated on the basis of the Austrian trend are subject to the greatest uncertainty because liquidity holdings in Austria were higher throughout the period and thus the intercept derived from the estimate for Germany had to be used in the trend regression as an approximation.

⁵⁰If GDP is taken as a reference point, there are only small quantitative changes.

The general weakness of this approach resides in the fact that the changed trend in Germany is ascribed solely to the demand from abroad. Since annual figures are used and since a major part of the domestic currency hoardings are liquidated again within this time-horizon, this assumption is not completely unfounded, however. A plausible alternative substantiation of the currency ratio in Germany, which has risen by about 2 percentage points in the past 15 years, and of the orders of magnitude behind it, is at the least not obvious.

2.5 The "life" of banknotes

Attempts are frequently made to derive the share of hoarding or the share of transactions in the different denominations from the average life of the banknotes (Anderson, 1977, Boeschoten, 1992, Cramer, 1986). This method can also be applied to the foreign use of Deutsche Mark. The basic assumption here is that the "life" of a banknote is prolonged by its use abroad. The holdings abroad can then be derived from a comparison of the "normal" life of notes and their actual life. This approach consists of three steps:

(1) Calculation of the average life of banknotes

Formulas for calculating the average life of banknotes have been devised at the Banknote Printers' Conference and in several central banks. Mainly in order to avoid internal hoarding problems but also because of the choice of the comparative yardstick (see (2)), reference is made only to small-denomination notes (sm) of between DM 5 and DM 50. The formula used reads (Boeschoten, 1992, p. 105):

$$(23) \quad AL_{sm,t} = \frac{C_{sm,t} + C_{sm,t-1}}{N_{sm,t} + V_{sm,t}}$$

AL is the average note life, C the number of notes in circulation, N the number of new notes, V the number of small-denomination notes withdrawn from circulation and t denotes the respective year. In a stable environment, this formula yields meaningful results. However, if the circulation of a given denomination changes markedly and/or if new notes are issued, only figures which are distorted by short-term fluctuations are obtained. Thus, owing to German unification and the introduction of the new banknote series in Germany, the calculation is confined to the period between the beginning of the seventies and 1989 and focuses on the longer-term trends.

(2) Calculation of the "normal" life of banknotes

In the Netherlands small denominations (Hfl 5 to Hfl 50) are used for transactions purposes only. There is virtually no demand for these notes in other countries (Boeschoten, 1992). In the case of small German denominations, too, it is to be assumed that they are only used for transactions, but both in Germany and abroad. The small denominations in the Netherlands are therefore used as a comparative yardstick in the sense of the "normal" average life of small-denomination banknotes. By equating this "normal" life with the actual average life this indicates which life would have to be expected for the German notes if they were used solely for domestic transactions. A constant age of the banknotes over time is not assumed, however, but due account is taken of the fact that the age depends on the real value of the denominations. This relationship was estimated by Boeschoten (1992) on the basis of Laurent (1974) for small-denomination notes.⁵¹ It reads

$$(24) \quad AL_{sm,t} = 0,99 + 0,12 \ln RD_{sm,t}$$

(7,0) (2,5)

where RD is the real value of the denomination. The semi-log linear relationship shown in (24) implies that a rise of 100% in the real value of a note increases the average life by 0.12 years. The "normal life" of the small German denominations is calculated using these parameter values. The actual life is consistently longer than the normal life. If the assumptions of the model are correct, this is probably attributable to the foreign demand for these notes.

(3) Calculation of the foreign share

After adjusting the average life of the banknotes for short-term fluctuations by means of a linear and quadratic trend, the percentage share of small-denomination Deutsche Mark notes held abroad (CUA) is obtained by means of equation (25). Fig. 37 illustrates this for the period from 1975 to 1989.

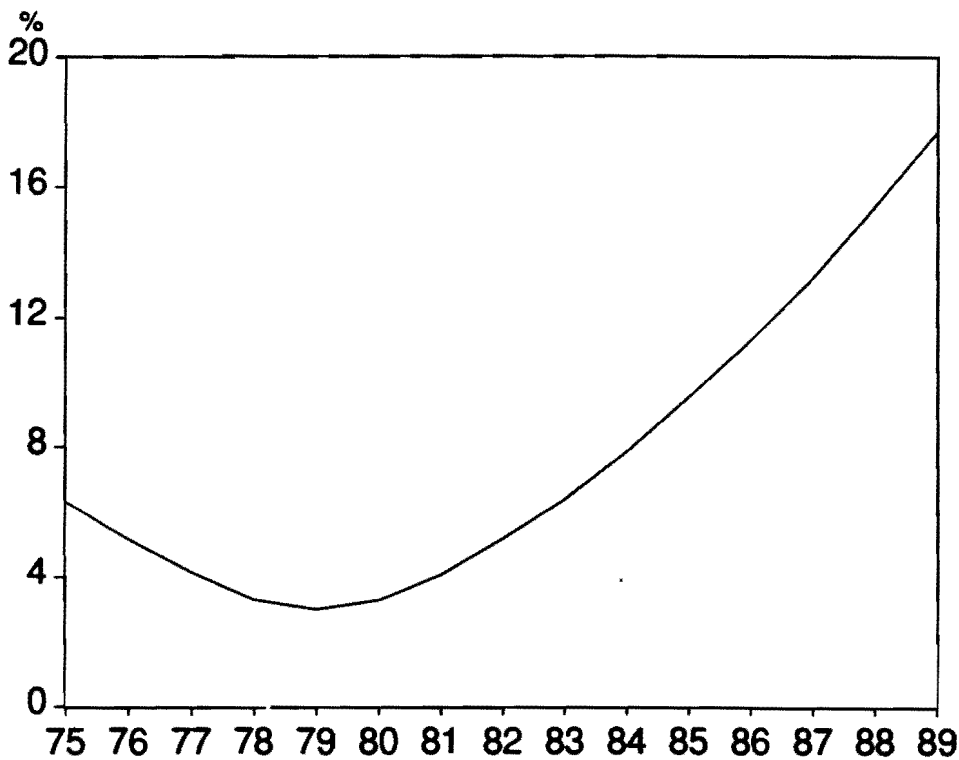
$$(25) \quad CUA_{sm,t} = \frac{(AL_{sm,t} - NAL_{sm,t})100}{AL_{sm,t}}$$

NAL stands for the normal life of the notes.

⁵¹A similar statistically significant relationship could not be ascertained for large denominations. This suggests that these notes are not used primarily for transactions purposes.

According to this figure, the foreign component has been increasing since the end of the seventies. All in all, the share rose from just over 5% to almost 20% between 1975 and 1989. In absolute terms, this represents an increase from about DM 1 billion in the middle of the seventies to just over DM 4 billion at the end of the eighties. If the trend from the beginning of the eighties onwards is extended to the current margin, a foreign percentage of just over 26% of all small-denomination notes is obtained, which corresponded to an order of magnitude of about DM 9 billion at the end of 1994. If it is assumed that a considerable proportion of the large-denomination notes which are not included here are also held abroad, orders of magnitude like those ascertained in the previous chapters seem to be quite plausible.

Figure 37: Share of small-denomination notes abroad



The great advantage of this model is that domestic hoardings and foreign holdings are not mixed up. The final result refers only to the proportion circulating abroad. On the other hand, this, of course, depends crucially on the situation in the reference country, the Netherlands. Particularly in the case of small-denomination notes, this comparison seems to be fairly plausible (see also section 2.2.2).

The results of the indirect approaches dealt with are summarised in table 9.

Table 9: Overview of the results of the indirect approaches for 1994

	Seasonal factors		German unification	Money demand estimates			Life
	Country comparison	Transactions variable		Best fit	Residuals	Trend	
As % of currency in circulation	30-40%	35%	about 35%	40%	abt. 40%	30-45%	26% ¹⁾
Absolute order of magnitude (DM billion)	65-85	75	70	85	abt. 90	60-100	9

1) Only relative to DM 5 to DM 50 notes.

3 Currency in circulation abroad, shadow economy and hoardings

In some of the indirect approaches described, no distinction could be made between hoardings of currency in Germany and currency in circulation abroad (see, for instance, sections V, 2.2 and 2.3). There are also attempts to explain the size of the shadow economy by reference to the increasing demand for currency (for a critical presentation, see Bowsher (1980) and Frey/Pommerehne (1984), p. 8 ff.). The conclusion could be drawn from this that the amounts ascertained have little to do with the Deutsche Mark circulating abroad, but are mostly held in internal hoards and in the shadow economy.⁵² The orders of magnitude of foreign holdings at the current end, amounting to between 40% and 45% of the total amount of currency in circulation, as resulting from some estimates, are no doubt an upper limit. Nevertheless, the thesis that the amounts derived are mainly attributable to factors other than the amount of currency circulating abroad does not stand up to a critical scrutiny.

First of all, it should be stated that, particularly in the approaches aimed at an econometric estimate of the demand for currency, both the shadow-economy element and the hoarding element are recorded in the sense that they are covered by the included arguments - interest rate and transactions variables. Hence the interest rate elasticity of the German currency demand function (see fig. 14) seems to derive mainly from domestic savings in the form of

⁵²Frey/Pommerehne (1984), p. 11 pointed out, however, that estimating the size of the shadow economy is more difficult if the currency of the country is also circulating abroad.

currency. Furthermore, shadow-economy activities exhibit a cyclical component which can be captured via a transactions variable (see also the model of Bhattacharyya, 1990).

When comparing seasonal factors, the attempt to separate currency circulating abroad from currency held in internal hoards (see p. 32 f.) has shown that the latter has declined since the eighties. Moreover, the age analysis of DM 5 to DM 50 notes (section 2.5), in which hoards could be eliminated, resulted in foreign holdings of almost DM 10 billion. Of the DM 100 and DM 1,000 notes, which have grown most sharply in the past 20 years, a multiple of the above amount may be held abroad. In theory, it should be mainly the largest-denomination notes which are hoarded. The DM 100 note thus contradicts the "hoarding thesis" in this direction as well. Finally, currency hoardings in Germany can probably be rejected as being the key factor behind the "overflowing" currency in circulation on account of the flexibility of this phenomenon over time - what is deemed to be a hoard, given a time-horizon of three months, is largely eliminated if the time-horizon is one year. Considering the orders of magnitude involved here, savings kept "under the mattress" (e.g. those of older persons) no doubt play only a subordinate role. In addition, an ever-growing part of the German population has become familiar with (safe) alternatives to currency holdings and has become increasingly interest-sensitive.

The shadow-economy objection must also be viewed with caution. In "currency approaches" it is usually assumed that, in the shadow economy, payments are settled exclusively in cash. Barter and cheques are not taken into account, and nor is the possibility of a higher velocity of circulation (Frey/Weck, 1983, p. 36). For instance, the sight deposits of German non-banks (even including the number of cashless payments), which are used almost exclusively for domestic transactions and, to a certain extent, are a substitute for currency, have expanded even more sharply than currency in circulation since the beginning of the seventies. It should also be borne in mind that currency is not in demand for its own sake. In many cases the funds turned over in the shadow economy are likely to flow back "into light" relatively quickly (compare, for example, a typical "illicit worker"). And in the case of extremely illegal activities, attempts will be made to "launder" the money. If this is done at home, the money is officially available again and may affect purchasing power in Germany. If such attempts are made abroad, the notes are either returned to Germany fairly quickly (for example, if western Europe is involved) or they remain abroad (for instance, drug funds) and should therefore be recorded as currency circulating abroad. Especially with large amounts, shadow-economy activities are likely to involve foreign countries.

All in all, the foreign holdings of DM 65 billion to DM 90 billion ascertained at the end of 1994 should therefore be regarded as fairly realistic.

VI. Monetary policy implications

As the intersection of the various empirical recording methods, the finding is as follows: at present 30% to 40% of the total amount of Deutsche Mark in circulation is presumably being held abroad. There is a demand for both small-denomination and large-denomination notes, albeit for different purposes. That part, and also the part used for domestic hoarding, are generally not available, at least over the short to medium term, for financing domestic transactions. In this sense the reasons for the "inactive" currency share are irrelevant to monetary policy. The trend over time of holdings abroad could not be determined unambiguously. But there are several indications that the share abroad has increased since the end of the eighties. Moreover, it cannot be ruled out that the amounts are subject to major fluctuations from year to year. For example, since the end of the eighties there have been pronounced fluctuations in currency in circulation, in some cases by up to DM 30 billion per year (see fig. 2). The definition of money for monetary policy purposes on the basis of the degree of liquidity or the medium of payments function is generally made more difficult on account of the foreign demand. On the other hand, the increased demand for currency, irrespective of from whom it stems and for what reasons it is exercised, generates demand for central bank money. This strengthens the ties between the banking system and the central bank, enhances the potential effectiveness of monetary policy and strengthens the negative interest elasticity of the demand for money.

The traditional monetary aggregates are geared to transactions at home. Fig. 12 shows that the share of currency in M1 and M3 has been fairly constant over the past 20 years.⁵³ For some years, however, there has been a rising trend. Owing to the small share in M3 of just over 10%, the Bundesbank's monetary management is likely to have been only slightly affected by currency circulating abroad. If, as an extreme example, it is assumed that a constant 50% of currency in circulation is withdrawn from domestic transactions as a result of foreign demand and domestic hoarding, and given a currency share of almost 12% in M3 at the end of 1994 (and assuming equal distribution), a fictitious monetary target of 6%

⁵³The share in the central bank money stock during this period has consistently been around 50%. In weighted monetary aggregates, such as Divisia aggregates or the transactions-oriented money stock (see Herrmann et al., 1994), currency in circulation is always given the greatest weight since it has the highest degree of liquidity. On the one hand, the external holdings of a specific currency have a greater effect as a result. On the other hand, this approach should generally be reconsidered if, for a variety of reasons, a substantial proportion of the currency is not due to transactions.

would have had to have been revised upwards by little more than 0.3 percentage point. In the case of M1 and the central bank money stock, the addition would have been 0.9 percentage point and 3 percentage points, respectively, given unchanged fundamentals. However, a large part of this effect is already captured by the trend addition to the velocity of circulation. Or, put differently: if an additional factor for the Deutsche Mark tied up abroad is taken into account, the velocity of circulation should be related only to M3 excluding foreign holdings. The range of uncertainty of the calculations is extended, however, as soon as the foreign share becomes relatively volatile from year to year. This could perhaps be absorbed by the range of the target formulation. At all events, demand equations used to estimate and forecast currency in circulation should include specific arguments for the currency circulating abroad (for example, the exchange rate between the Deutsche Mark and the US dollar).

By incorporating the money-supply side, one can further examine how the money multiplier has changed on account of the currency circulating abroad, and whether it has tended to be stabilised or destabilised thereby. Since the relationship between currency and sight deposits or between currency and M1 or M3 has changed only a little over time, only a small impact of currency holdings abroad on the money multiplier is to be expected. To verify this hypothesis, the following general definition of the multiplier m_j is assumed (for its basic structure, see Papademos/Modigliani, 1990, p. 427):⁵⁴

$$(26) \quad m_j = \frac{k + \sum_{i=1}^j d_i}{k + \sum_{i=1}^j d_i z_i} = \frac{\sum_{i=1}^j d_i}{c_j + (1 - c_j) \sum_{i=1}^j d_i z_i},$$

where k is the ratio of currency (CU) to sight deposits (D_1) and c_j is the ratio of currency to the underlying money stock concept (MJ), i.e. for example, M1 or M3. There are N categories of deposits (D_1, D_2, \dots, D_N), where $\mathbf{d} = (d_1, d_2, \dots, d_N) = (1, D_2/D_1, D_3/D_1, \dots, D_N/D_1)$ is the vector of the deposit shares relating to sight deposits. This yields the following equation for the monetary aggregate: $MJ = CU + D_1 + D_2 + \dots + D_N$. The minimum reserve ratios $\mathbf{z} = (z_1, z_2, \dots, z_N)$ may vary, depending on the type of deposit. In an economy with only currency and sight deposits, the multiplier relative to the monetary aggregate M1, on which the following qualitative considerations focus without loss of generality, simplifies to (Issing (1993), p. 63):

⁵⁴For the sake of simplicity, it is assumed that there are no excess reserves.

$$(26) \quad m_1 = \frac{1+k}{k+z_1} = \frac{1}{c_1 + z_1(1-c_1)}.^{55}$$

The influence of foreign demand for Deutsche Mark can be recorded via a higher currency ratio c_1 . The following partial derivatives result:

$$(27) \quad \frac{\partial m_1}{\partial c_1} = -\frac{1-z_1}{[c_1 + z_1(1-c_1)]^2} < 0$$

$$\frac{\partial^2 m_1}{\partial c_1^2} = \frac{2(1-z_1)^2}{[c_1 + z_1(1-c_1)]^3} > 0$$

The multiplier thus falls with a rising amount of currency circulating abroad, but the decrease is ever-smaller as the external influence increases. It therefore has a convex shape. (27) may be interpreted as a variability or stability measure. The forecastability of the multiplier is improved if c_1 rises on account of currency circulating abroad. Since, however, c_1 is fairly constant in Germany, the repercussions on m_1 , $dm_1 = (\partial m_1 / \partial c_1) dc_1$, are only of a marginal nature. This can be reconstructed in a more general context from fig. 38, where the multipliers for M3 and M1 are compared including and excluding currency.⁵⁶ The multiplier m_3 is, admittedly, more volatile than m_1 . However, currency in circulation as a whole is apparently responsible only for a change in the level, but not for the fluctuations. This is also suggested by the estimate of the currency demand function in section III in which it was shown that it was above all the long-term relationship which changed, for instance by the opening-up of eastern Europe. If the portfolio-theoretical approach applies to currency, these statements may have to be modified because a simultaneous estimate of the money multiplier, taking due account of the (foreign) determinants of c_1 and possibly of an explicit split between domestic and foreign currency holdings and of their repercussions on c_1 , would then be appropriate.

Moreover, a correction factor for monetary aggregates is to be viewed with caution in the light of the primary goal of monetary policy, viz. combating inflation. Initially, the Deutsche Mark amounts circulating abroad have no effect on purchasing power in Germany. It is not certain, however, that they are permanently withdrawn from the German economy. As soon as they flow back (and some actually flow back in the short run, as the

⁵⁵The multiplier excluding currency ($m_0 = 1/z_1$) is thus greater than m_1 ; see Champ/Freeman (1994), chapters 7 and 8.

⁵⁶The proposal to exclude currency from the usual money stock definitions owing to the foreign demand is found, for example, in Sprenkle (1993), p. 183.

analysis of the statistically recorded outflows and return flows of notes shows) and are not deposited in hoards or at the Bundesbank, they can be used again for domestic transactions and are thus relevant to prices. For this, a change in the preferences of economic agents is not necessarily required. The incentive may also emanate from changed price signals. A return flow may take place precisely because goods are purchased in Germany. These factors would have to be considered in a correction and a possible reversal in the case of a return flow of Deutsche Mark amounts. This is not advisable because of the associated range of uncertainty.

Owing to the voluntary demand of non-residents for (non-interest-bearing) Deutsche Mark notes, which has always been accommodated by the Bundesbank, part of the Bundesbank's seigniorage (S) and thus ceteris paribus part of the Bundesbank profit is paid by non-residents. Seigniorage is defined as the additionally circulating real central bank money in a given period t (Issing, 1993, p. 231). The part of it (S_t^*) attributable to currency abroad (M^a) corresponds to

$$(28) \quad S_t^* = \frac{\dot{M}_t^a}{p_t} = \frac{\dot{M}_t^a}{M_t^a} \frac{M_t^a}{p_t}$$

Seigniorage arises even with an unchanged positive growth rate of the foreign share, and thus an unchanged rate of inflation in the long run. A higher rate of monetary growth induced by non-residents (initially) has no opposite effect on seigniorage, unlike a domestically-induced expansion (which results in a higher rate of inflation at home). This effect would arise, through declining real (foreign) holdings, only if the attractiveness of the Deutsche Mark in countries in which it is in demand were impaired. In principle, therefore, the unstable countries in which the Deutsche Mark circulates grant Germany a (long-term) interest-free loan. In 1994, with currency holdings abroad of 30% and a growth rate of 5%, this would have led to a nominal seigniorage of just over DM 3 billion, or about 30% of the Bundesbank profit in that year. However, this "distributional problem" cannot be solved in Germany, but requires stability efforts on the part of the countries using Deutsche Mark.

VII. Summary, conclusion, outlook

"Appearance and reality"

The sustained "boom" in German currency cannot be covered properly by a narrow rationality concept. Many of the motives for holding currency at home are obscure. It is far less unclear, however, why the demand for Deutsche Mark is so heavy abroad. The opportunity costs involved in this decision are fairly obvious, and the US dollar is virtually the only "competing product". Yet it is extremely difficult to quantify the foreign holdings precisely. The theoretical and empirical penetration of this external phenomenon, taking due account of monetary policy considerations, was at the centre of the present study.

Even simple statistical ratios - e.g. per capita currency holdings, by denomination or on an international comparison, and currency in circulation, relative to a transactions variable - point to "inconsistencies" in currency circulation. The ample currency endowment in Germany, in statistical terms, can only partly be explained by the domestic shadow economy and internal hoardings. There is little evidence to suggest that the currency holdings of enterprises - given retail sales amounting to a monthly average of about DM 50 billion in 1994 and the tendency to rationalise cash holdings - explain a significant part of the phenomenon. The only explanation that remains of the continuously rising figures is therefore that large amounts of Deutsche Mark are abroad (held by residents and non-residents). This foreign stock is probably confined almost exclusively to banknotes. But the concrete nature of the "inactive" money is irrelevant for monetary policy purposes.

When estimating currency demand functions for Deutsche Mark, improved and statistically significant results over both the short term and the long term can be obtained if foreign demand is explicitly modelled. Because of the substitution relationship of Deutsche Mark and US dollars in this respect, this was done by including the exchange rate between the Deutsche Mark and the US dollar. An (expected) appreciation of the Deutsche Mark has the result that demand for Deutsche Mark increases. In the short run this reflects currency substitution effects, in the long run the co-circulation of the Deutsche Mark in unstable countries. The theoretical explanation of this is found in transactions and store-of-value motives.

The main part of the paper was concerned with the various ways of recording and quantifying Deutsche Mark held abroad. This meets with difficulties, above all because the foreign holdings can regularly be observed and substantiated, but cannot be measured dir-

ectly or derived from statistics. On the whole, not only should the past few years and the developments in eastern and central Europe be borne in mind, but the entire period since the introduction of the Deutsche Mark and developments in all unstable countries and also in Germany (e.g. tax considerations).

A distinction was made between direct and indirect quantifying methods. The former were viewed with some scepticism. In the case of the latter, "proxies" were sought on which foreign demand exerts an impact, in order to estimate its magnitude on that basis. With most approaches, an attempt was made first to record the other side of the coin, the domestic share. Even if in some cases it proved impossible to distinguish between foreign holdings and domestic hoardings, and even if some approaches differed greatly in methodology, a certain general tendency emerged: Between 30% and just over 40% of the total amount of currency in circulation outside the German banking system now appears to be held abroad. In 1994 this involved orders of magnitude of between at least DM 60 billion and at most DM 90 billion. German per capita currency holdings, adjusted for these figures, would then amount to between DM 1,400 and nearly DM 1,900.⁵⁷ This figure still seems to be relatively high, but is far more realistic compared with the amount of over DM 2,600, including holdings abroad. This range roughly corresponds to the situation in Denmark, Sweden and Norway, whose currencies are probably not much used abroad. There are some indications that foreign demand arose, above all, since the mid-sixties. Between 1965 and the end of 1994 nominal GDP and nominal private consumption grew on average by about 6.5% per annum. This rate compares with a rate of growth of currency averaging 7%. If, for simplicity, we assume zero foreign holdings in the period prior to 1965, a growth rate for domestic currency in circulation (adjusted for the foreign share) of 5% to 5.5% is obtained. This figure is also more in accordance with the theoretical beliefs. Foreign demand affects small-denomination notes (for transactions purposes) and large-denomination notes (mainly for store-of-value purposes). The study could not establish unambiguously whether the external phenomenon has increased or decreased in the past few years. A priori considerations suggest that it increased - at least initially - upon the opening-up of eastern Europe. This is also implied by the changed currency demand relationships from the beginning of the nineties onwards.

The present study is the first to concern itself in this form and with this emphasis with currency in circulation abroad for the case of the Deutsche Mark. Direct comparisons were

⁵⁷This includes the domestic share of the shadow economy, hoards in Germany and corporate holdings.

therefore frequently missing. Special attention was paid to the indirect approaches. Any future research projects should attempt to develop these further.

For example, in the context of the approaches presented, the seasonal model, which is problematic on account of the restrictive assumptions, could be improved by looking for further variables to approximate the seasonal component for currency in circulation without the foreign influence (for instance, by taking the seasonal for sight deposits or coins). Moreover, it would be worthwhile to adopt similar methods for individual denominations. It would also be desirable to apply the "age analysis" of banknotes to large-denomination notes. For this purpose, indications of a "normal" currency hoarding function are needed. This would facilitate the application of methods in which a distinction between internal hoardings and currency in circulation abroad is not possible. In general, more resources should be devoted to investigating the "psychology of currency holding" and the actual opportunity costs of holding Deutsche Mark, especially in Germany.

What other indirect approaches are conceivable? First, data from the income and consumption samples of the Federal Statistical Office on cash-financed expenditure could be used to ascertain the domestic transactions-based demand for currency. Secondly, there is information suggesting that coins are almost entirely held in Germany. If there were some proxy of a normal relationship between coins and notes or the total amount of currency in circulation, the stock of notes held abroad could be inferred. Thirdly, data on currency in circulation are available on a daily basis. Assuming that the fluctuations in currency in circulation within one week are caused by domestic factors, a currency demand function supplemented by "daily effects" could be estimated. By determining the absolute value of these effects, it may perhaps be possible to calculate the domestic share. The remainder is then, by definition, held abroad. Fourth, it is possible to apply different methods to a potential importing country of Deutsche Mark (for example, Poland) (see also section V, 2.2.1). For this purpose economically meaningful data would have to be available over a fairly extended period, and only the Deutsche Mark should circulate as a second currency in the country concerned. The best fit of the transactions demand, for example, could then be sought (analogous to section V, 2.4.1), or it could be assessed whether the circulation of Deutsche Mark currency and of the respective other currency are correlated. As a last option, an approach taken from biology, which has already been applied to the US dollar case (Porter, 1994, Judson/Porter, 1994, chapter 8), should be mentioned. In biology the problem often arises that the overall population N (for example, of fish in a lake) is not known. By marking newly released fish F and taking a sample n after some time, a ratio estimator can be constructed. This allows an inference to be drawn about the entire

population. An analogous problem is posed by currency in circulation, as it is not known how much is circulating at home and how much abroad. This approach could be applied, for instance, to new and old notes or notes and coins (F would be the new notes or coins). However, in Germany one is faced with the awkward problem that the state of development of currency statistics is extremely rudimentary in some areas, which currently prevents the satisfactory implementation of this method.⁵⁸ More attention should be paid to improving the relevant statistics. This would considerably advance the search for concrete variables to record the circulation of Deutsche Mark abroad (see also the proposal by Feige, 1994).

All in all, the use of currency is in no way to be regarded as obsolescent, at least as far as the Deutsche Mark is concerned. Foreign demand contributes a great deal to this. The currency circulating abroad has reached an order of magnitude which suggests that, while it should not be ignored in monetary policy, it is not that disturbing either. Attempts by the German authorities to contain the circulation abroad are doomed to failure; for better or worse it must be tolerated. Such attempts must be made, rather, in the countries where the Deutsche Mark is being used.

⁵⁸To mention only a few points: the serial numbers of notes flowing back are not recorded. Data on sorted-out banknotes are only available annually. And with notes returned by the branch offices it is not possible to distinguish between own holdings and circulated notes.

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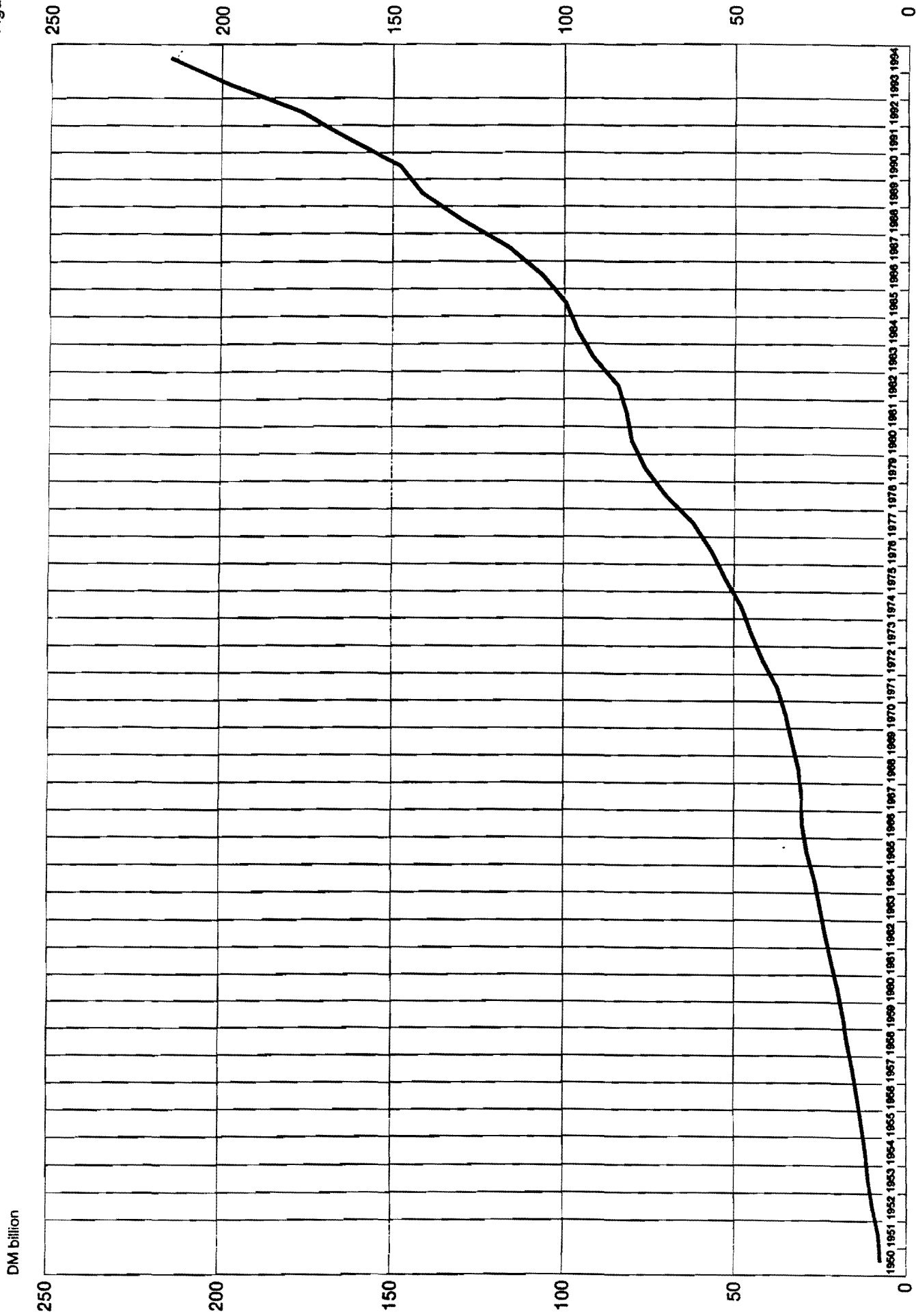
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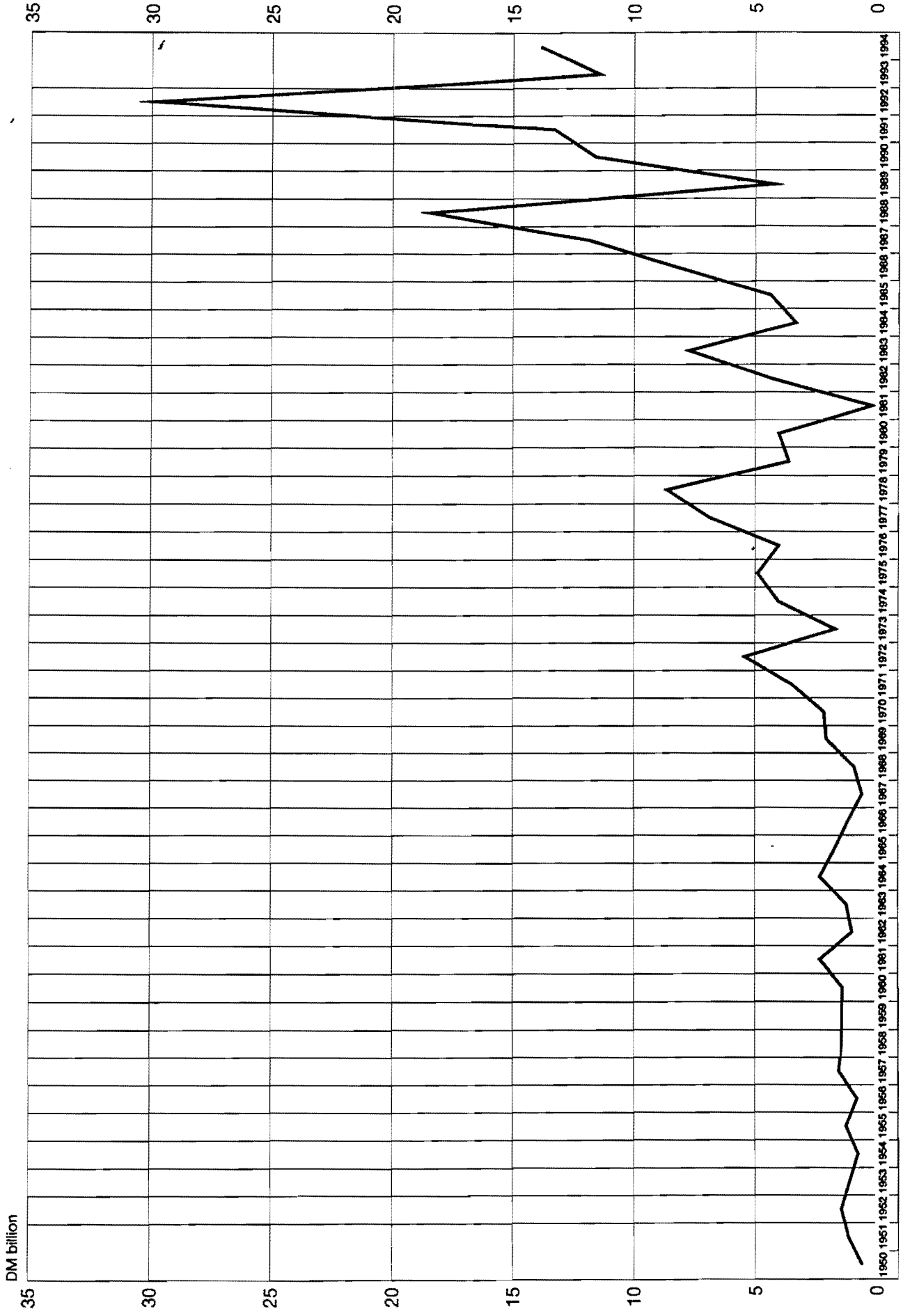
Deutsche Mark in circulation

Figure 1



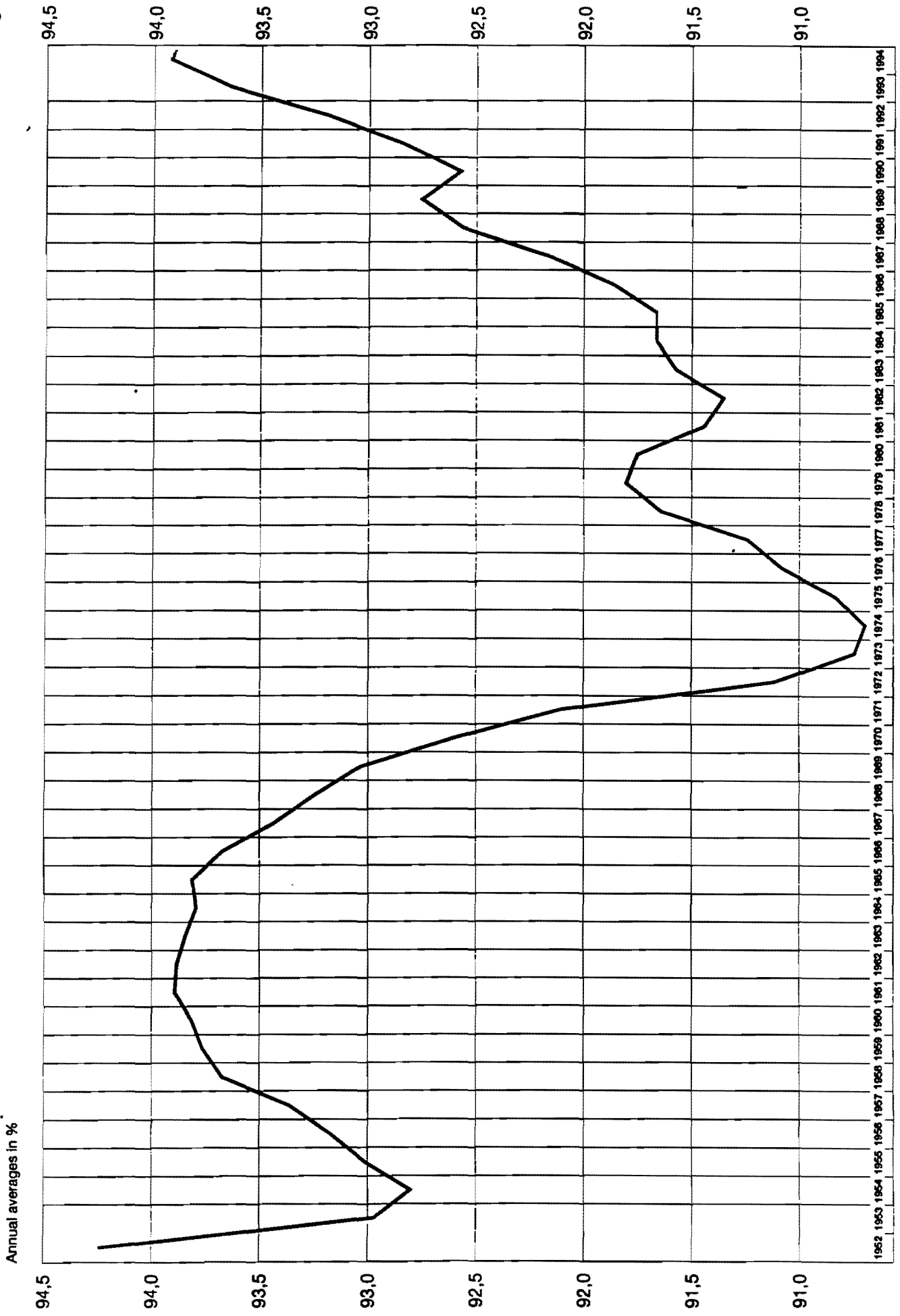
Absolute annual change in currency in circulation

Figure 2



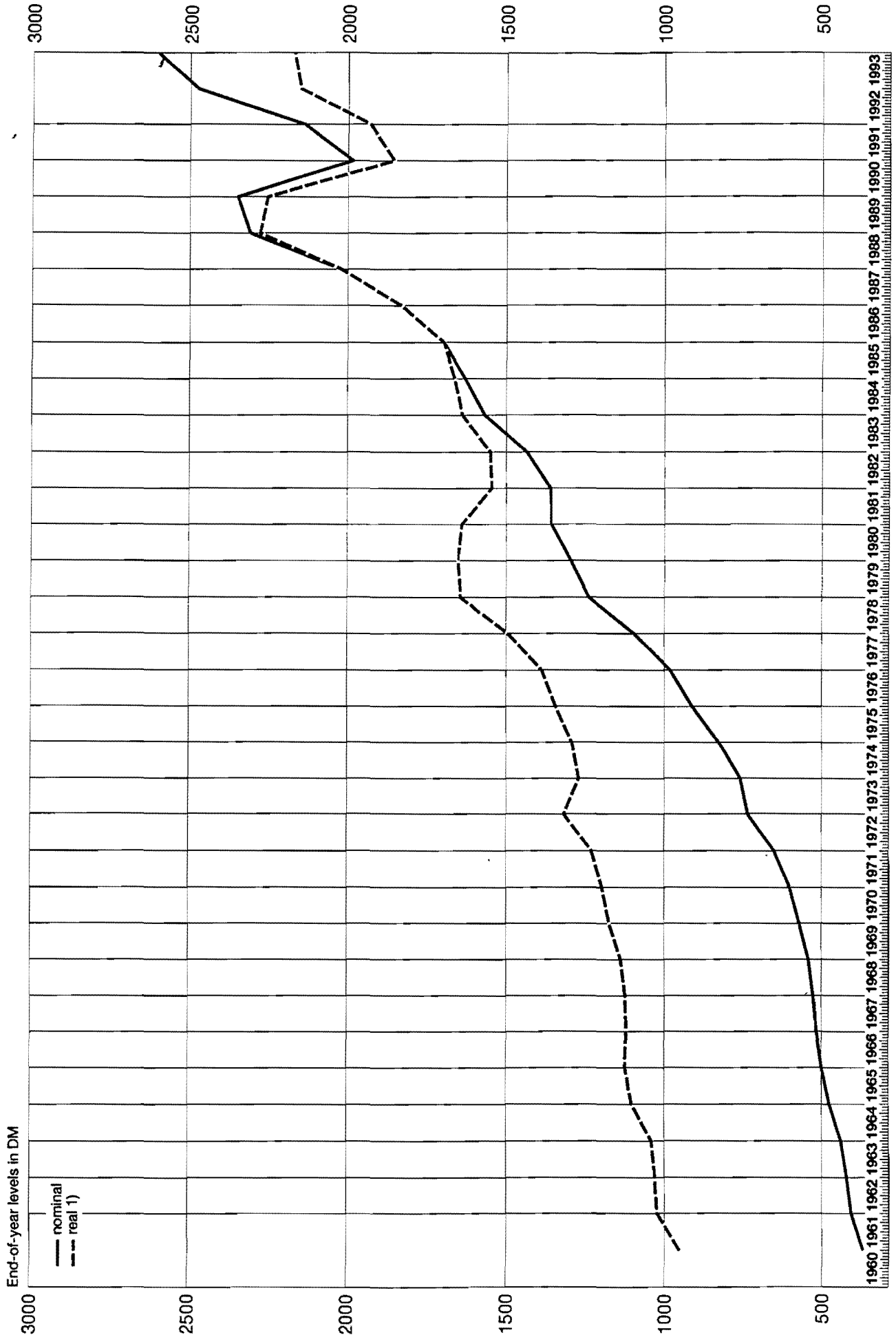
Share of banknotes in total currency in circulation

Figure :



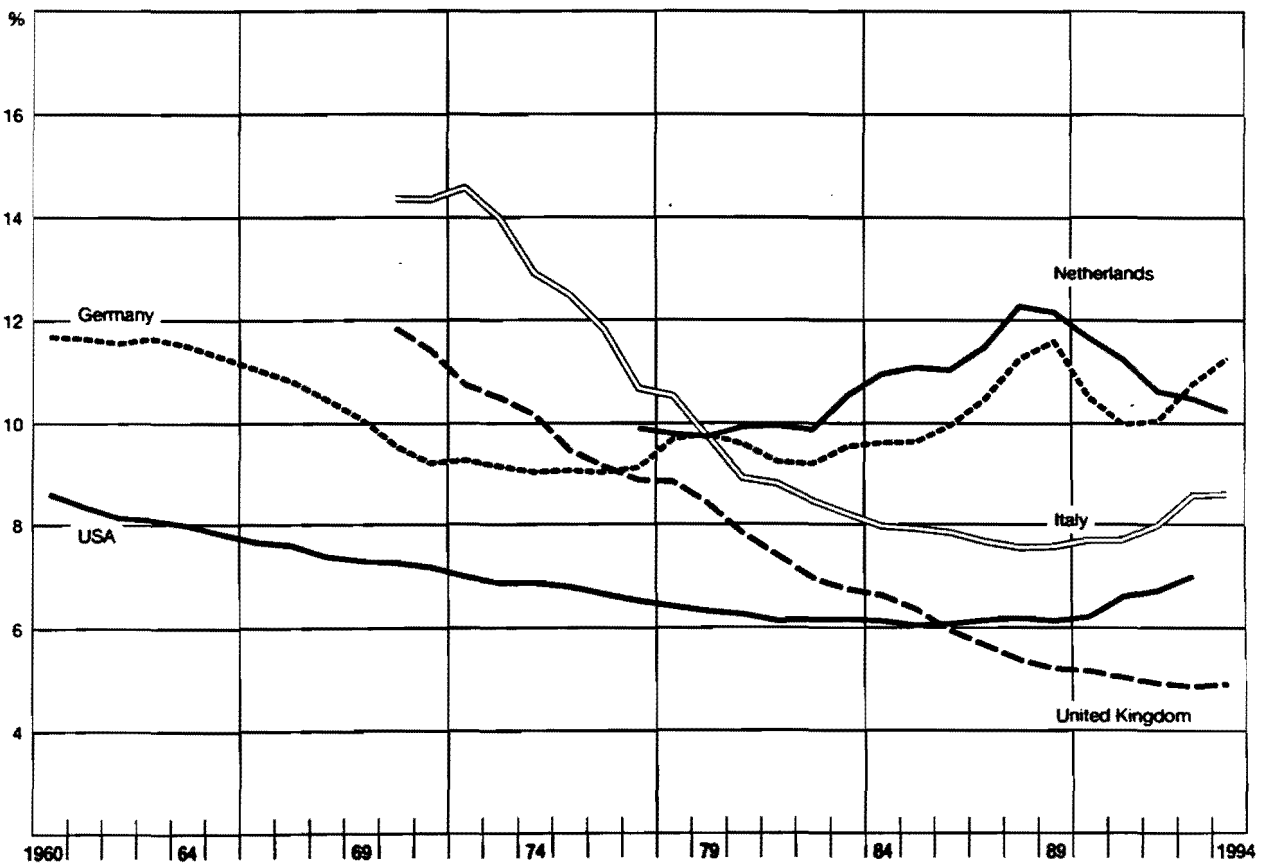
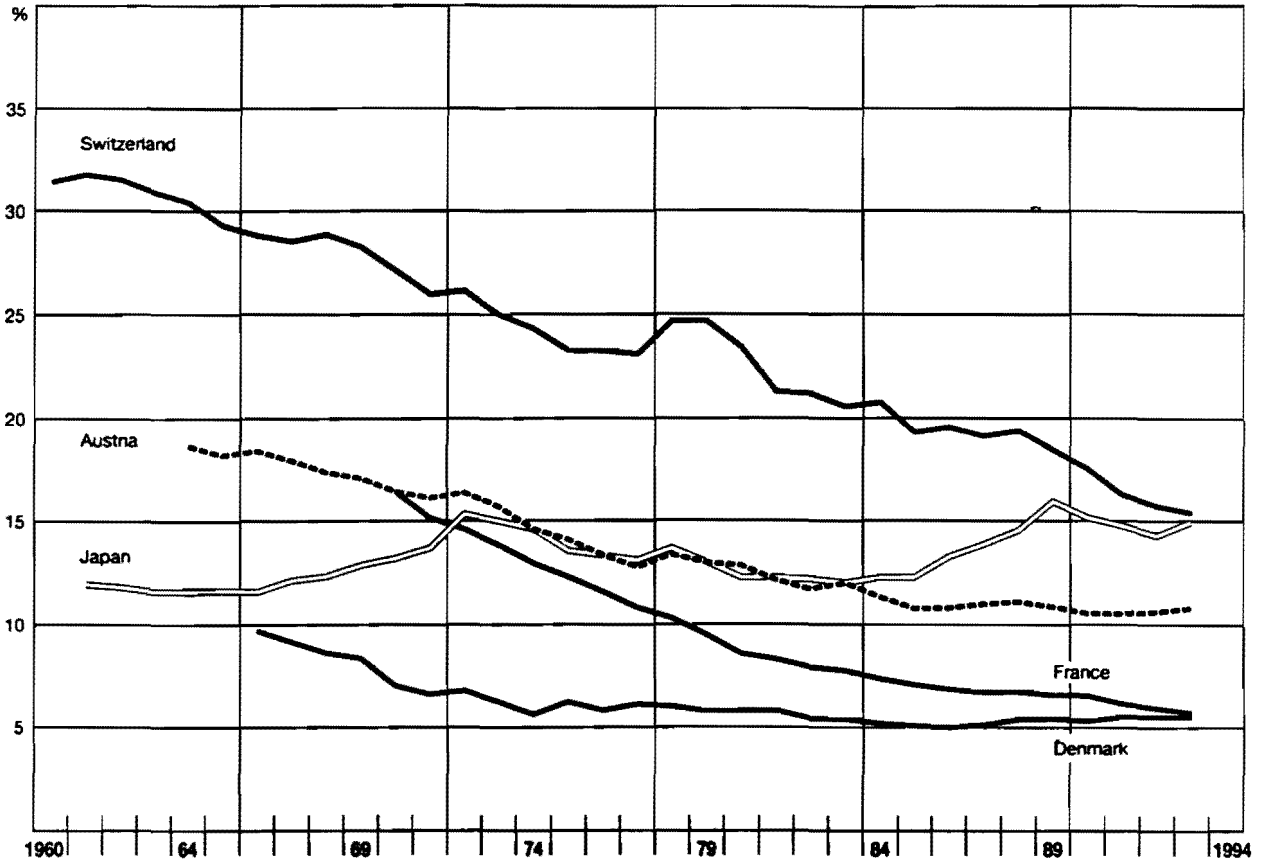
Nominal and real per capita currency holdings in Germany

Figure 4



1) At 1985 prices, as measured by the cost-of-living index for western Germany

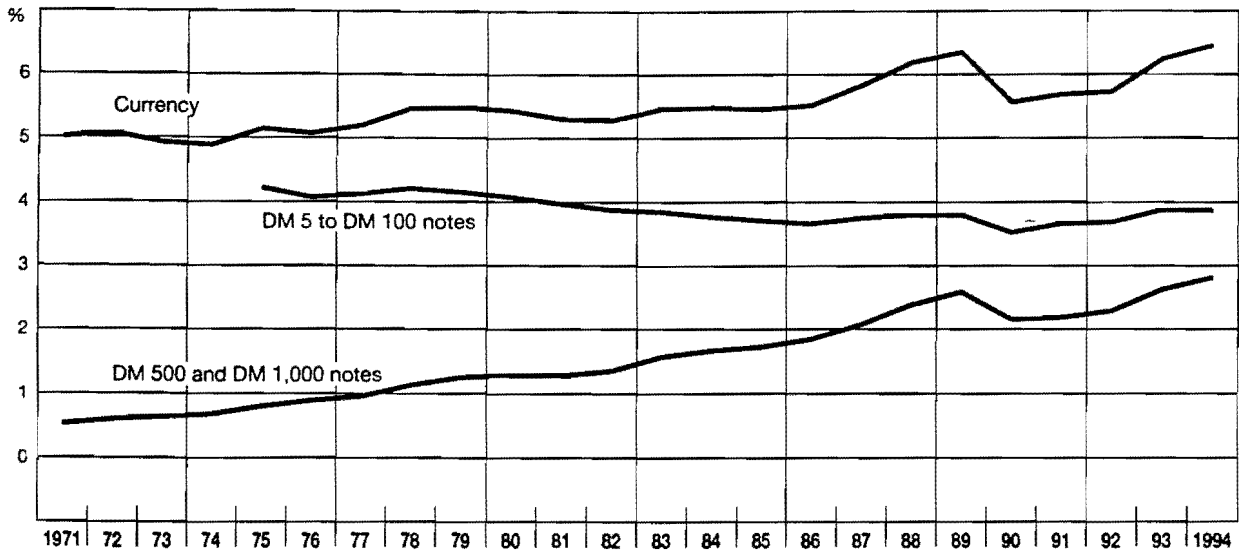
Currency holdings relative to private consumption¹



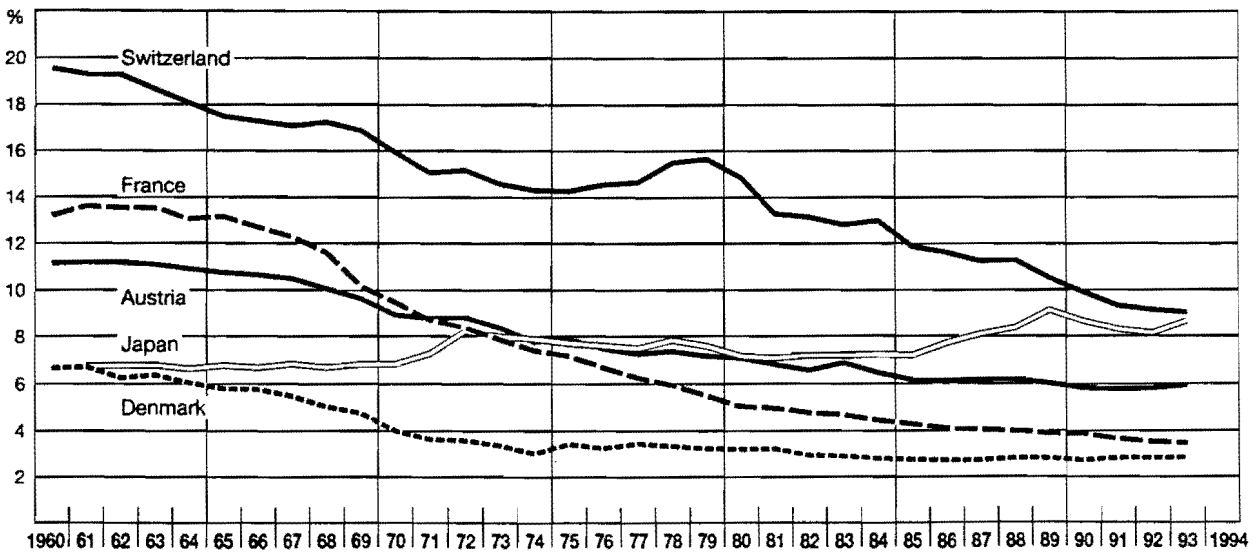
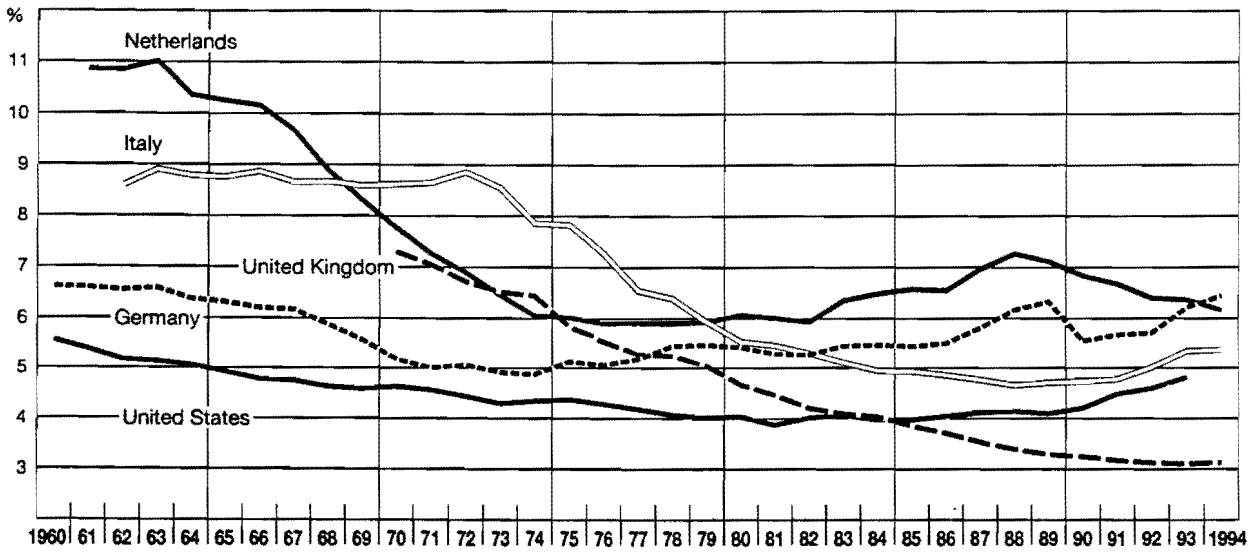
¹ Excluding credit institutions' currency holdings

Trends in currency and GDP

(a) Currency, in total and in various denominations, relative to GDP in Germany

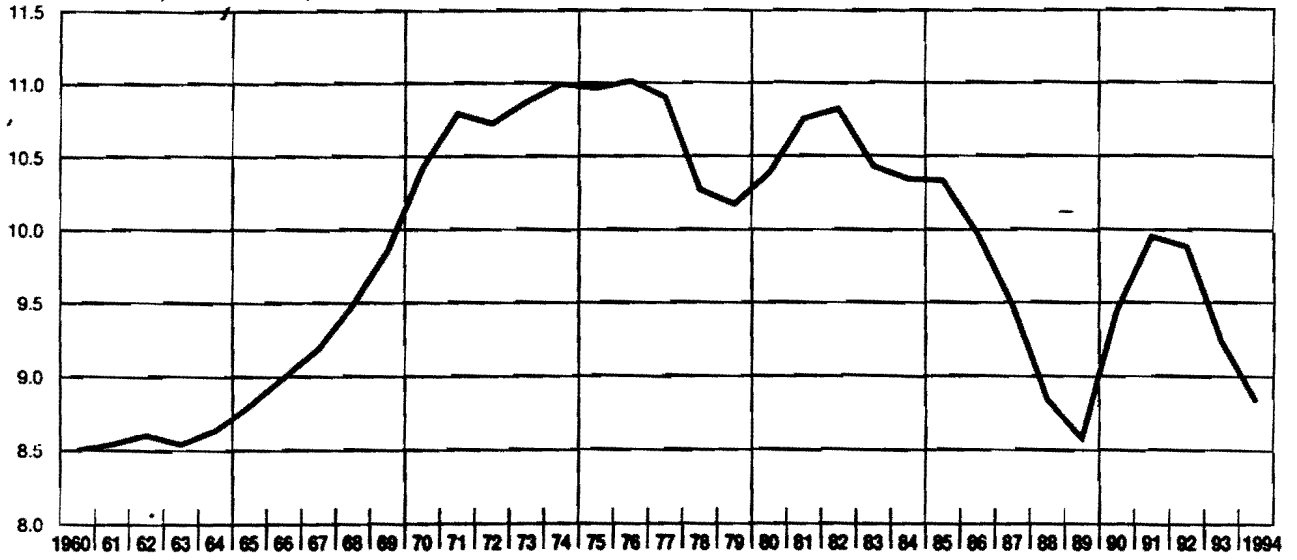


(b) Currency holdings relative to GDP



Velocity of circulation and currency

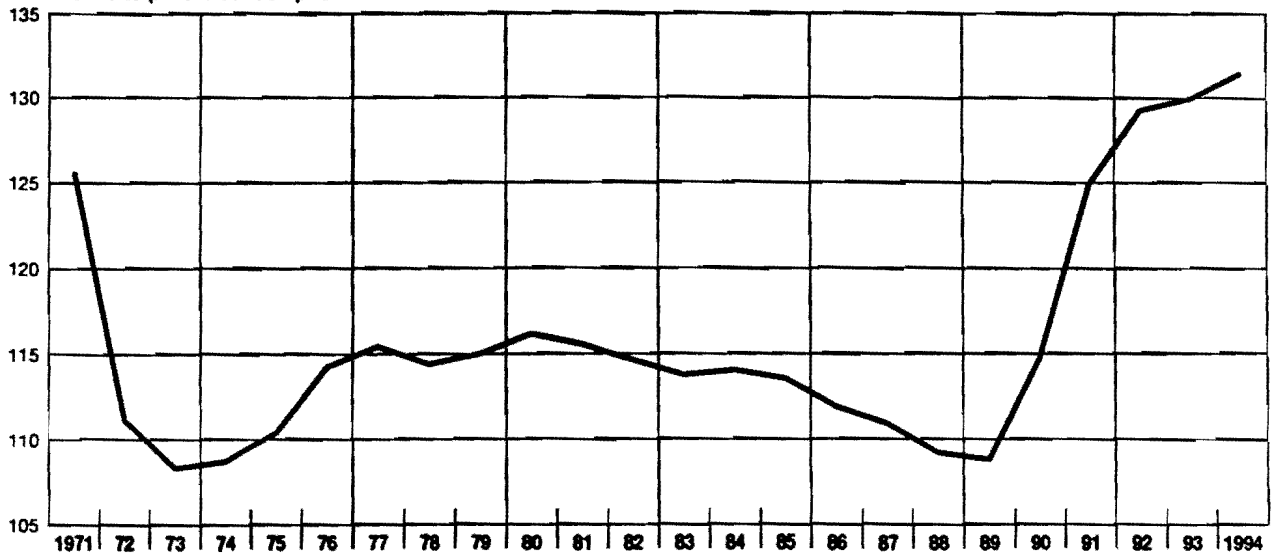
Velocity of circulation of currency outside the banking system
relative to private consumption



Velocity of circulation of banknotes
relative to private consumption

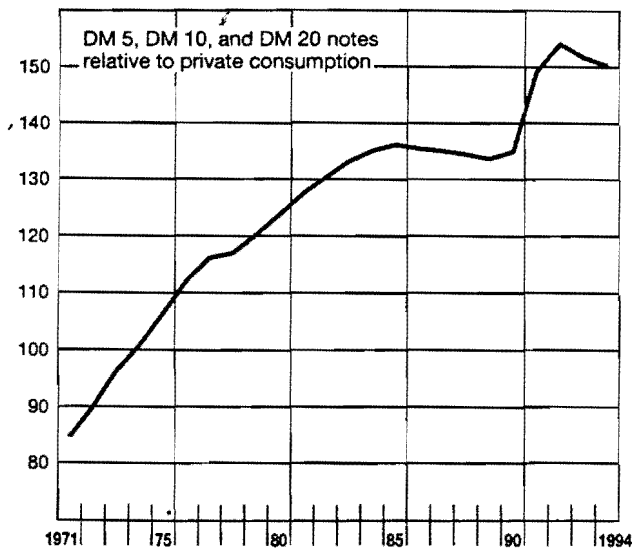


Velocity of circulation of coins
relative to private consumption

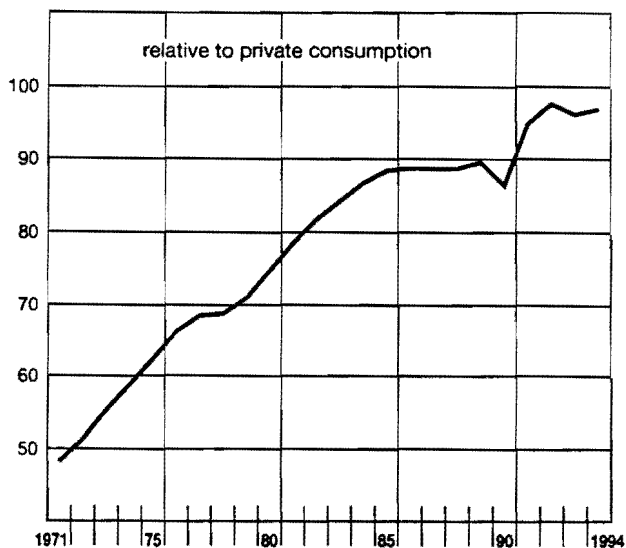


Velocity of circulation of Deutsche Mark notes

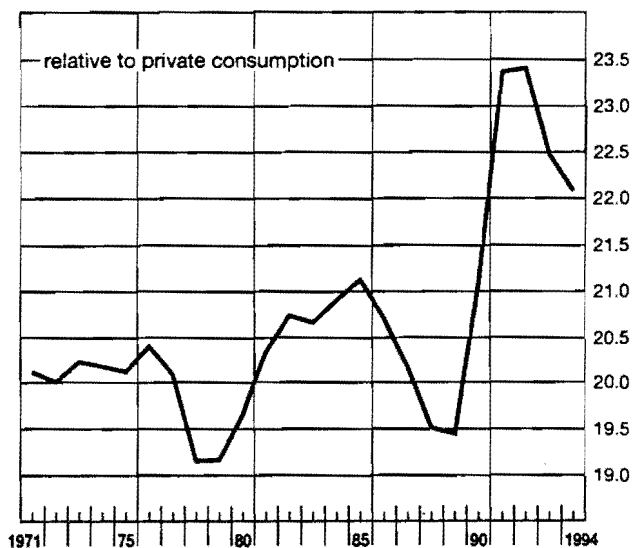
Velocity of circulation of small-denomination notes



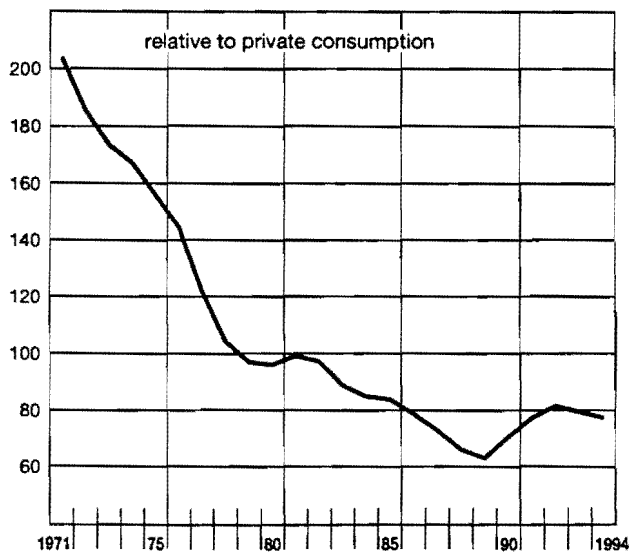
Velocity of circulation of DM 50 notes



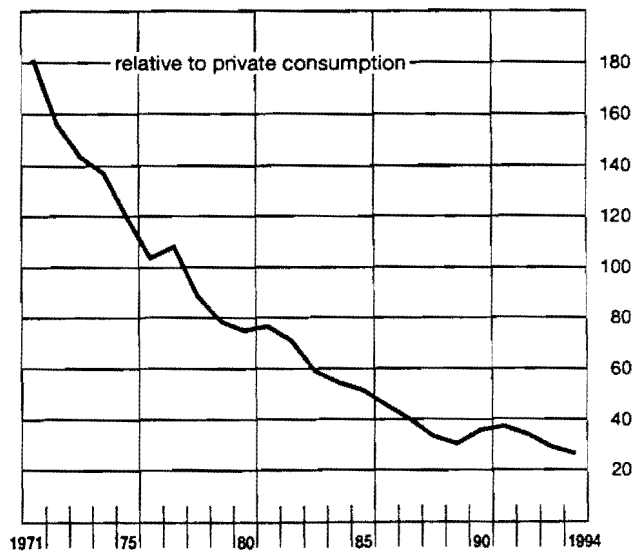
Velocity of circulation of DM 100 notes



Velocity of circulation of DM 500 notes

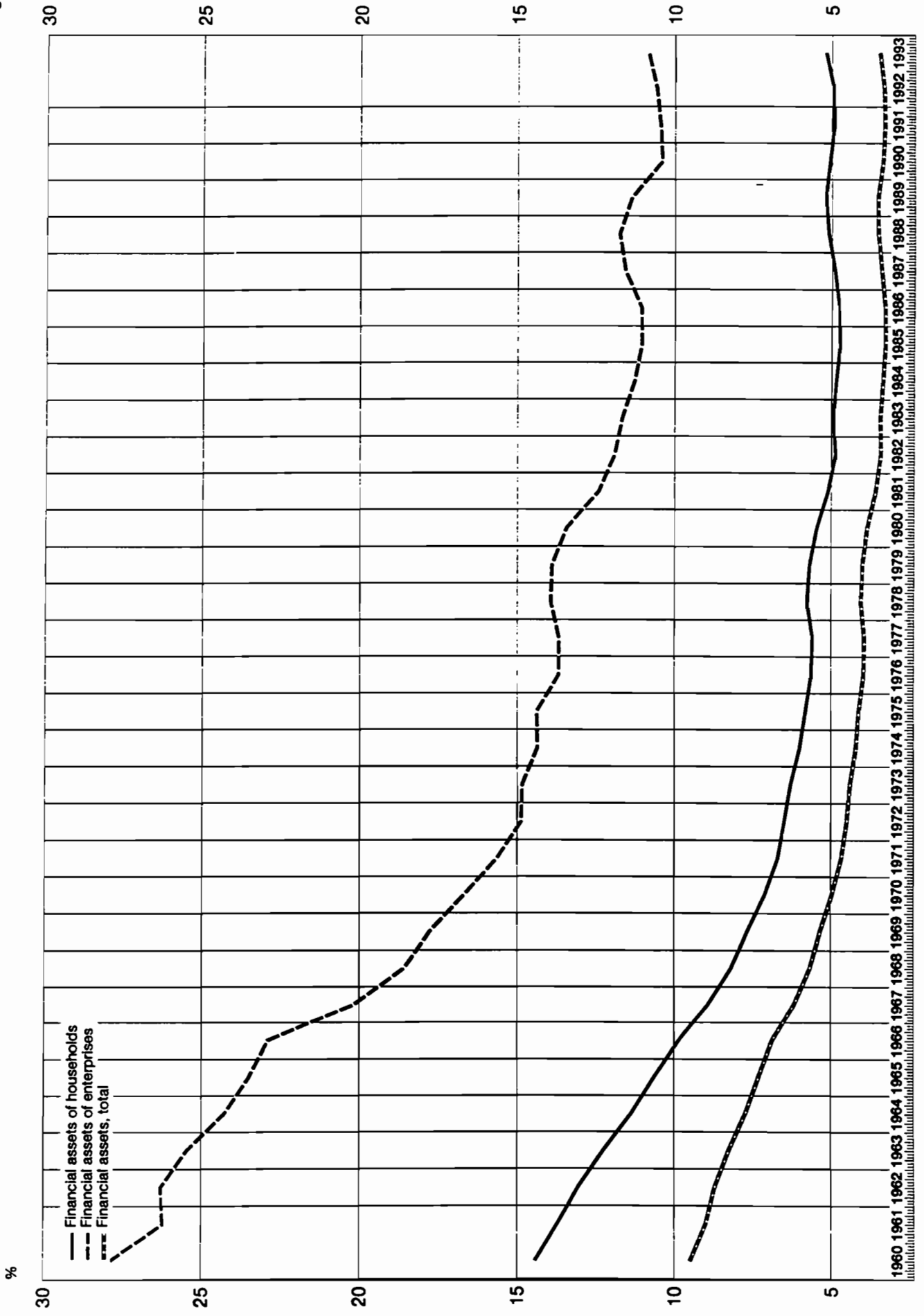


Velocity of circulation of DM 1,000 notes



Currency relative to private financial assets

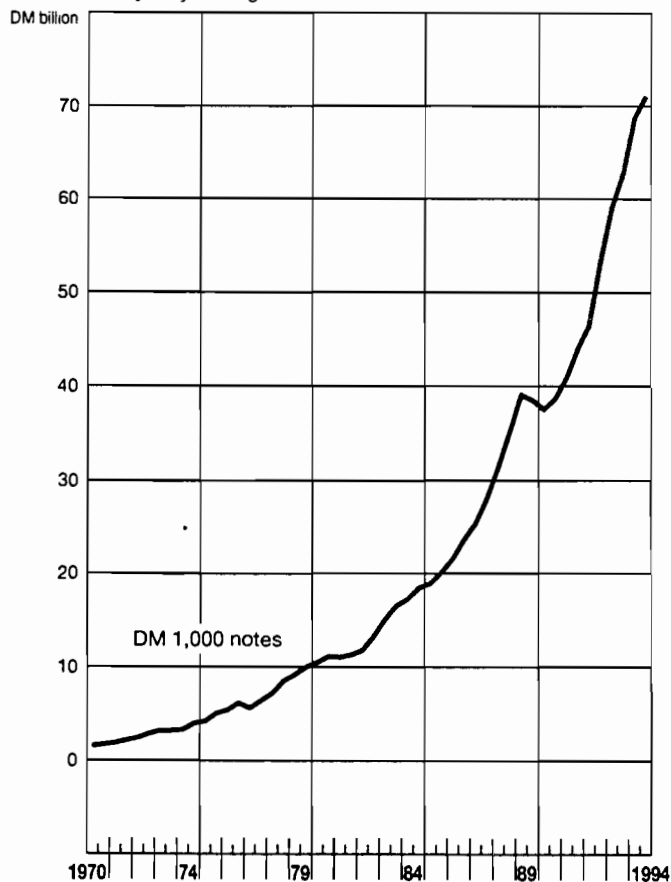
Figure 9



Deutsche Mark notes in circulation

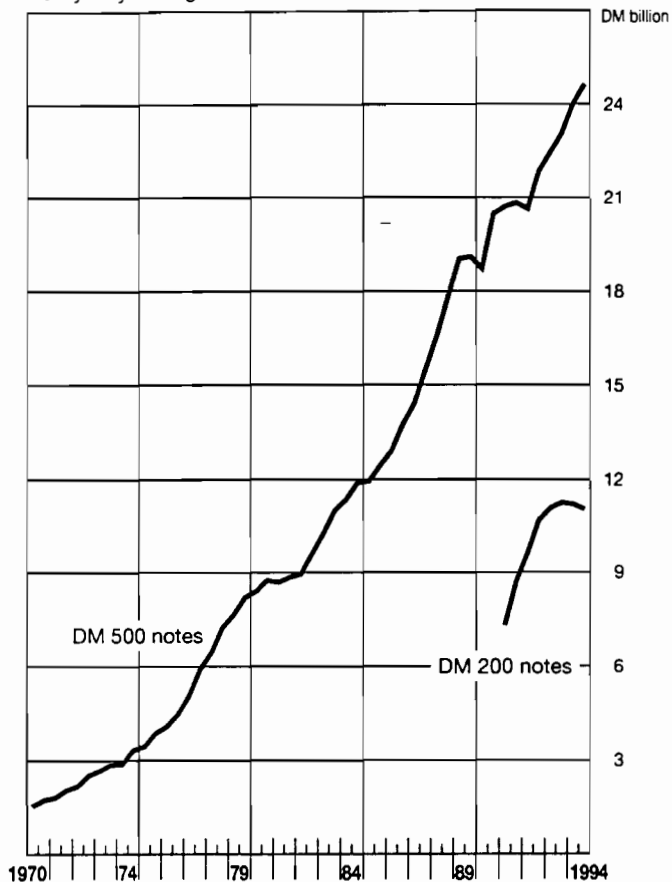
Circulation of DM 1,000 notes

Half-yearly averages



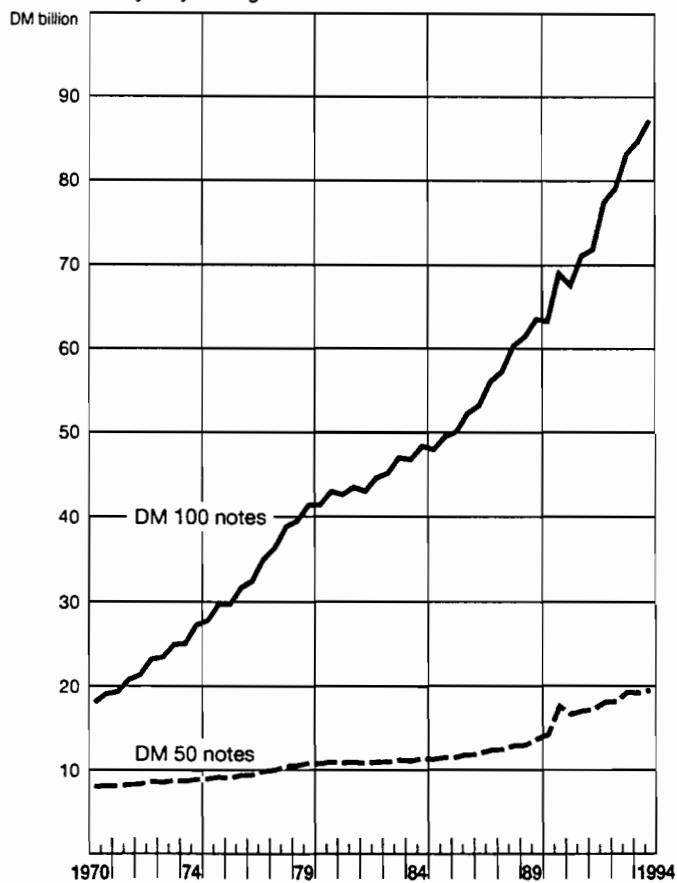
Circulation of DM 200 and DM 500 notes

Half-yearly averages



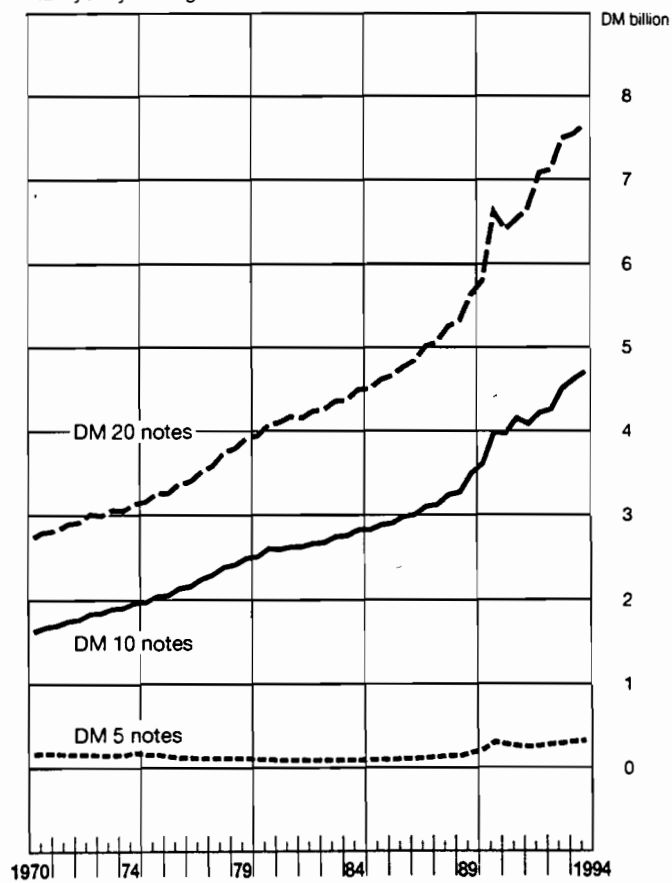
Circulation of DM 50 and DM 100 notes

Half-yearly averages



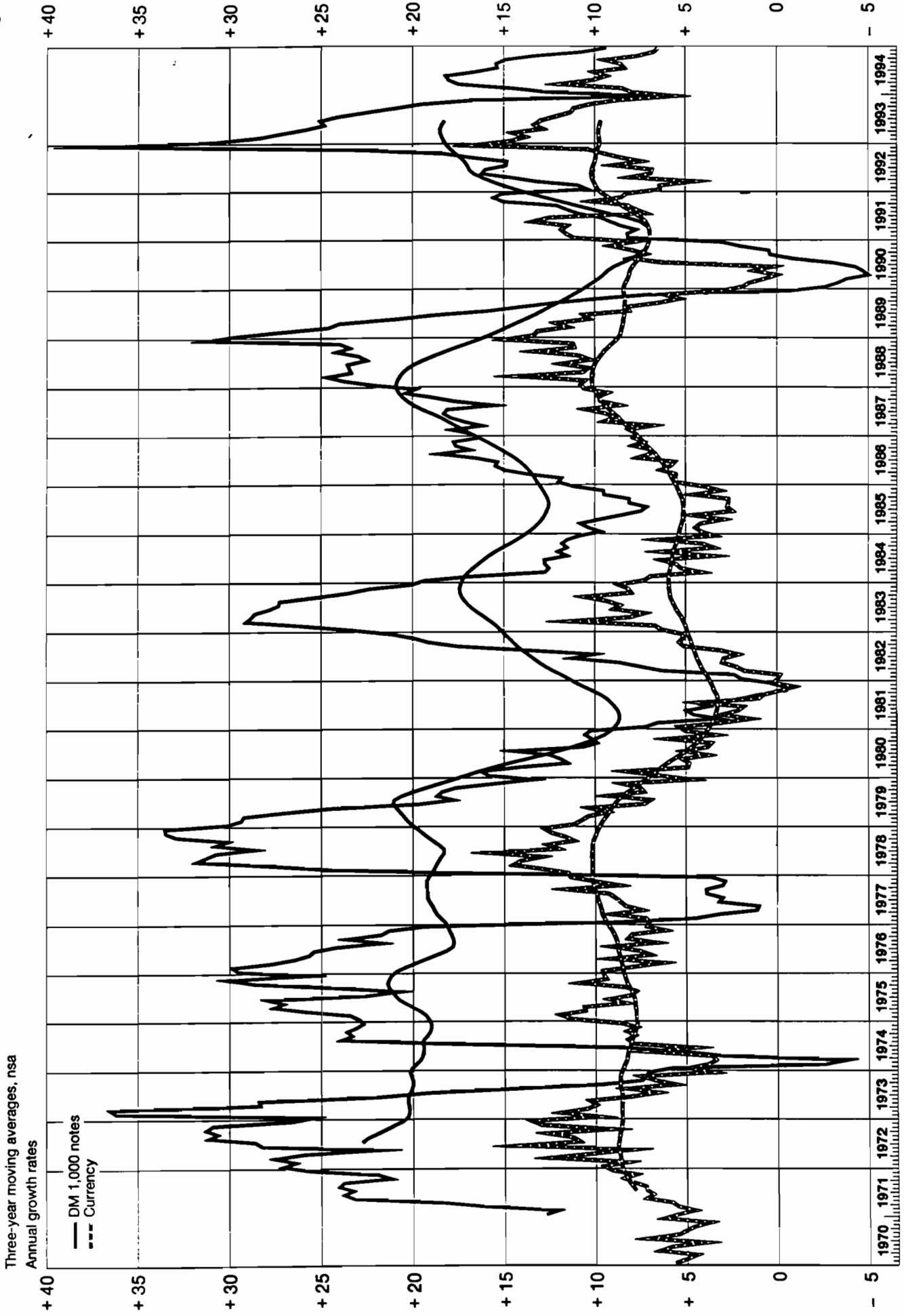
Circulation of DM 5, DM 10 and DM 20 notes

Half-yearly averages



Currency, total, and DM 1,000 notes

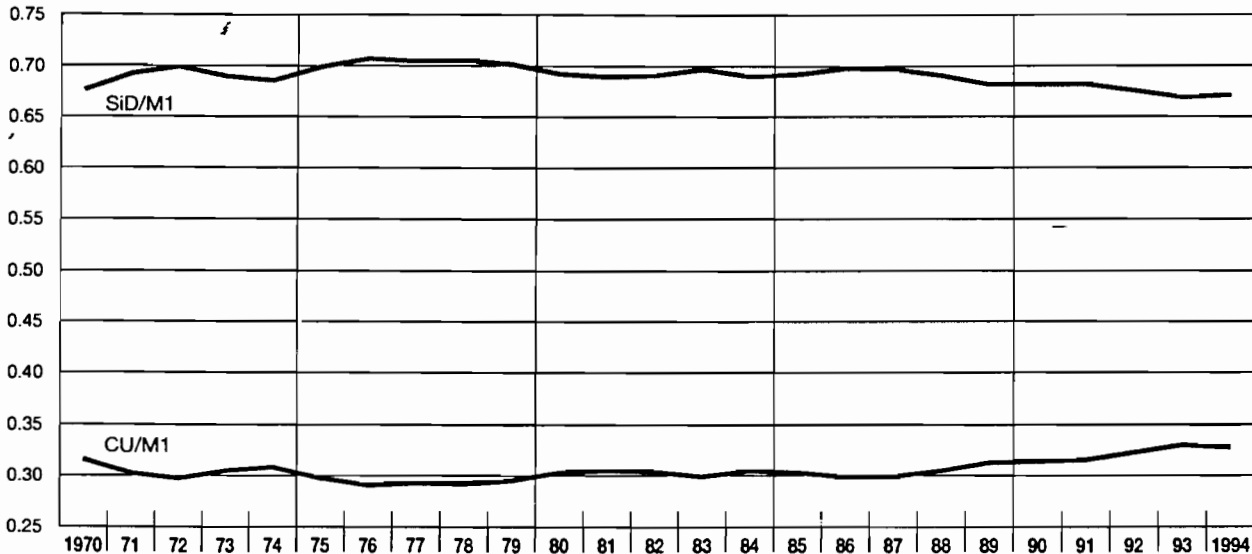
Figure 11



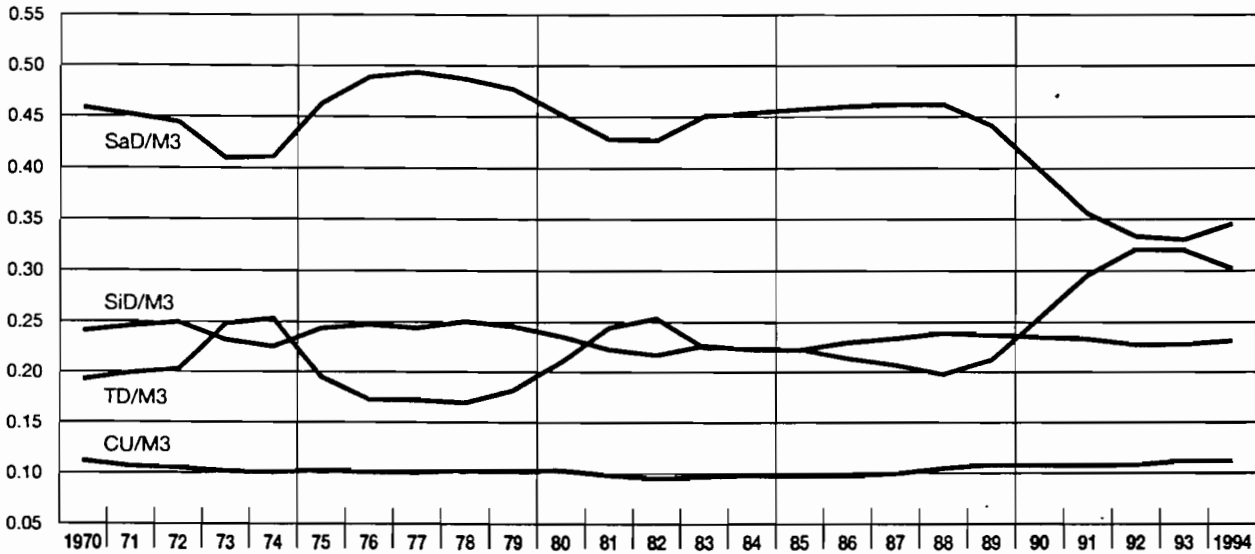
Components of the money stock

CU: Currency
 SiD: Sight deposits
 TD: Time deposits < four years
 SaD: Savings deposits at three months' notice

Shares of components in M1

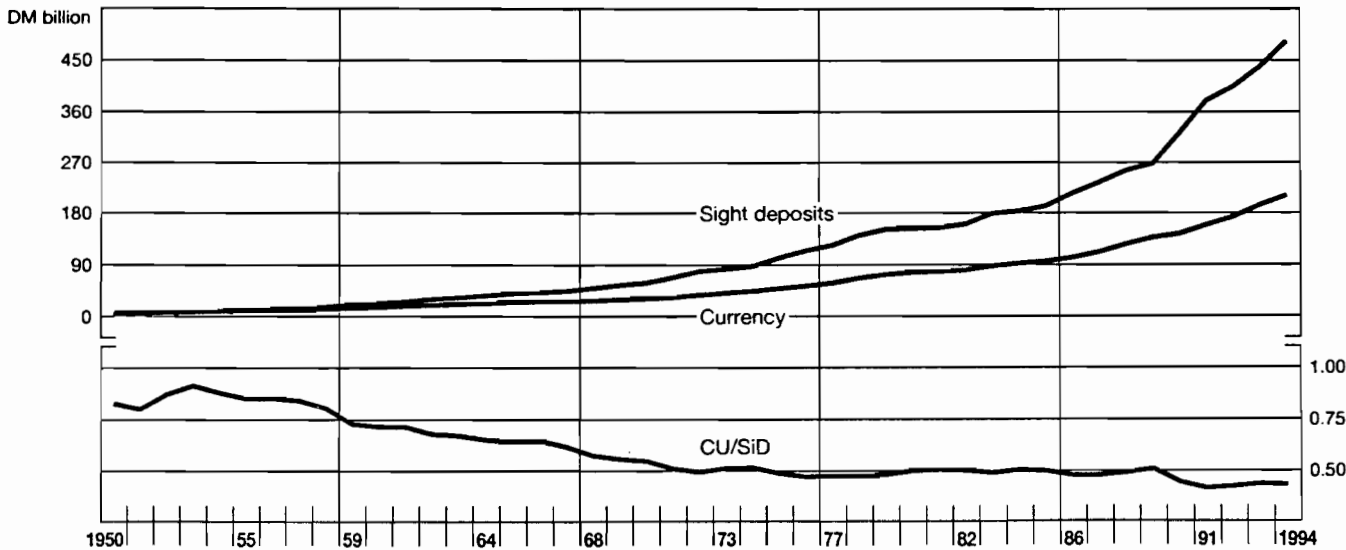


Shares of components in M3



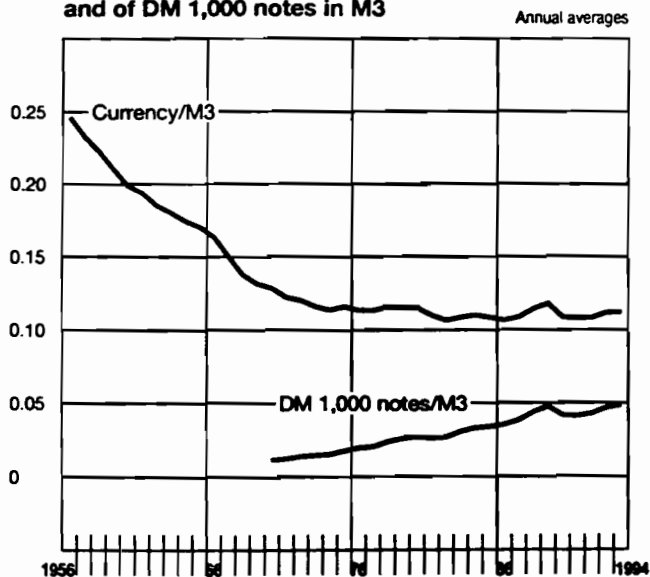
Movement of currency in circulation and sight deposits

Annual averages

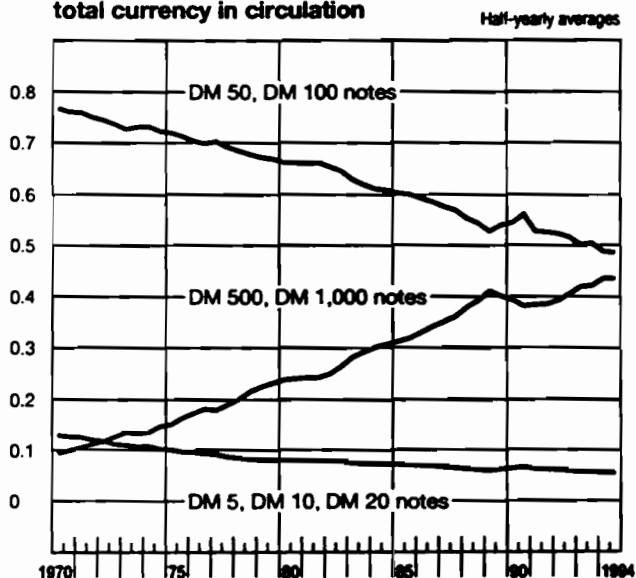


Banknote denominations and currency in circulation

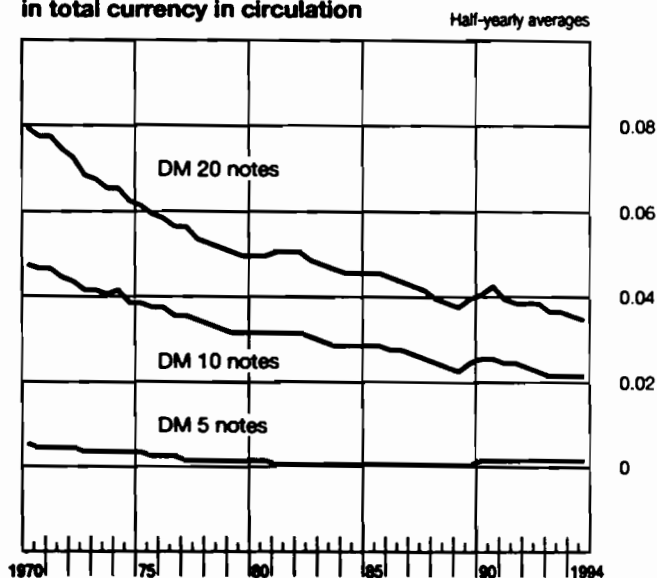
Shares of total currency in circulation and of DM 1,000 notes in M3



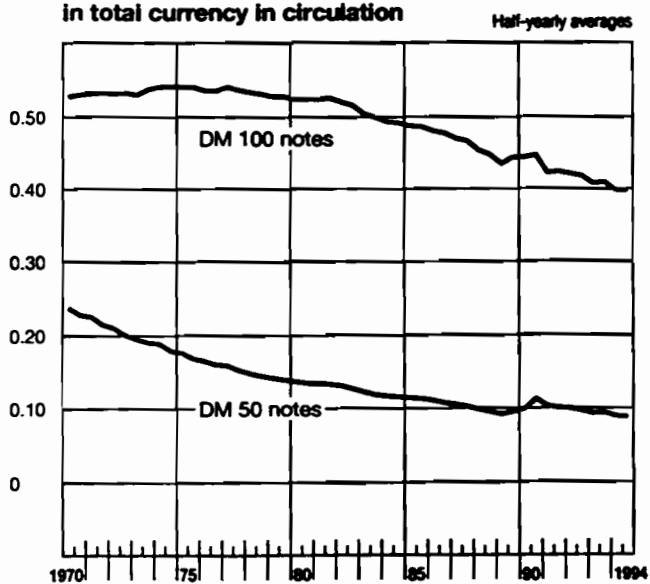
Share of various denominations in total currency in circulation



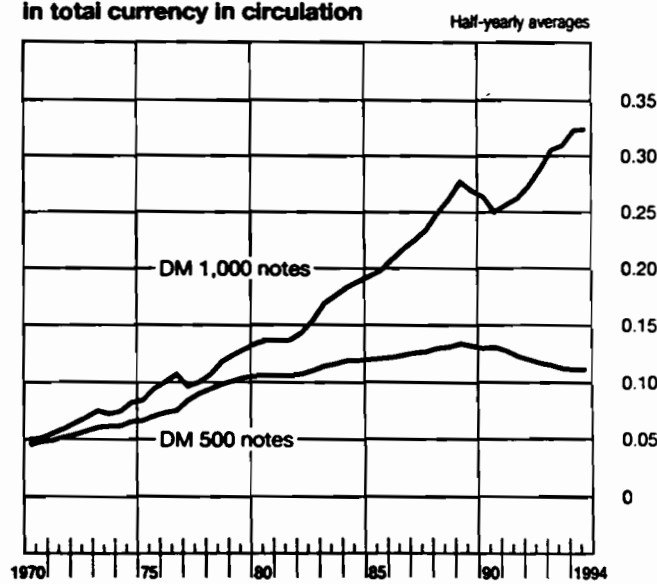
Share of DM 20, DM 10 and DM 5 notes in total currency in circulation



Share of DM 100 and DM 50 notes in total currency in circulation

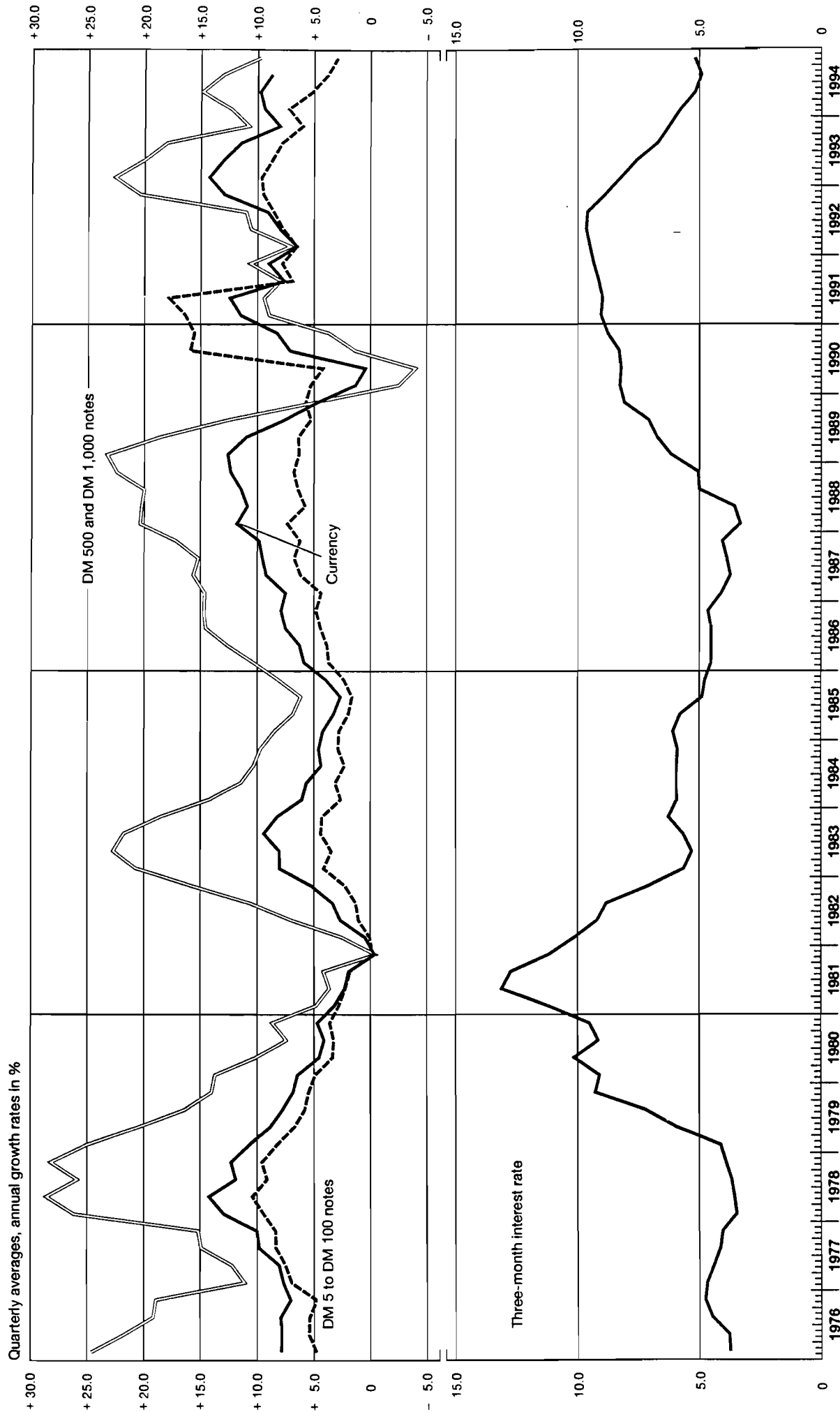


Share of DM 500 and DM 1,000 notes in total currency in circulation



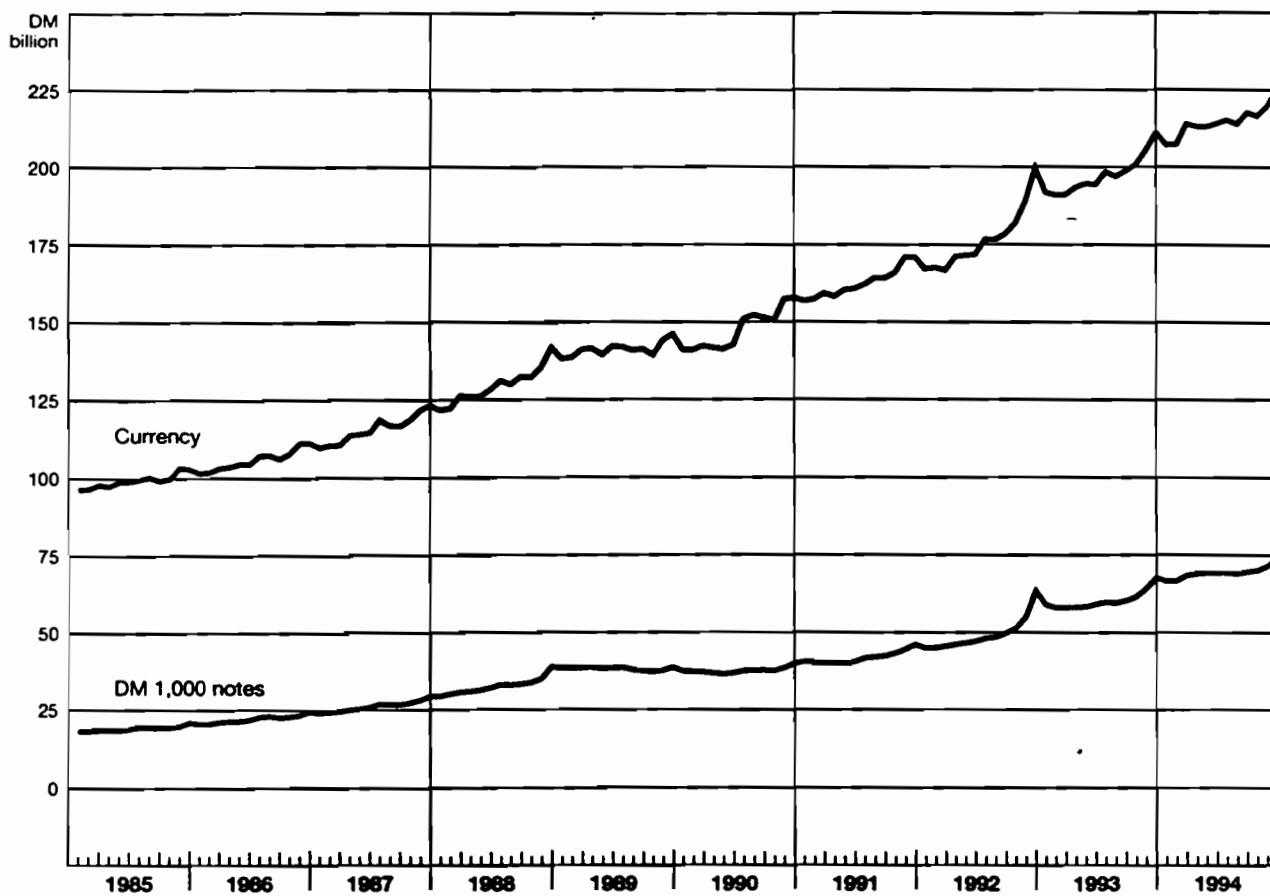
Currency in circulation, total and by denomination, and interest rate movements

Figure 14

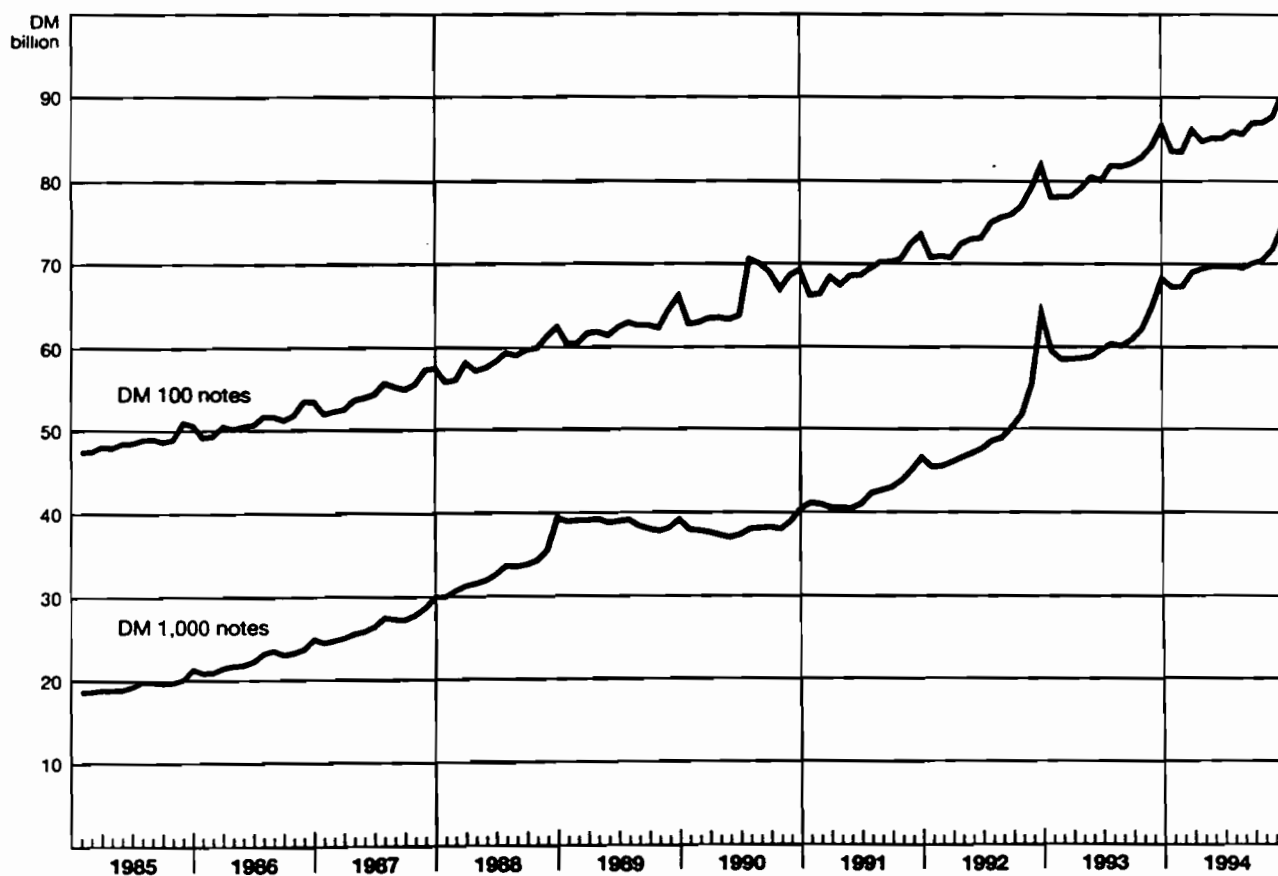


Trends in currency (nsa)

Currency in circulation, total and DM 1,000 notes



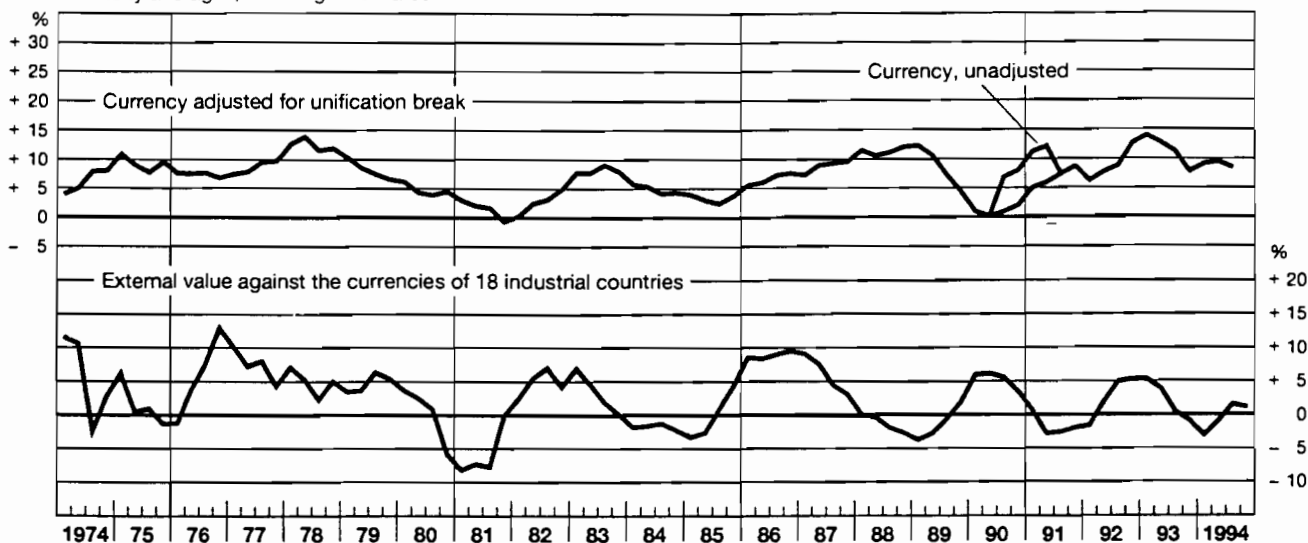
DM 100 and DM 1,000 notes



Currency in circulation and exchange rate movements

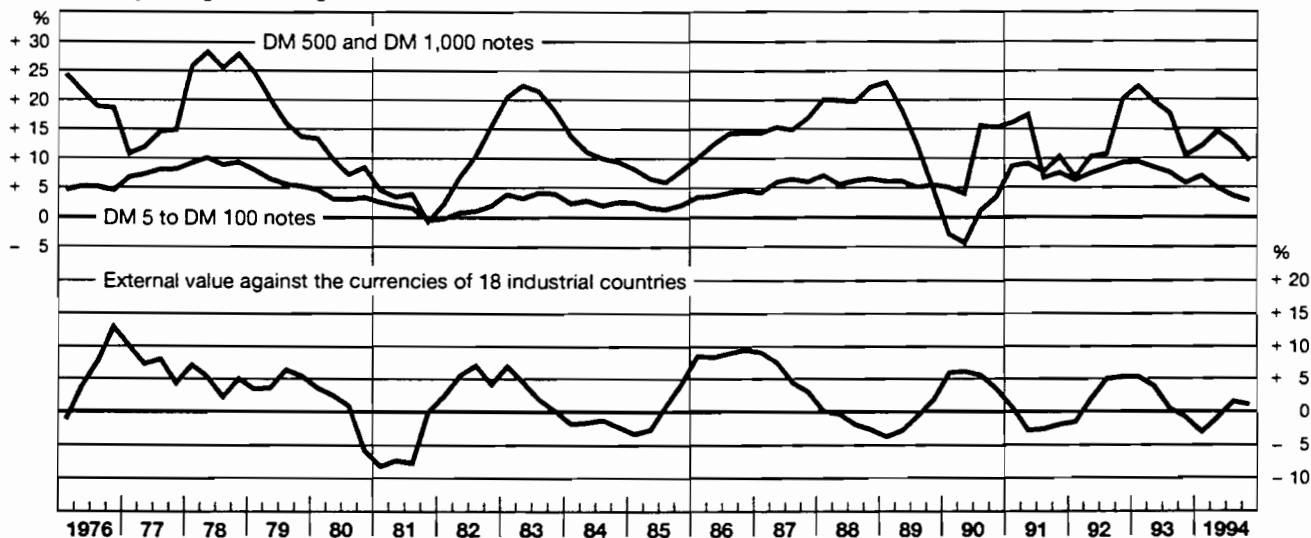
Currency in circulation and external value of the Deutsche Mark

Quarterly averages, annual growth rates



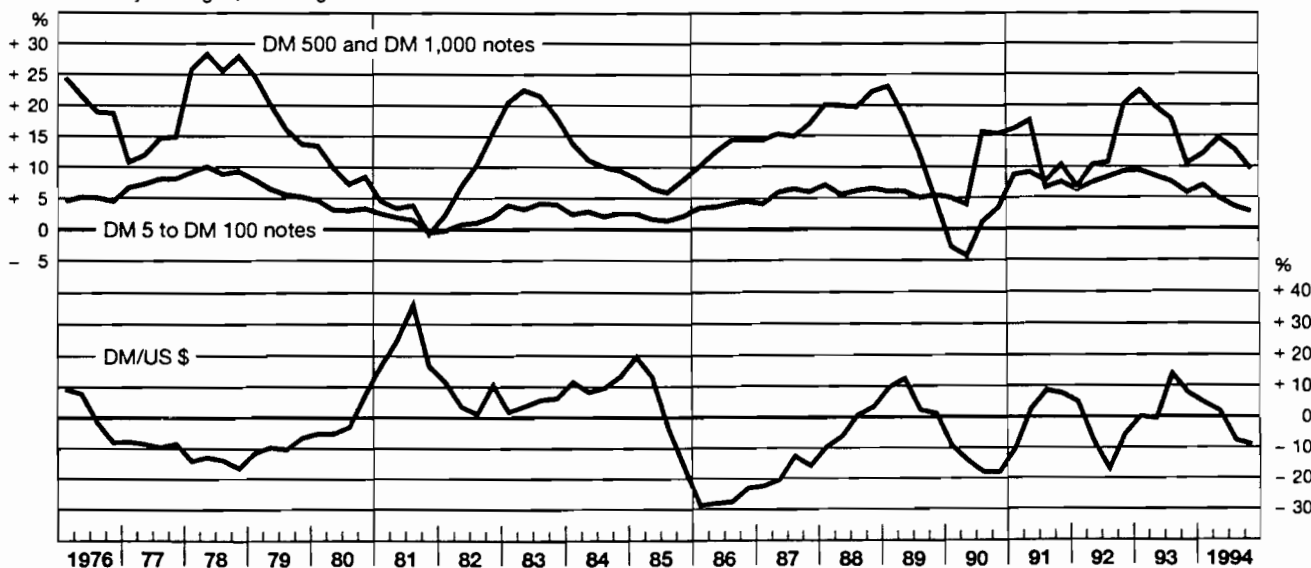
Currency in circulation, by denomination, and external value of the Deutsche Mark

Quarterly averages, annual growth rates



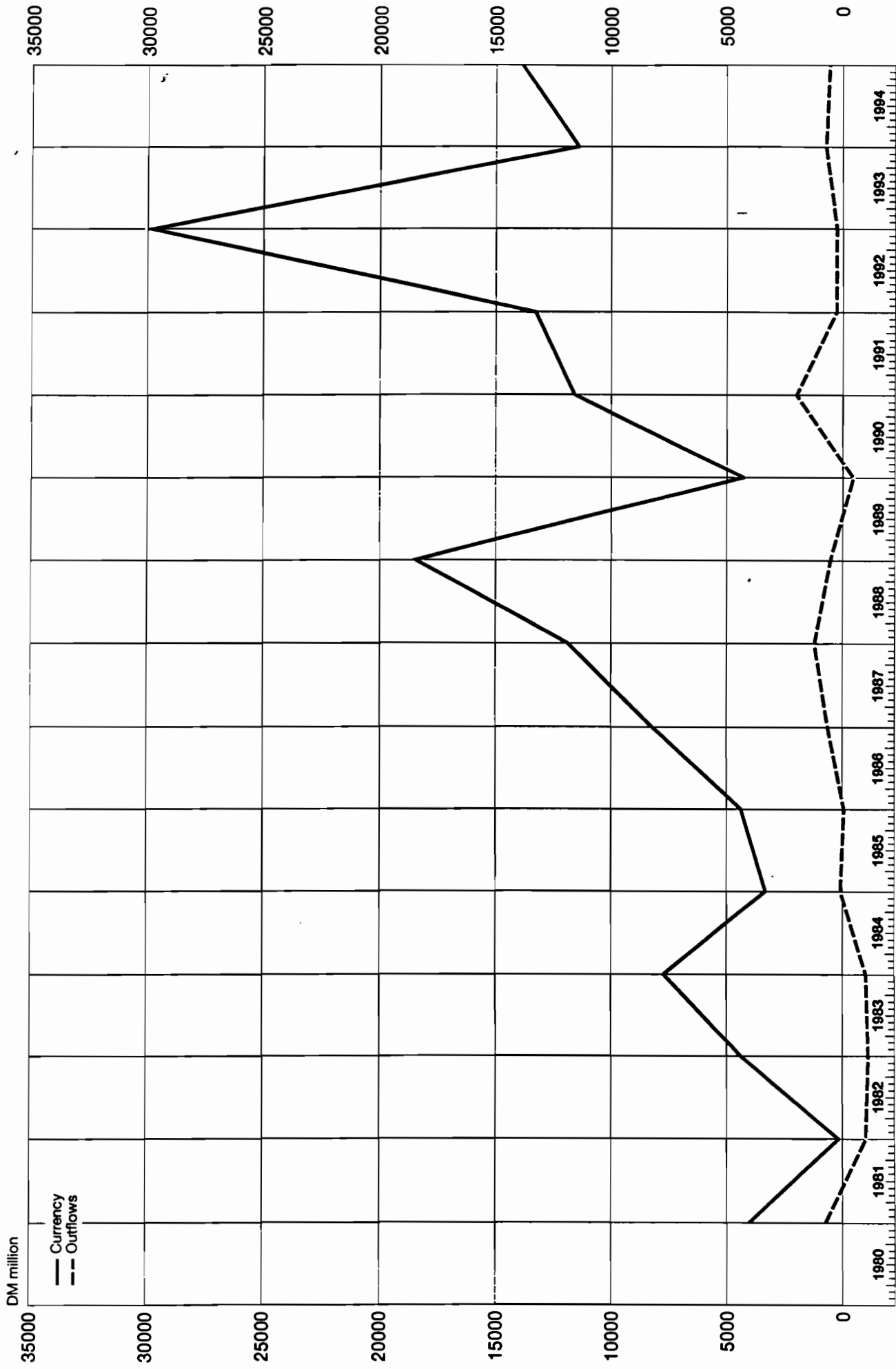
Currency in circulation, by denomination, and Deutsche Mark/US dollar exchange rate

Quarterly averages, annual growth rates



Absolute annual change of currency in circulation and official net outflows of notes abroad

Figure 17

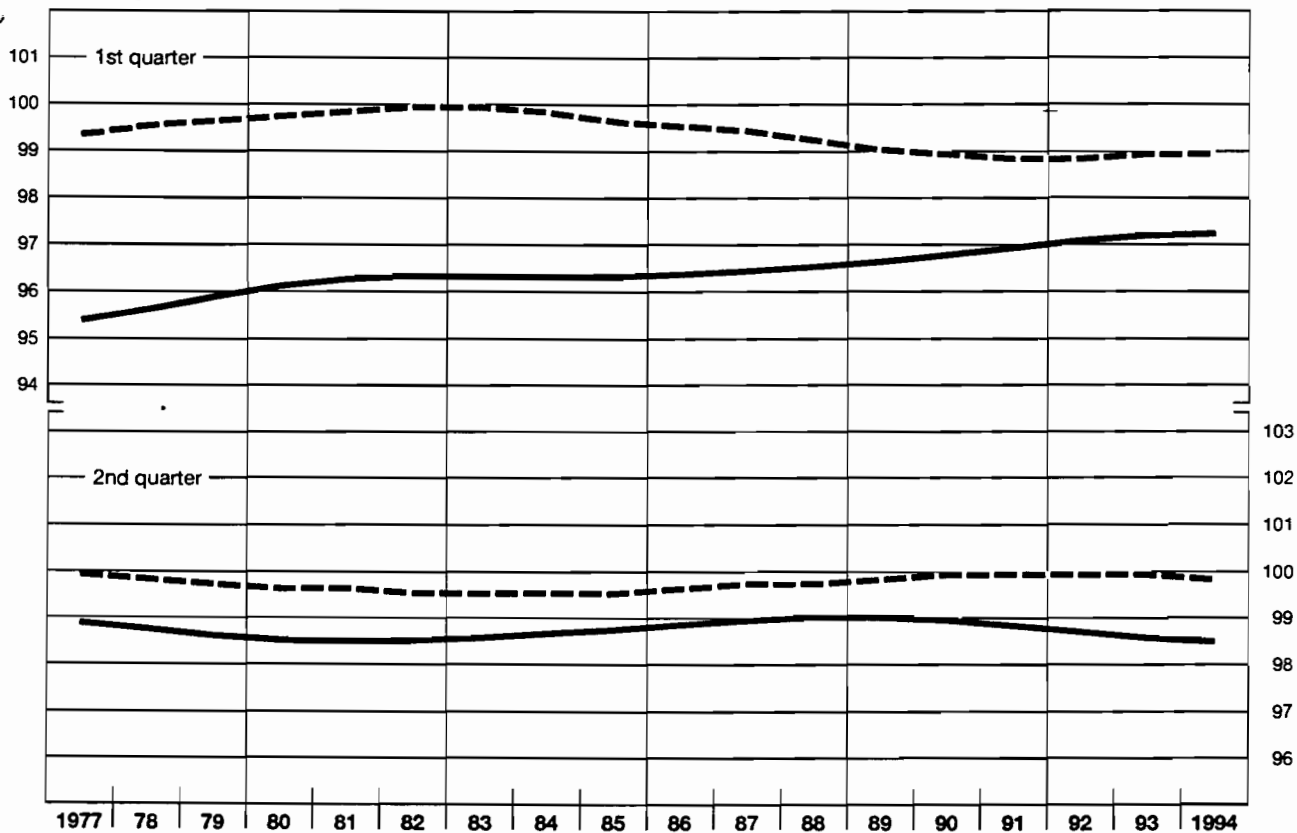


Comparison of seasonal factors for private consumption in Germany and the Netherlands

— Germany
 - - - Netherlands

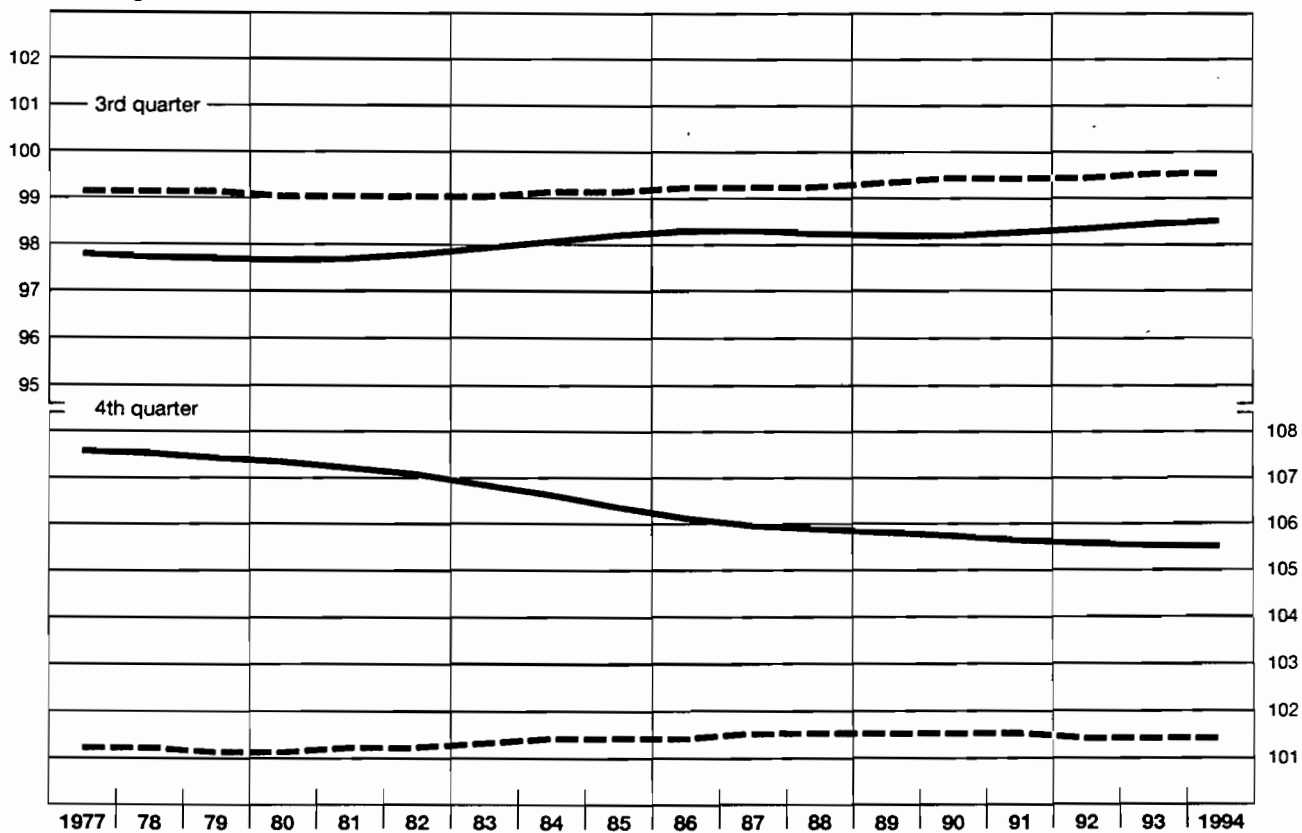
1st quarter and 2nd quarter

Annual figures



3rd quarter and 4th quarter

Annual figures

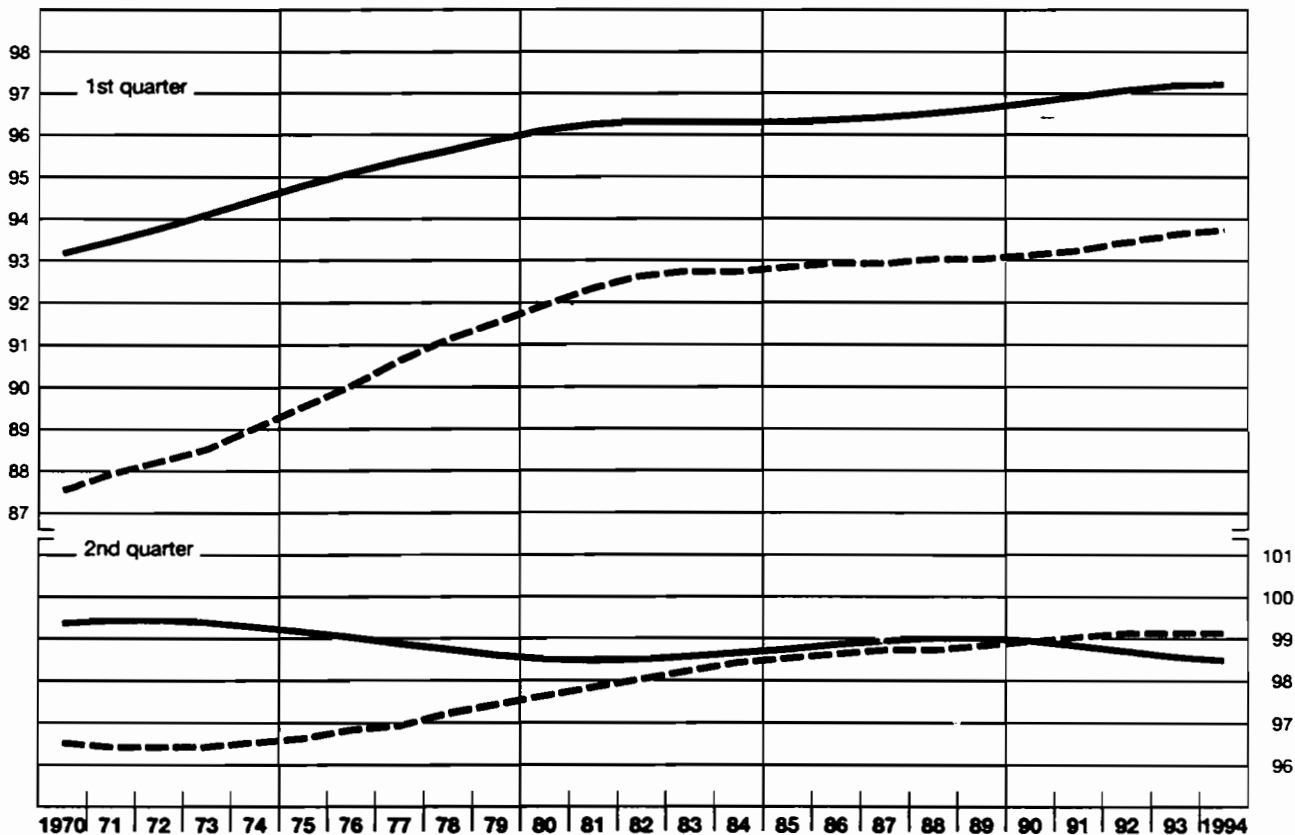


Comparison of seasonal factors for private consumption in Germany and Austria

— Germany
 - - - Austria

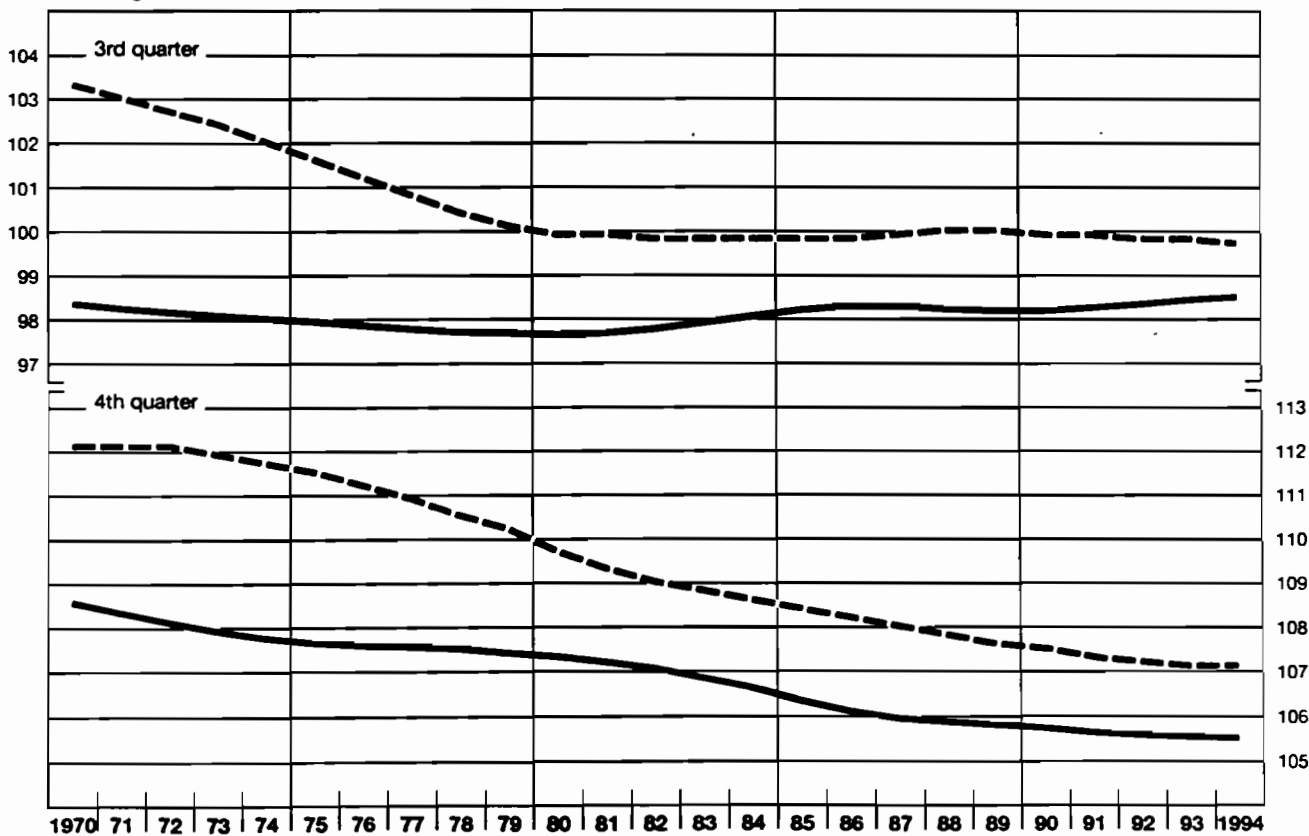
1st quarter and 2nd quarter

Annual figures



3rd quarter and 4th quarter

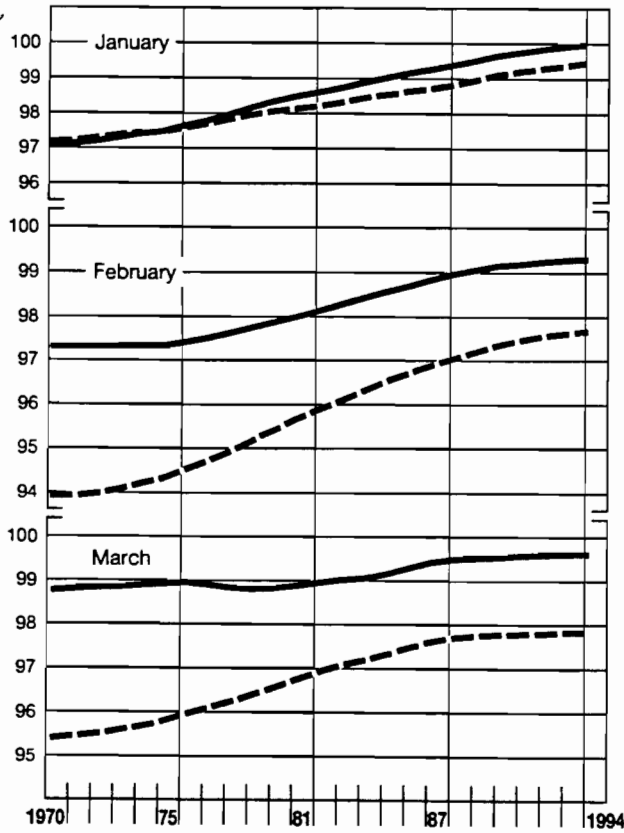
Annual figures



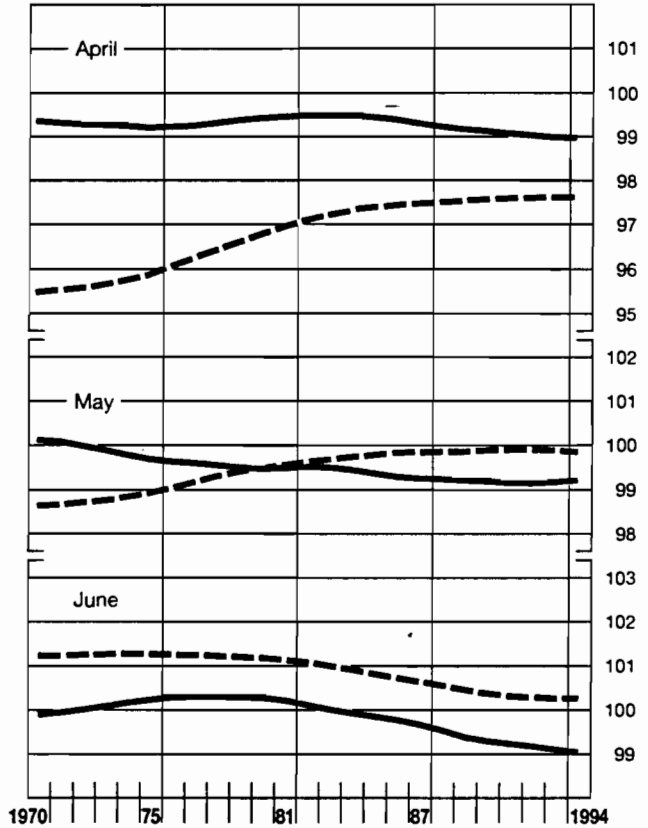
Comparison of seasonal factors for banknotes in circulation in Germany and Austria

— Germany
 - - - Austria

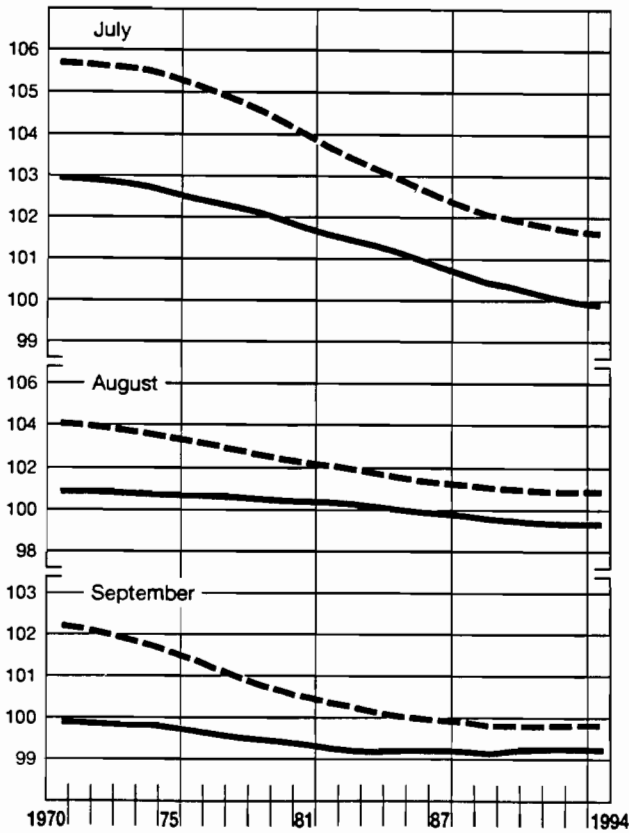
January to March



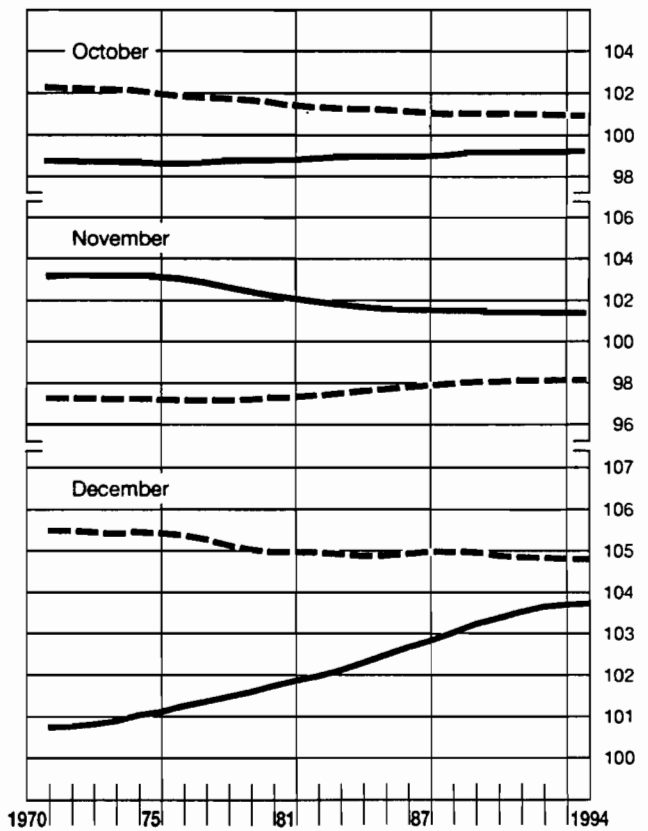
April to June



July to September



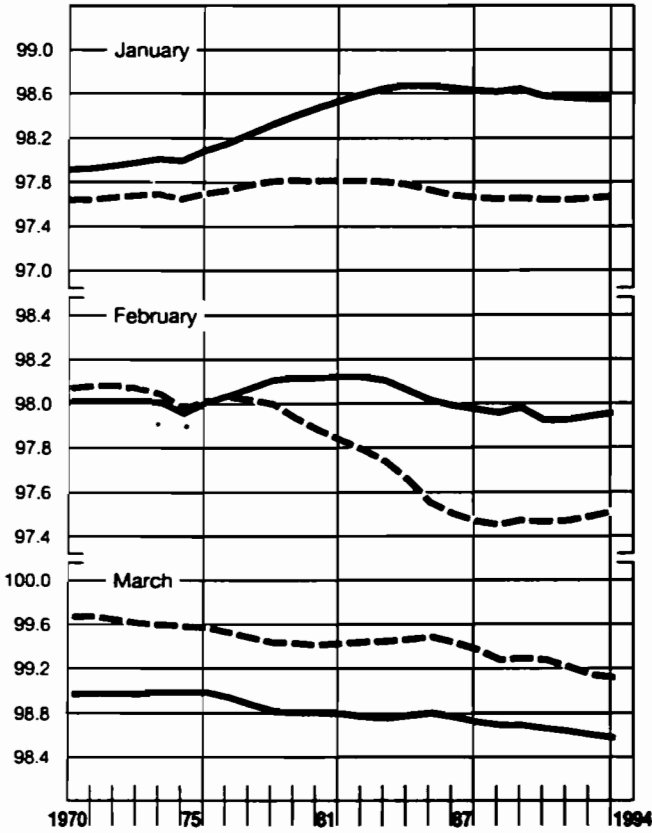
October to December



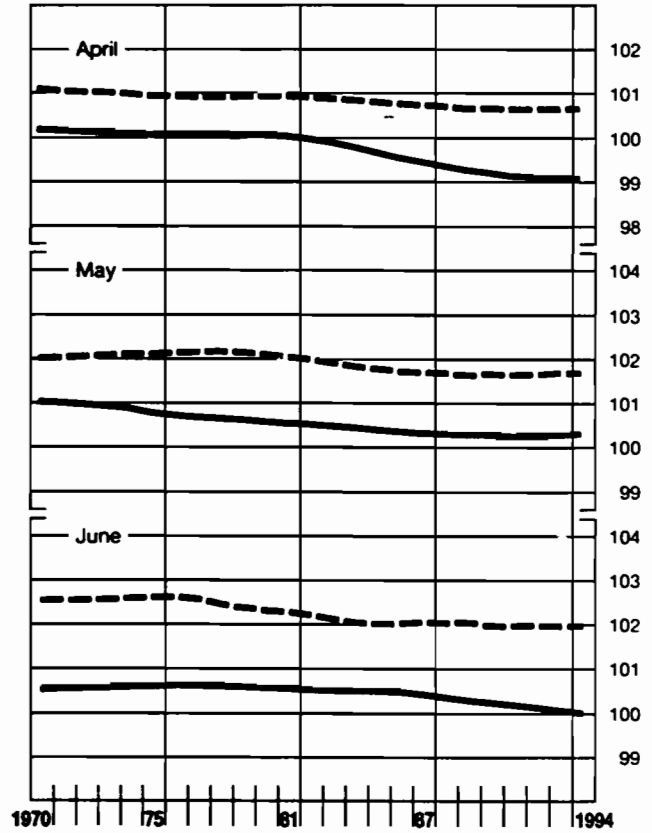
Comparison of seasonal factors for DM 10 and Hfl 10 notes

— Germany
 - - - Netherlands

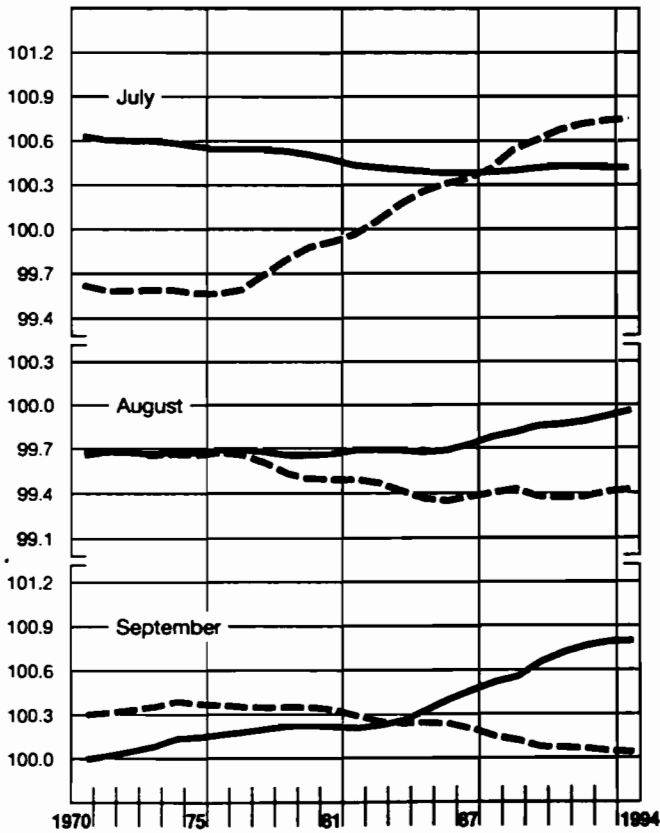
January to March



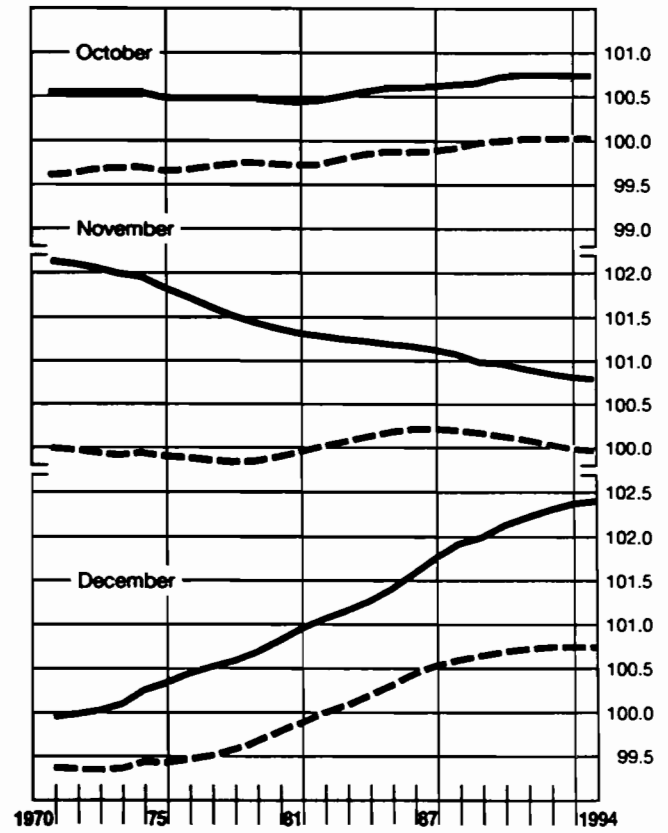
April to June



July to September



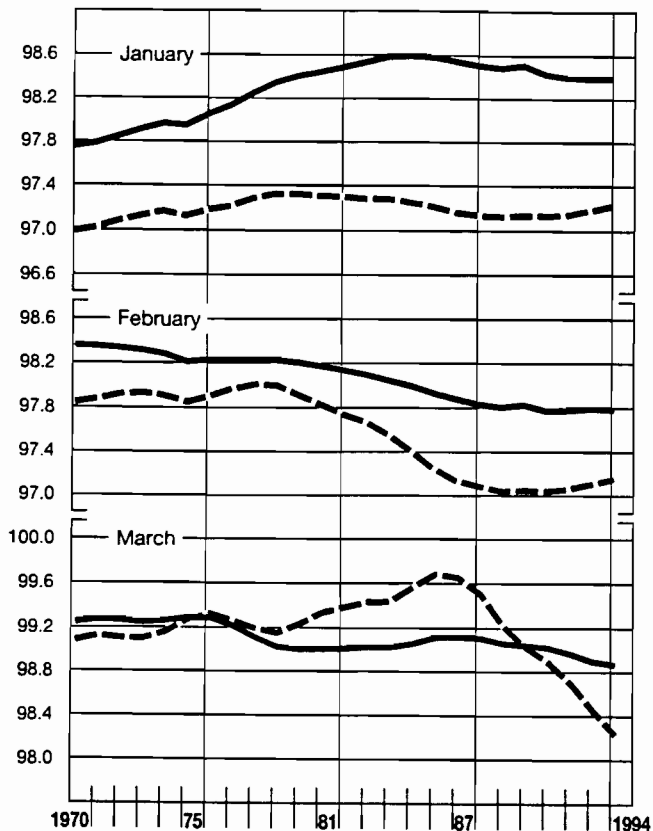
October to December



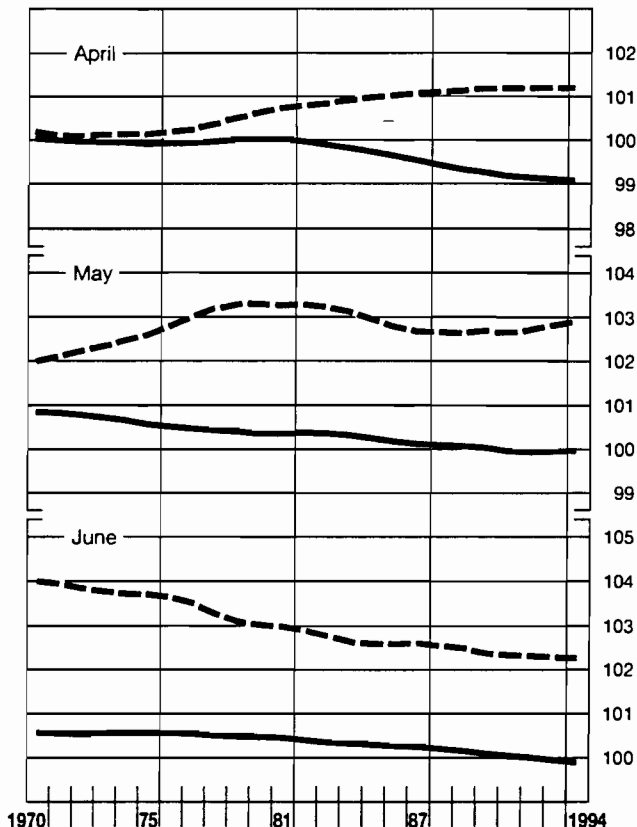
Comparison of seasonal factors for DM 20 and Hfl 25 notes

— Germany
 - - - Netherlands

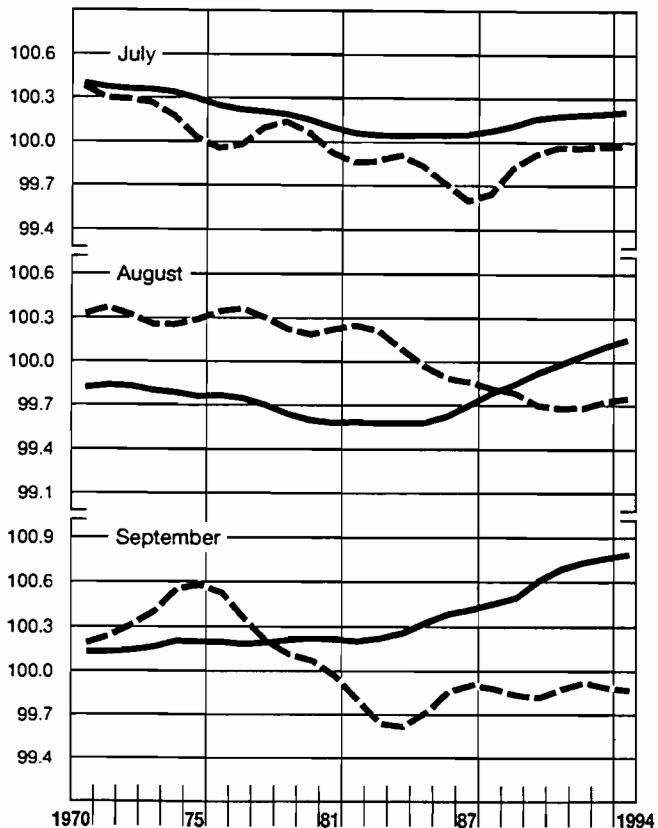
January to March



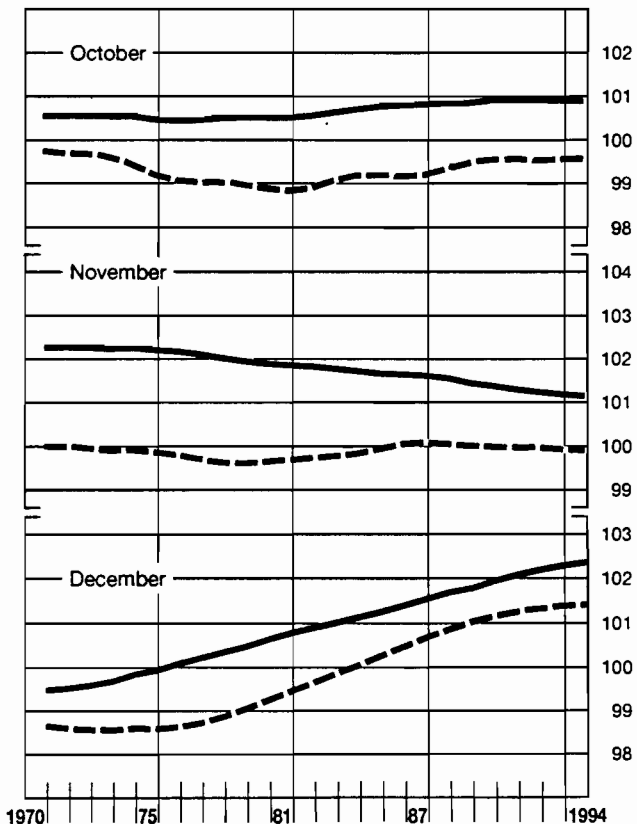
April to June



July to September



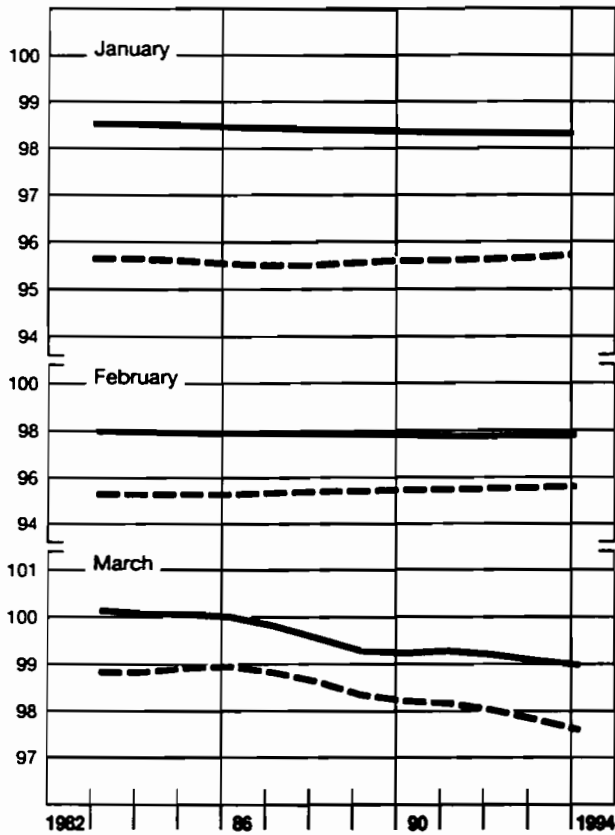
October to December



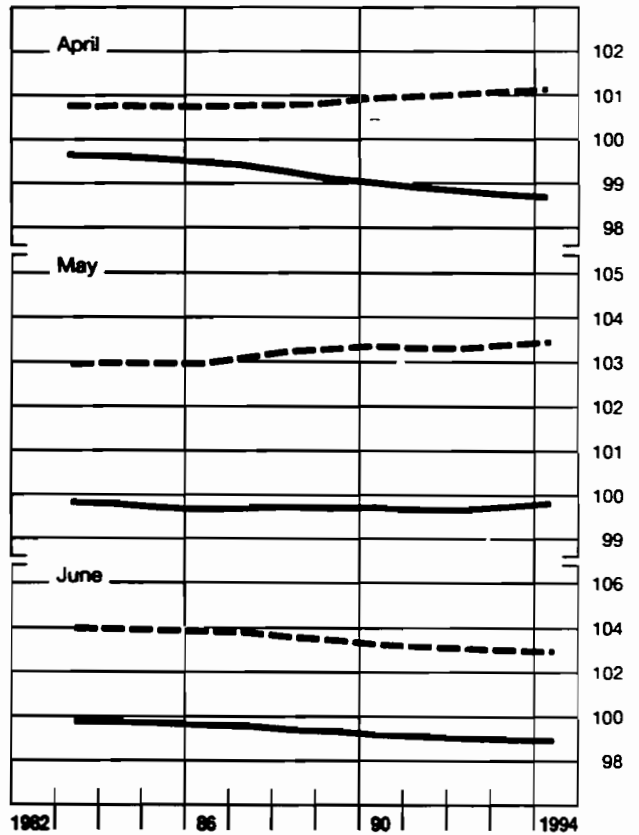
Comparison of seasonal factors for DM 50 and Hfl 50 notes

— Germany
 - - - Netherlands

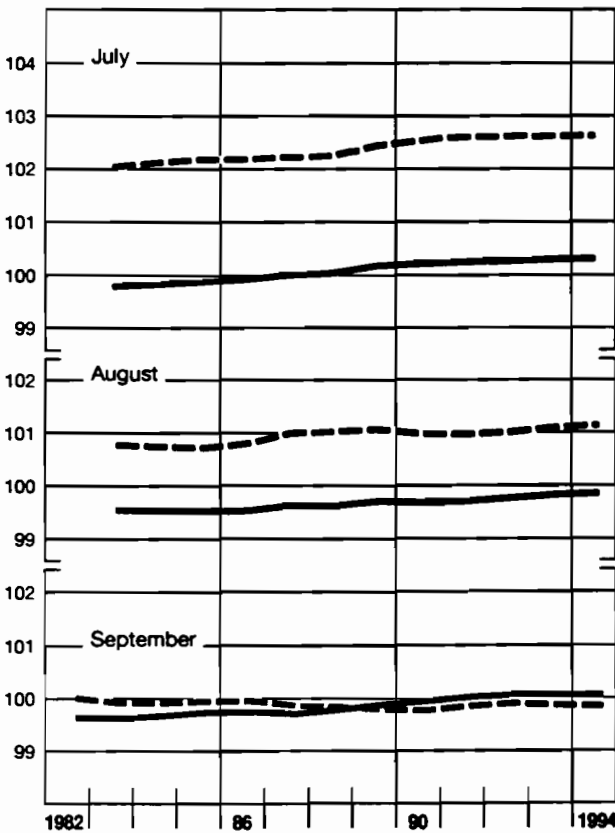
January to March



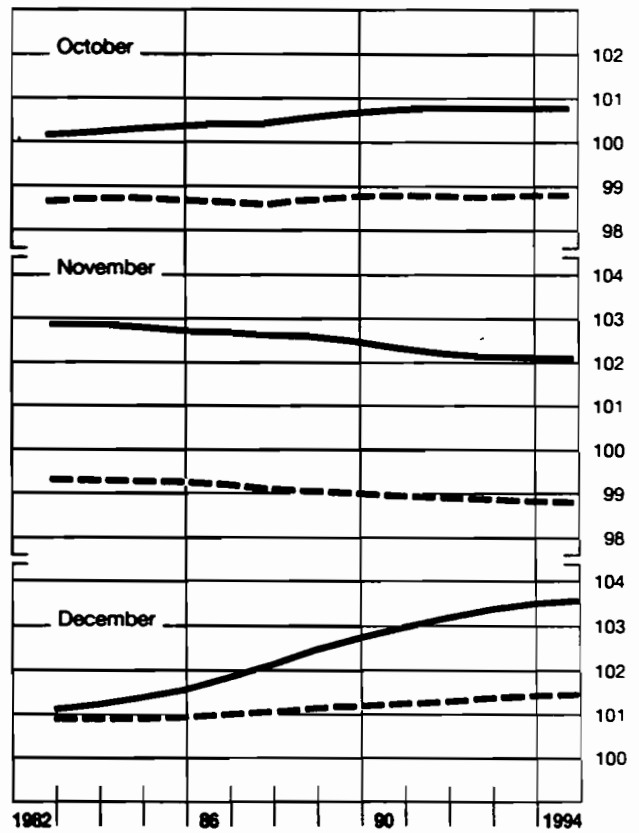
April to June



July to September



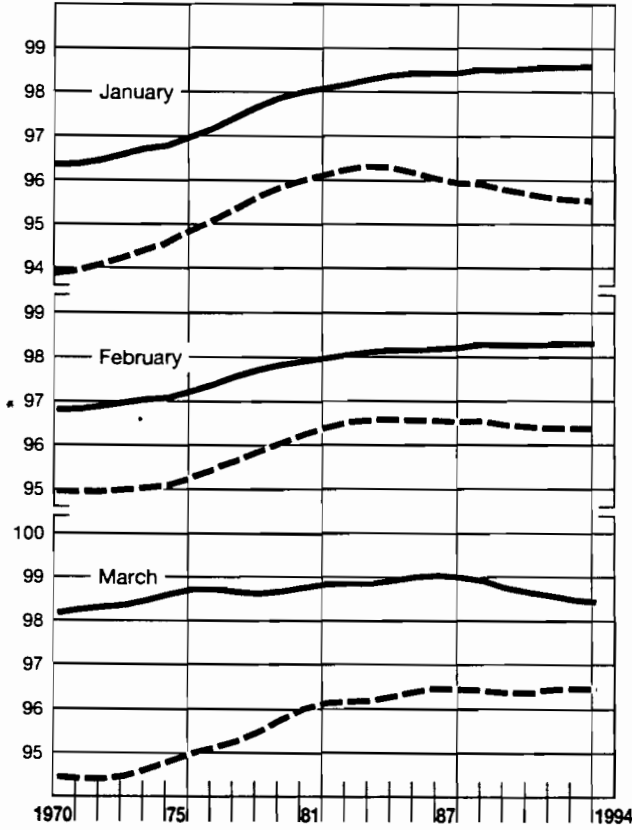
October to December



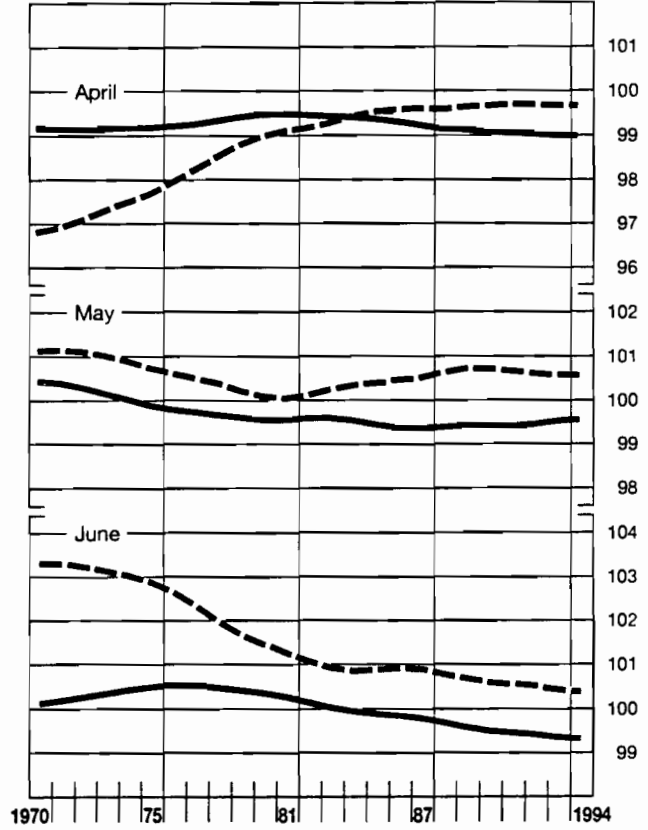
Comparison of seasonal factors for DM 100 and S 1,000 notes

— Germany
 - - - Austria

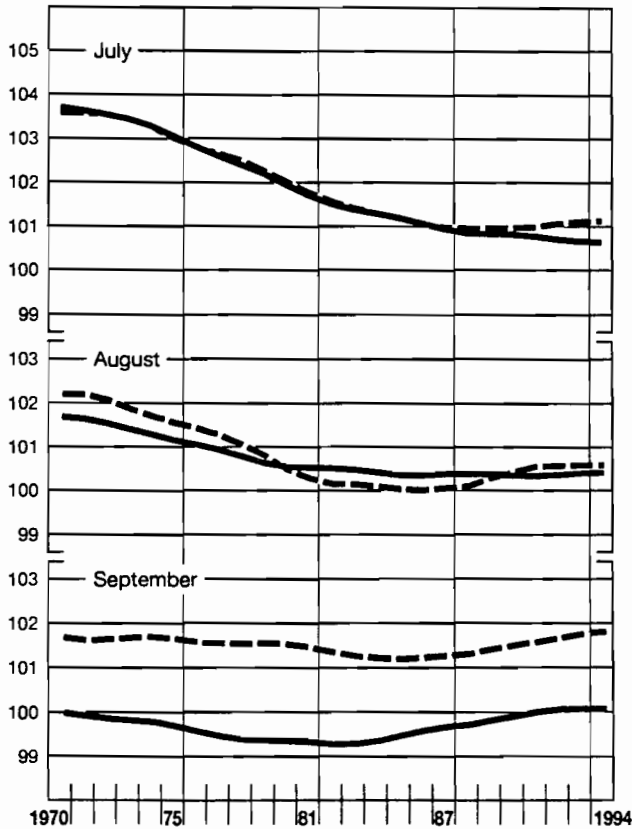
January to March



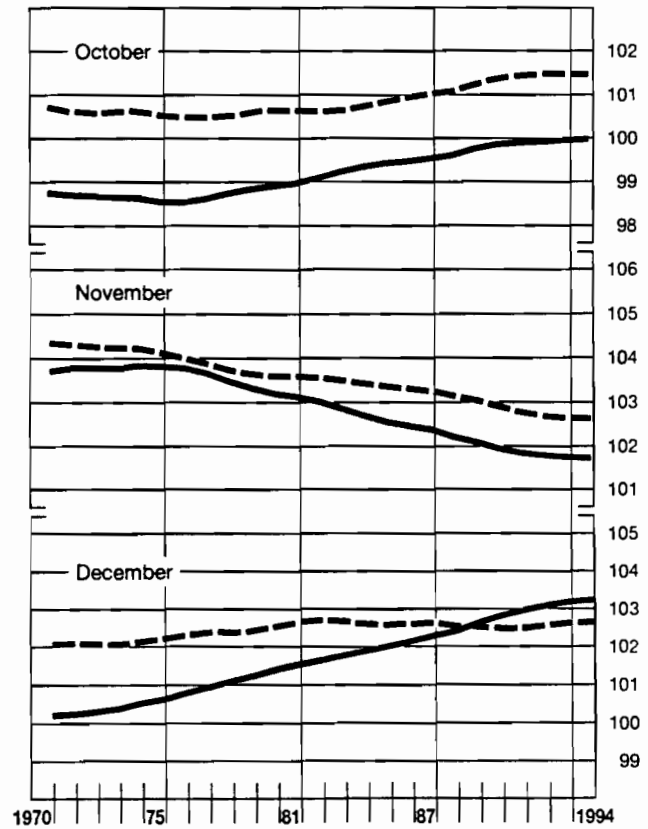
April to June



July to September



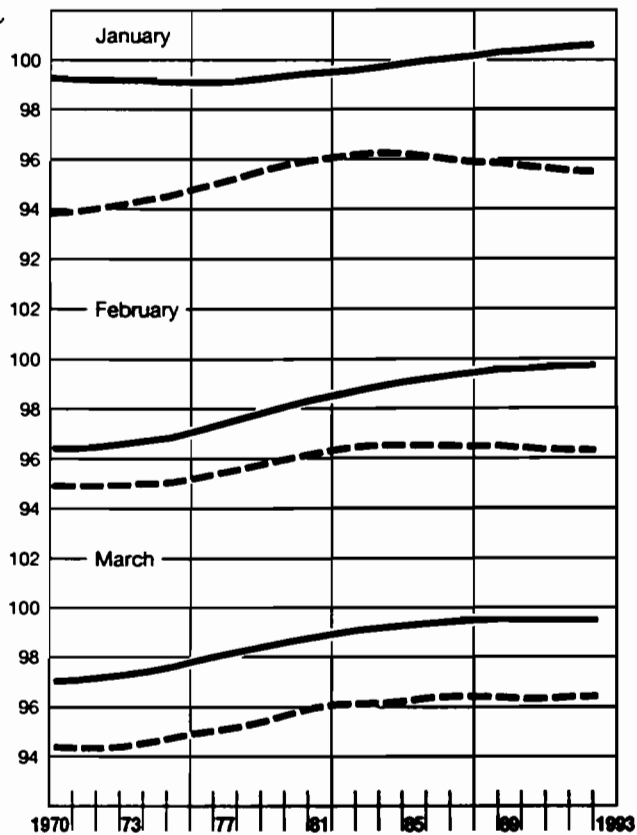
October to December



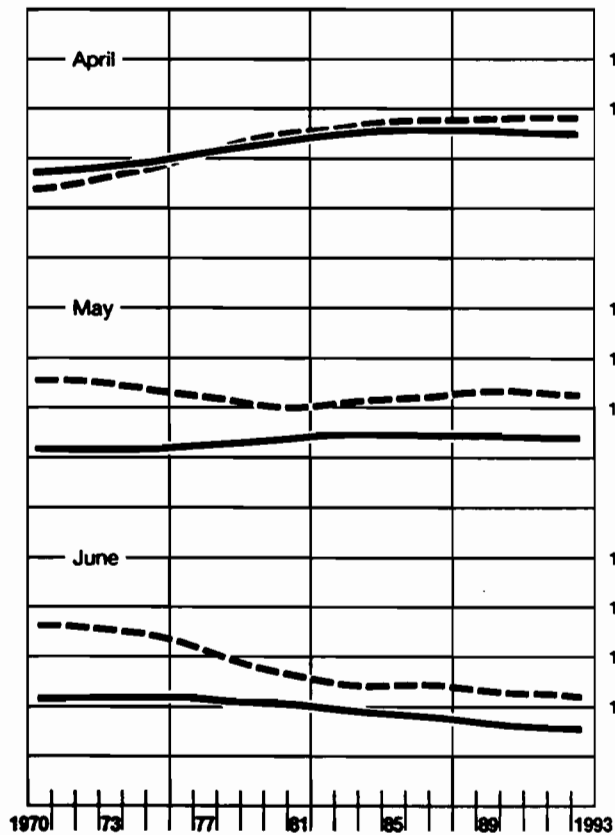
Comparison of seasonal factors for DM 500 and S 1,000 notes

— Germany
 - - - Austria

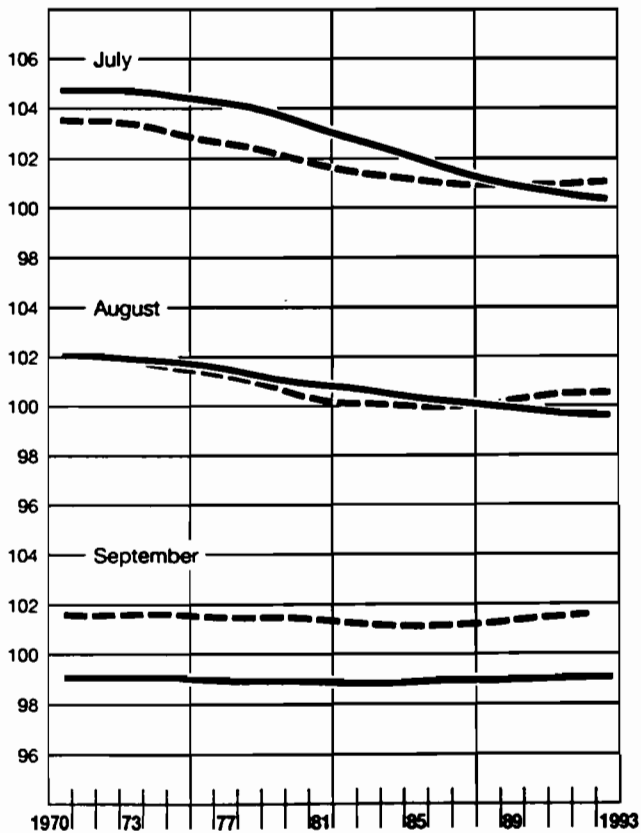
January to March



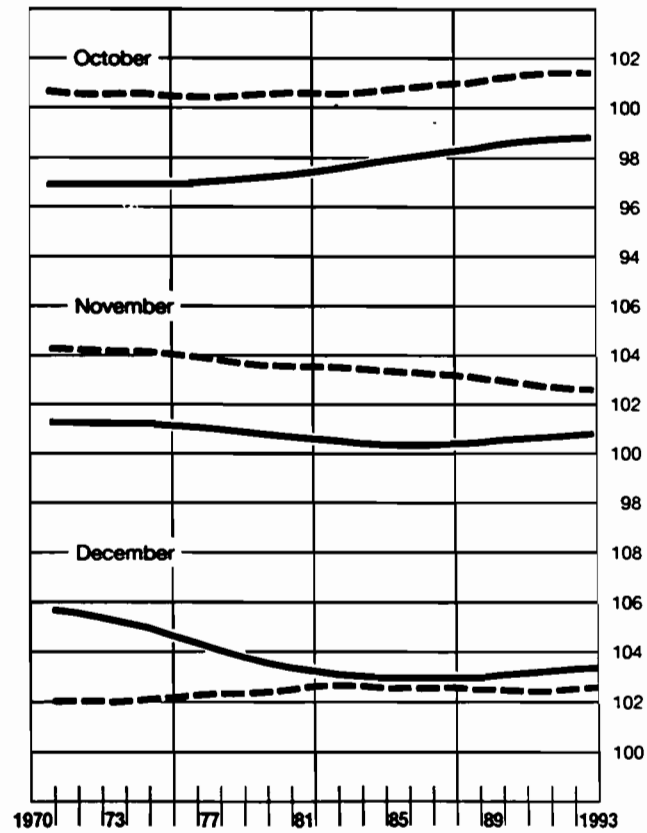
April to June



July to September



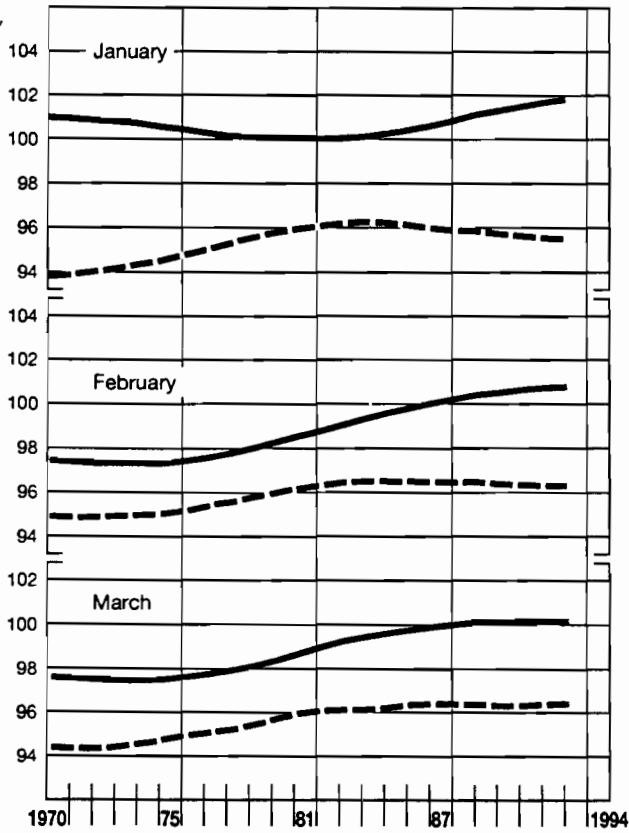
October to December



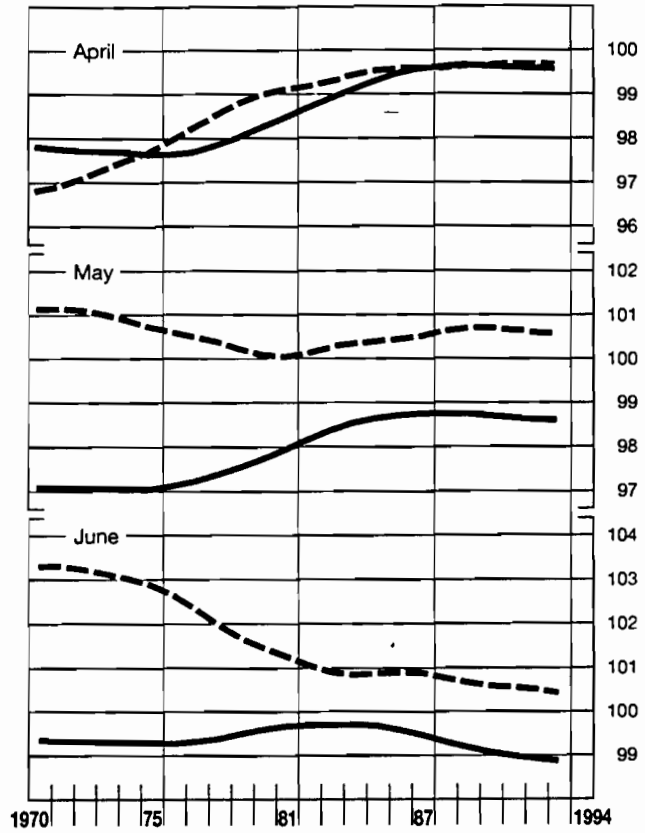
Comparison of seasonal factors for DM 1,000 and S 1,000 notes

— Germany
 - - - Austria

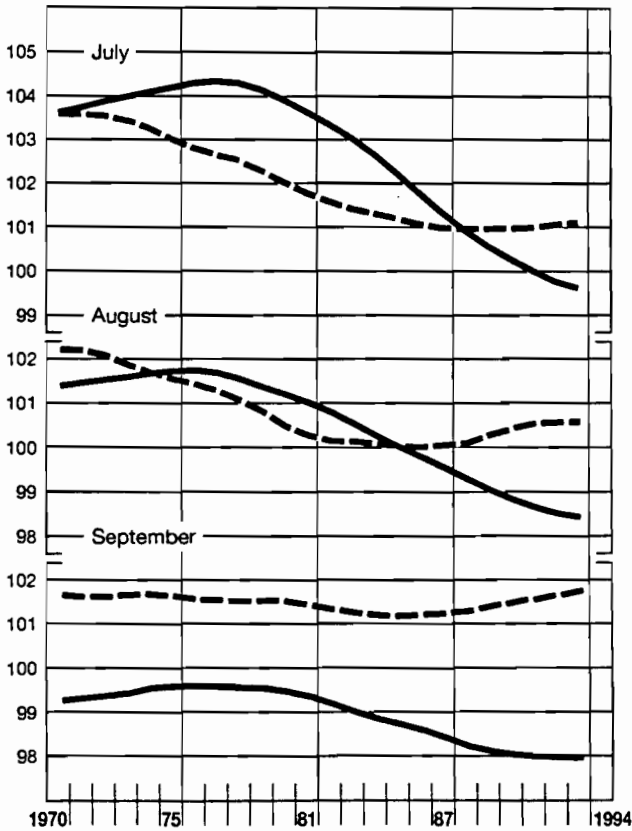
January to March



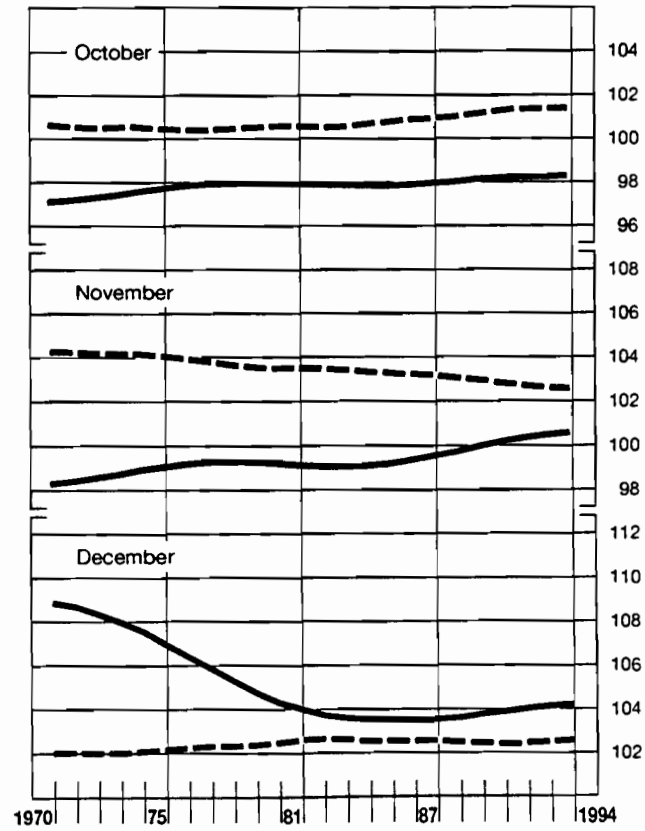
April to June



July to September



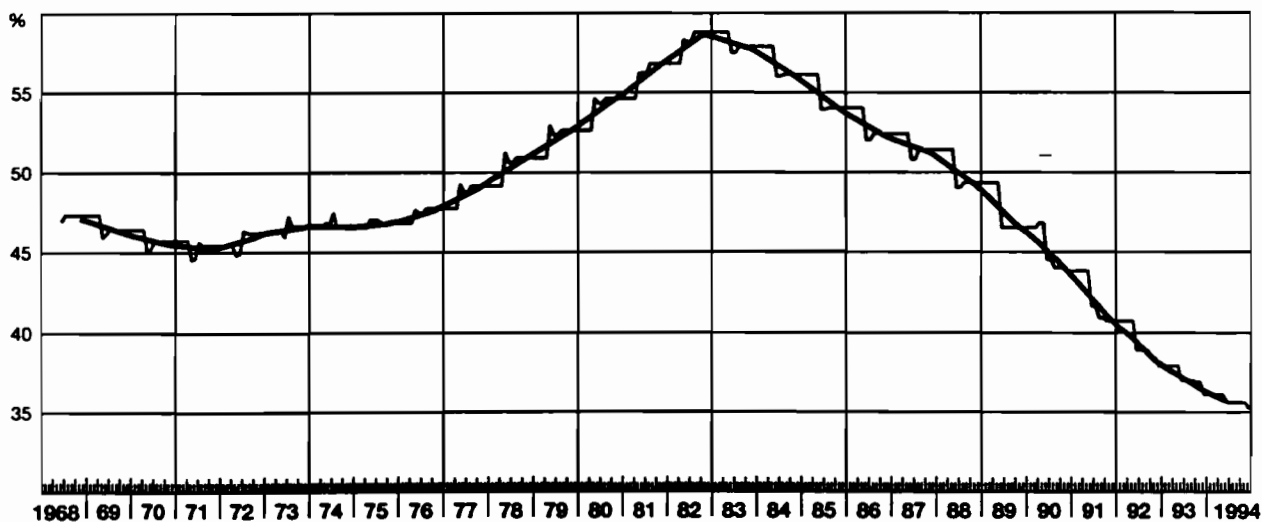
October to December



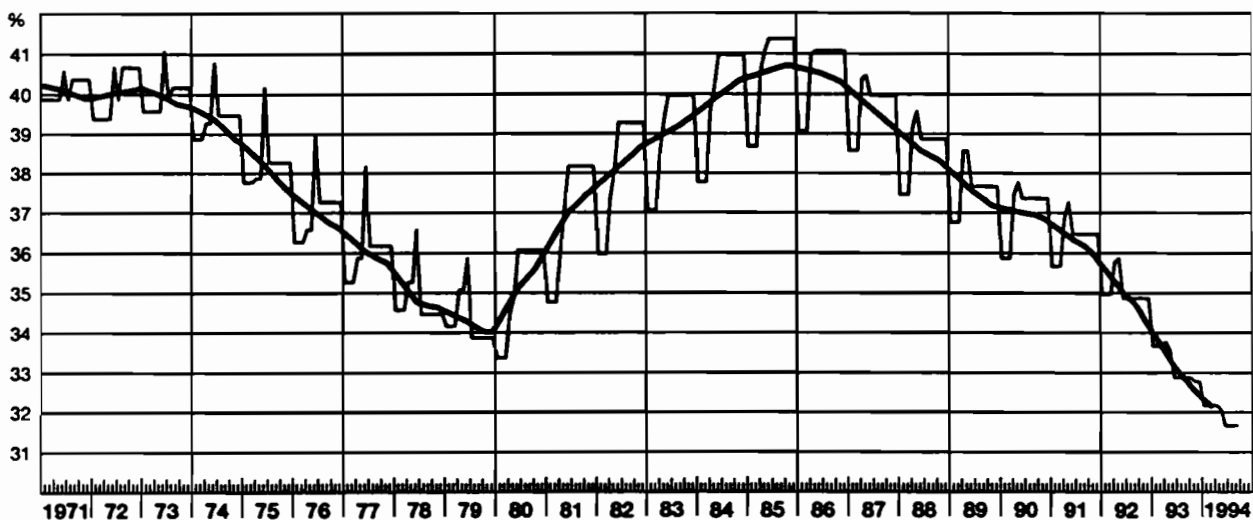
Deutsche Mark notes abroad, reference country Austria

— Unsmoothed, raw estimate
 — Smoothed estimate ¹

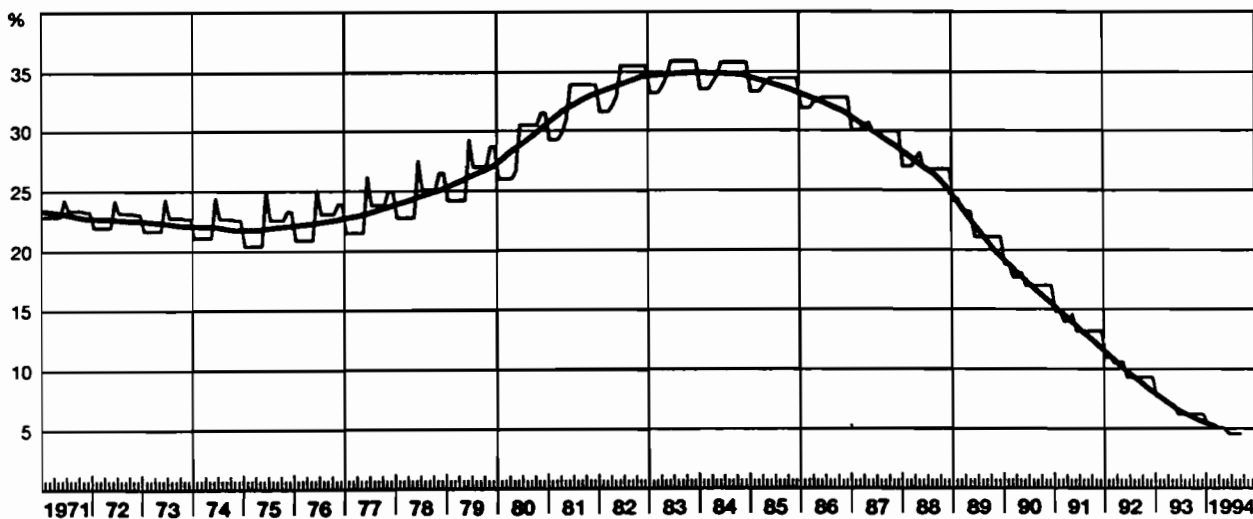
Share, total %



Share of DM 500 notes abroad



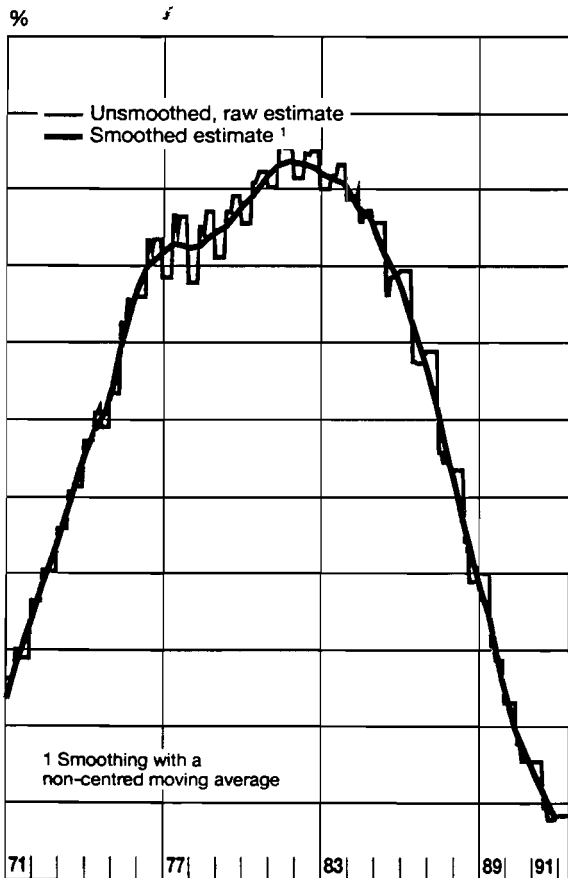
Share of DM 1,000 notes abroad



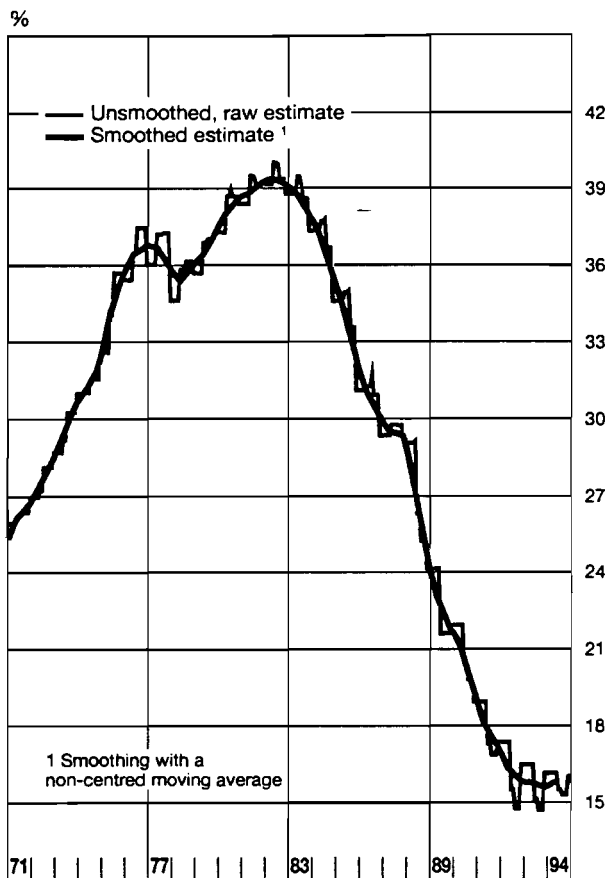
¹ Smoothing with a non-centred moving average.

Share of small-denomination notes abroad

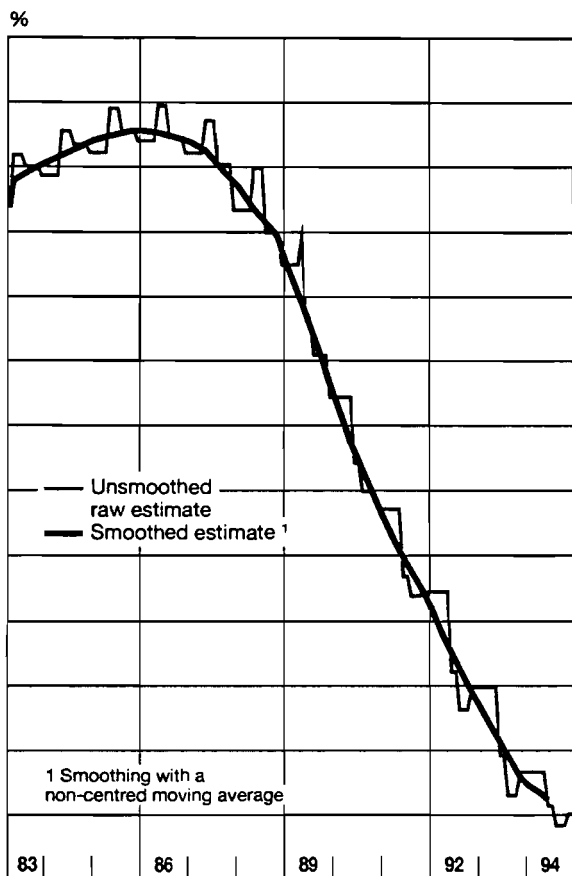
Share of DM 10 notes abroad
Reference country: Netherlands



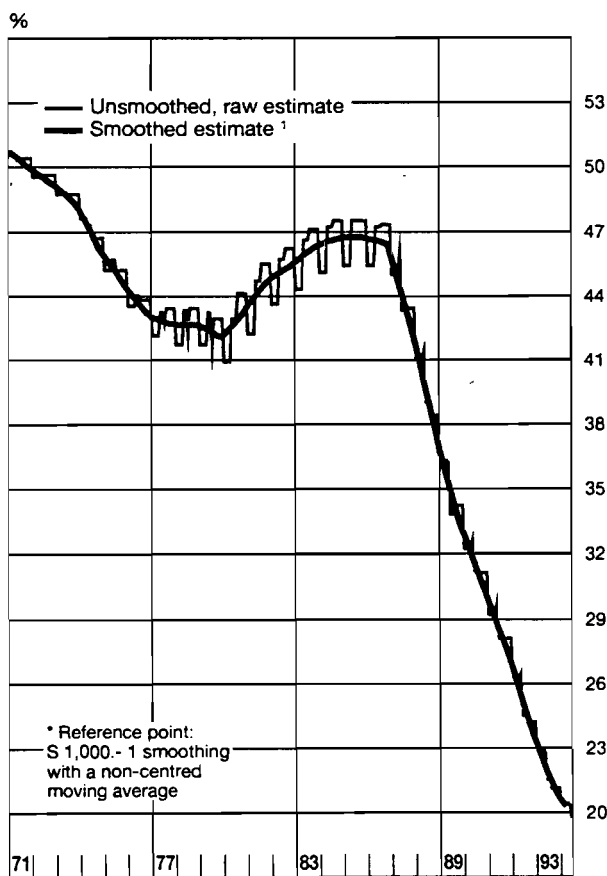
Share of DM 20 notes abroad
Reference country: Netherlands



Share of DM 50 notes abroad
Reference country: Netherlands



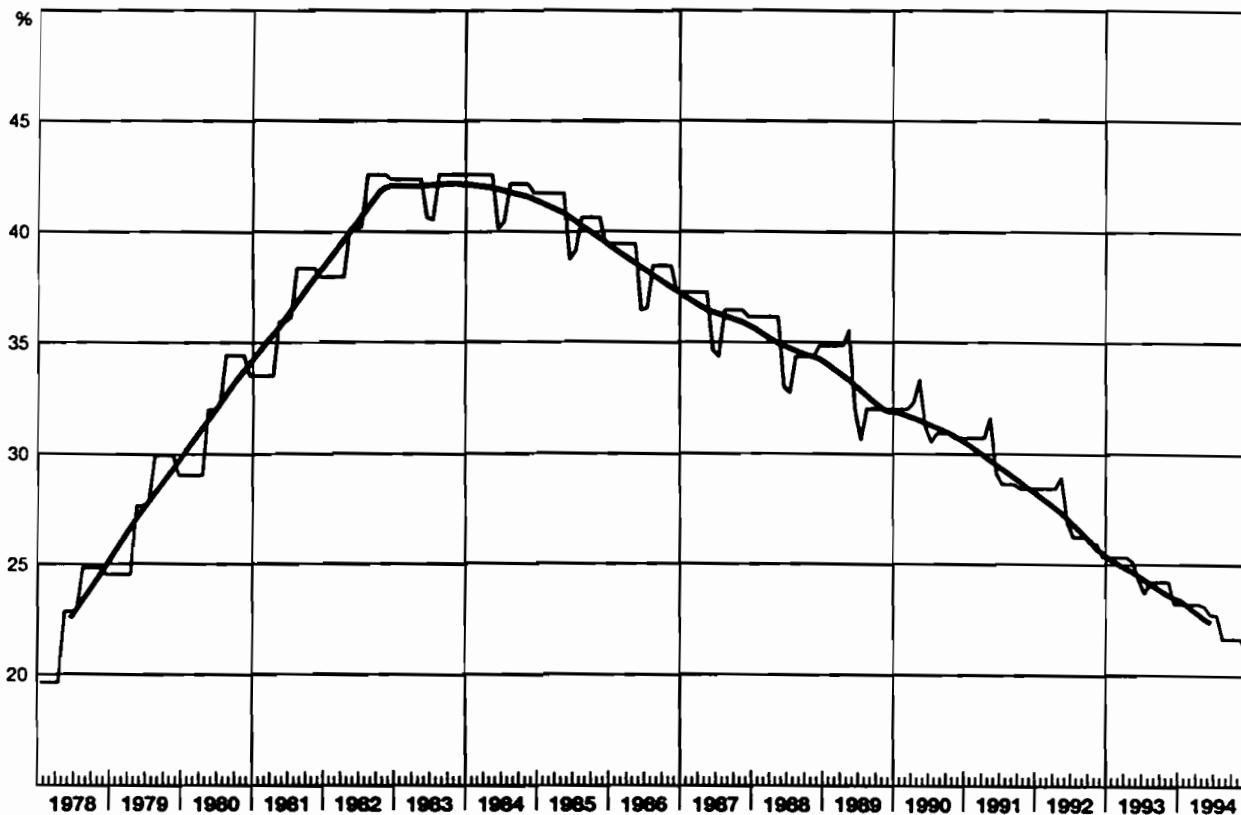
Share of DM 100 notes abroad *



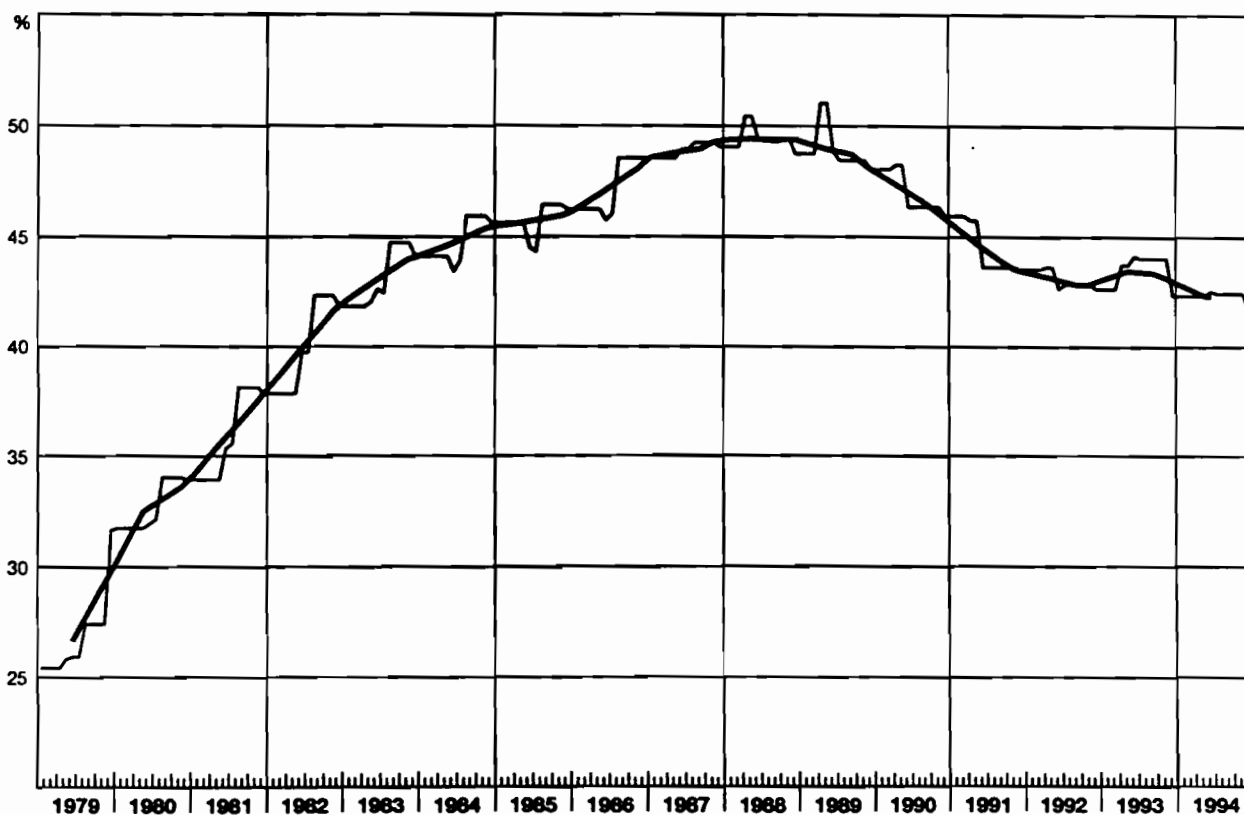
Share of currency abroad with different reference countries

— Unsmoothed, raw estimate
 — Smoothed estimate ¹

Share of Deutsche Mark notes abroad, reference country: France



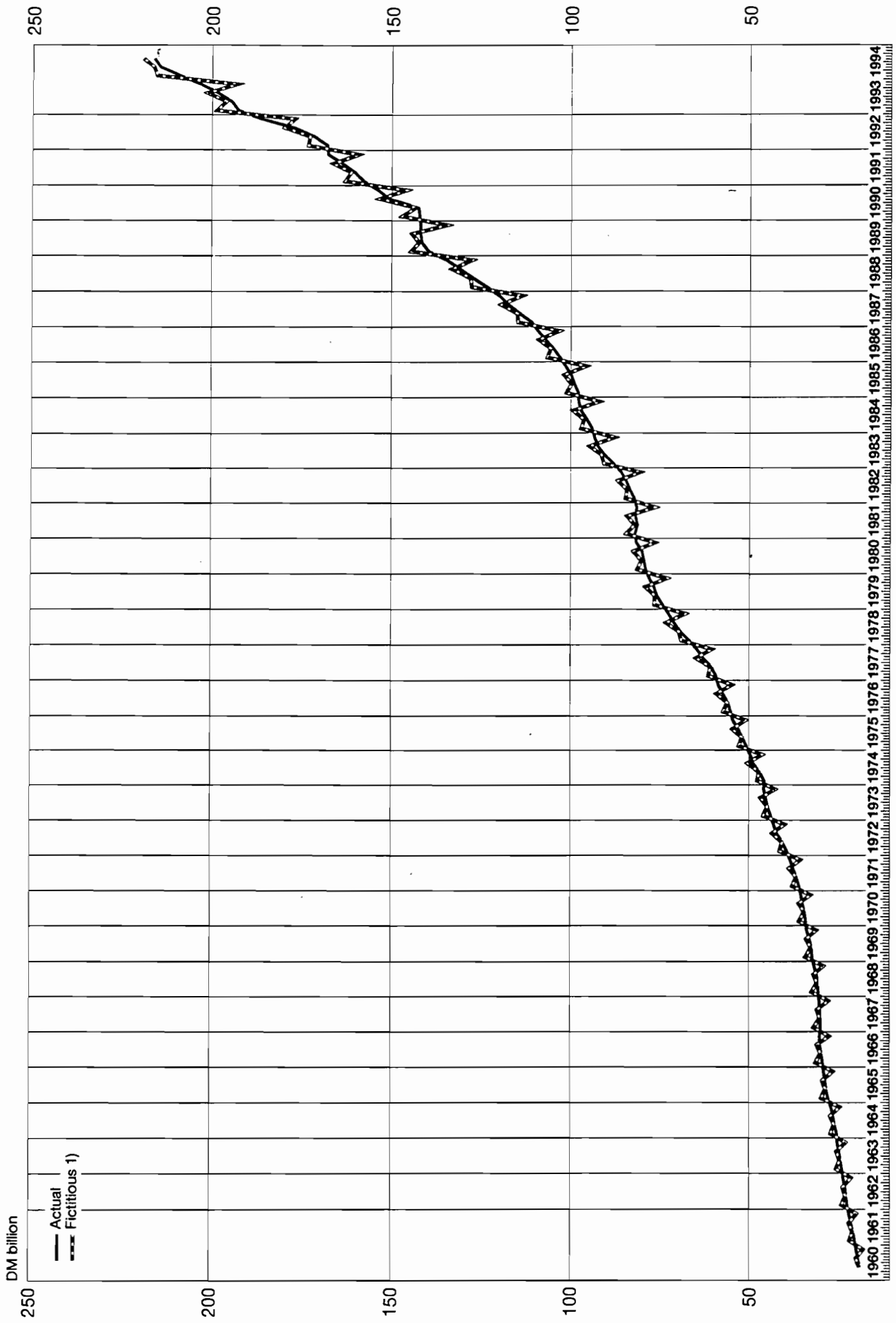
Share of Deutsche Mark currency abroad, reference country: Belgium



¹ Smoothing with a non-centred moving average.

Actual and fictitious seasonally adjusted currency in circulation

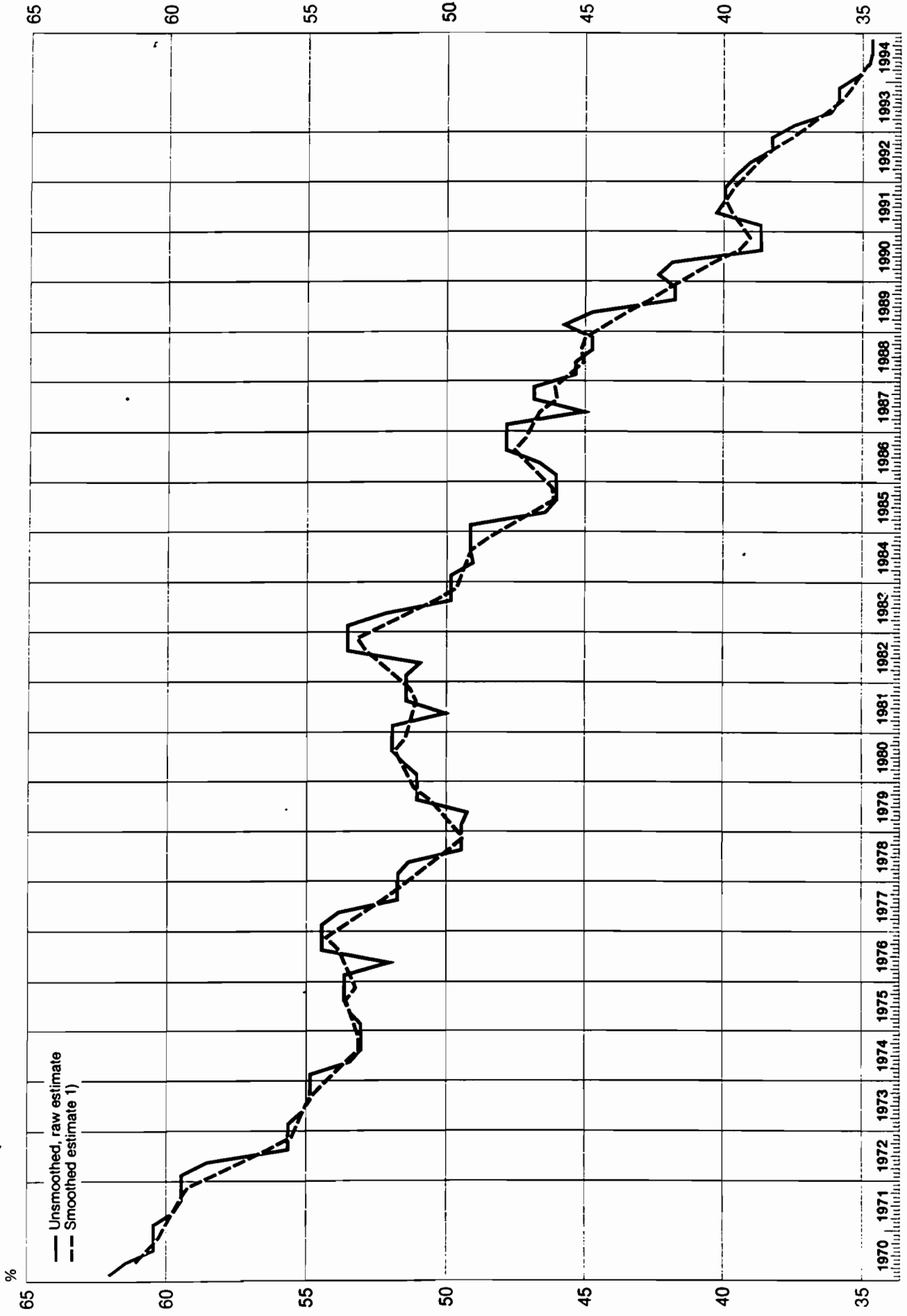
Figure 30



1) Seasonally adjusted by the seasonal factor of private consumption.

Share of currency abroad
Reference point: seasonal of the transactions variable

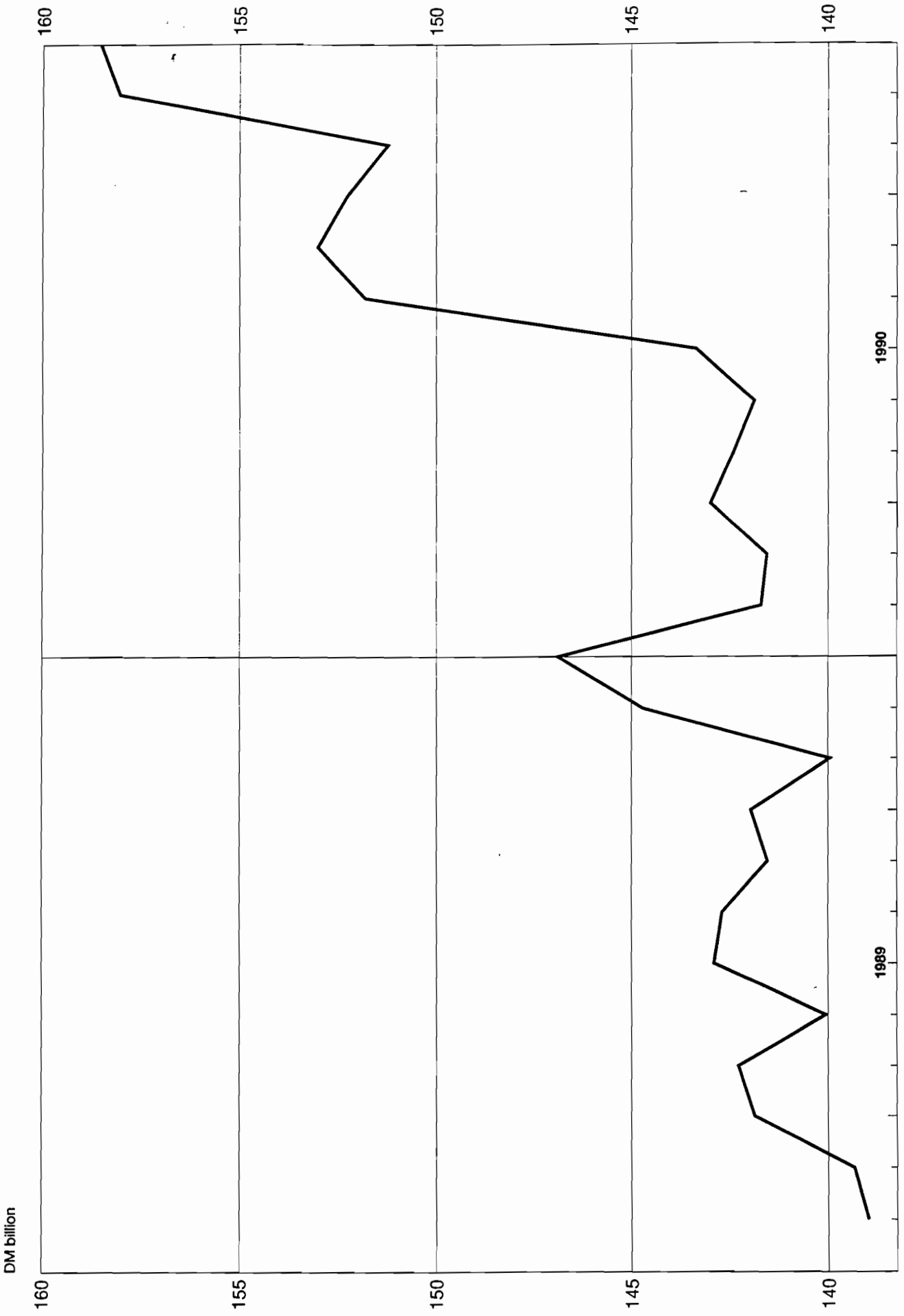
Figure 31



1) Smoothed with a non-centred moving average.

Currency in circulation in 1989 and 1990

Figure 32



The money multiplier in Germany

Figure 38

