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ON STRUCTURING THE CURRENCY COMPOSITION OF EXTERNAL DEBT PORTFOLIOS

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Thorsten Mehltretter**
and Reinhard Solte***

1. Introduction

After the strong appreciation of the US-\$ beginning in the early 1980s, LDCs faced serious problems in servicing their external debt. For the same time period an increasing share of \$-denominated debt can be observed: (See next page table.)

This paper asks the question whether it may be worthwhile to diversify the currency composition of debt and if so, are there any guidelines for efficient currency debt management. Even though several articles have been written on the optimal currency structure of foreign exchange reserves¹, very little has been said with regards to the currency structure of debt portfolios.²

In the first section we derive a measure of the real burden for the economy caused by the external debt. In section 2.1, we apply an ordinary portfolio approach in order to determine the optimal composition of debt. This approach will be extended in section 2.2 where we include export earnings in our optimization policy and allow for fluctuations in export prices. Thereafter the behaviour of a debtor under flexible export prices is considered. Finally we take the case of Korea and try to analyze empirically the main determinants of the real cost of borrowing.

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1. See Ben-Bassat (1980).

2. See Dooley (1983).

In addition we test the relative superiority of different currency compositions.

Shares of Key Currencies in Public Long-Term Debt, 1974-83 (percent)

Currency	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
U.S. dollars ^a	65.1	69.0	70.3	67.8	64.8	66.8	68.1	71.8	73.4	76.3
Deutsche mark	8.8	7.3	7.6	8.2	9.2	8.6	7.3	6.3	6.0	4.8
Japanese yen	3.8	3.8	4.1	5.4	7.2	5.9	6.9	6.2	6.0	6.0
French francs	4.3	4.3	4.1	4.4	4.8	4.9	4.6	3.8	3.6	2.9
Pounds sterling	5.6	4.3	3.3	3.1	2.7	2.5	2.3	1.9	1.6	1.5
Swiss francs	0.8	0.7	0.8	1.1	1.6	1.5	1.3	1.4	1.3	1.0
Canadian dollars	1.5	1.5	1.5	1.3	1.1	1.1	1.1	1.1	1.0	0.9
Others	10.1	8.9	8.4	8.6	8.7	8.8	8.4	7.6	7.2	6.5
Total	100	100	100	100	100	100	100	100	100	100

Note: Data are based on the currency of denomination, not the currency of repayment.

a. The share of U.S. dollars includes "multiple currency" lending, predominantly in dollars, at variable interest rates, and accounting for an 8-10 percent share of external debt during 1974-83. The share of U.S. dollars is therefore an upper bound, but the trend is unaltered, with the dollar's share rising by eleven percentage points in a decade.

Source: World Bank data.

2. The Portfolio Approach to the Currency Composition

2.1. The Real Cost of Borrowing

First we need to derive some measure of real debt service (RDS). We define RDS as the quantity of exported goods that are transferred to the creditors for their provision of capital. Thus RDS can be expressed as total nominal debt service (NDS) deflated by the weighted price of exported goods in the rest of the world (P_x), which is assumed to consist of two other countries (country 1 and 2).

$$(1) \text{ RDS} = \frac{\text{NDS}}{P_x} = \frac{\alpha \text{NDS}_1 E_1 + (1 - \alpha) \text{NDS}_2 E_2}{\varepsilon P_1 E_1 + (1 - \varepsilon) P_2 E_2}$$

The total nominal debt service is split up into 2 components, NDS_1 and NDS_2 . NDS_1 (NDS_2) is the nominal debt service of total debt

denominated in currency 1 (2). E_1 (E_2) is the exchange rate of the debtor country's home currency vis a vis currency 1 (2). α is the share of total debt denominated in currency 1. P_x is derived by multiplying the price of the exported goods in the creditor countries (P_1 and P_2) with their respective trade shares (ϵ and $1 - \epsilon$) and convert them to the debtor country's currency.

However it has to be noted that the export price index can be replaced by another deflator. The underlying assumption for using the export price index is related to the idea that the debtor is supposed to earn the foreign exchange to service the debt through exports. If the creditor runs a project leading to the substitution of imports by domestic production, the import price index would be a suitable deflator.

Assuming that NDS_1 and NDS_2 are given constants, the real debt service might be affected by stochastic changes of the exchange rates and the deflator on the one hand and by the choice of the currency weights on the other. Within this context the main objective of the debtor should be to reduce the average value and the fluctuations of the real cost of borrowing by a favorable choice of α . Nevertheless, we can see from equation (1) that fluctuations of the export price index cannot be avoided by a corresponding choice of α , as it can be done with exchange rate fluctuations. However, it is not the variance of E_1 (E_2) per se that matters since we have to consider the covariances of the exchange rates and P_x , which gives us a measure for the simultaneous development of the exchange rates and the export prices. Exchange rates and export prices work together to determine the fluctuations of the real debt service.

For instance, if the variance of E_1 is a little higher than the variance of E_2 whereas the covariance of E_1 and P_x is positive but the covariance of E_2 and P_x is negative, it is advisable for the debtor to choose a high α since it is less risky when the nominal debt service fluctuates in the same direction as the export price level.

Neglecting interest rate differentials, optimal α must be in the ranges indicated by the table below depending on the values of the variances and covariances: (See next page table.)

In order to make a decision for the fields in the corner, we have to look at the individual values.

Since we consider the possibility that $\text{Cov}(E_1; P_x)$ and $\text{Cov}(E_2; P_x)$ are not equal in the short run, we implicitly reject the purchasing power parity and perfect interregional goods arbitrage.

In addition we assume that the future development of the exchange rates is not totally reflected in the interest rate differentials so that the

debtor can vary the average level of the real debt service by altering α . Simultaneously the debtor has to consider the riskiness of the currency composition.

	Var (E_1)	Var (E_2)	Var (E_1) = Var (E_2)	Var (E_1)	Var (E_2)
Cov (E_1 ; P_x) Cov (E_2 ; P_x)			0.5		0.5
Cov (E_1 ; P_x) = Cov (E_2 ; P_x)		0.5	= 0.5		0.5
Cov (E_1 ; P_x) Cov (E_2 ; P_x)		0.5	0.5		

2.2. The Mean-Variance Approach

In the preceding section we showed that there might be a trade-off between the riskiness and the absolute expected value of the debt service. Since it is not possible to derive the optimal α from equation (1), we have to apply a portfolio approach. According to the portfolio theory the foreign debt of a country or a private enterprise can be treated as an asset giving negative returns. In the following section we consider a small country which cannot by definition affect the interest rates in the world and the exchange rates of the two creditor countries vis à vis each other. Furthermore, the small developing economy faces given export prices, which are assumed to be constant in the short run.

This assumption implies that there is no difference between the real and the nominal debt service, as far as the target value for the optimization of α is concerned. This assumption will be relaxed in section 4.

The asset called "debt" has a negative return called "debt service" that can be derived as follows. We assume that the loan is taken in period 0 and repaid in t_1 . The total nominal debt service of a loan taken in currency i can be expressed as

$$(2) \text{ NDS}_i = [i_i D_{i,0} + i_i (D_{i,1} - D_{i,0})] + [D_{i,0} + (D_{i,1} - D_{i,0})]$$

= interest payments + amortization

where $D_{i,0}$ ($D_{i,1}$) is the loan taken in currency i denominated in home currency in t_0 (t_1) and i_i is the interest rate for borrowers in currency i . In our

case the lender may choose between two currencies so that the index i can equal 1 or 2.

Since we have to take into account exchange rate fluctuations, the value of the loan denominated in home currency will change over time:

$$(3) D_{i,1} = E_{i,1}/E_{i,0} D_{i,0},$$

where $E_{i,0}$ ($E_{i,1}$) is the exchange rate in t_0 (t_1).

Dividing (2) by $D_{i,0}$ and substituting $D_{i,1}$ for (3) we gain:

$$\begin{aligned} (2') \quad s_i &= \frac{NDS_i}{D_{i,0}} = i_i + i_i \frac{\frac{E_{i,1}}{E_{i,0}} D_{i,0} - D_{i,0}}{D_{i,0}} + \frac{\frac{E_{i,1}}{E_{i,0}} D_{i,0} - D_{i,0}}{D_{i,0}} + 1 \\ &= i_i + i_i \frac{E_{i,1} - E_{i,0}}{E_{i,0}} + \frac{E_{i,1} - E_{i,0}}{E_{i,0}} + 1 \\ &= i_i + i_i e_i + e_i + 1. \end{aligned}$$

Neglecting the fluctuations of interest payments due to exchange rate changes and the repayment of $D_{i,0}$ we can reduce (2') in the following way:

$$(2'') \quad s_i = i_i + e_i.$$

The return of asset i equals $i_i + e_i$, where e_i is the rate of depreciation of the debtor's home currency. According to equation (1) the currencies 1 and 2 contribute to the mean and the variance of our debt portfolio:

(4) Mean return of total debt:

$$\bar{s} = \alpha \bar{s}_1 + (1 - \alpha) \bar{s}_2 = \alpha (i_1 + \bar{e}_1) + (1 - \alpha) (i_2 + \bar{e}_2) \text{ and variance :}$$

$$(5) \sigma_s^2 = E [\alpha (\hat{e}_1 - \bar{e}_1 + i_1 - i_1) + (1 - \alpha) (\hat{e}_2 - \bar{e}_2 + i_2 - i_2)]^2$$

$$= \alpha^2 \sigma_{e_1}^2 + 2 \alpha (1 - \alpha) \sigma_{e_1 e_2} + (1 - \alpha)^2 \sigma_{e_2}^2.$$

The utility function of the debtor reflects his main objectives, namely minimizing the mean \bar{s} and σ_s^2 simultaneously.

$$(6) \quad U = U(\bar{s}, \sigma_s^2), \text{ where } U_1 = \frac{\partial U}{\partial \bar{s}} < 0 \text{ and } U_2 = \frac{\partial U}{\partial \sigma_s^2} < 0$$

(risk aversion) in order to maximize the utility.

Differentiating (5) with respect to α we get:

$$(6') \quad \frac{dU}{d\alpha} = U_1 (\bar{s}_1 - \bar{s}_2) + U_2 [-2(1-\alpha)\sigma_{e_2}^2 + 2\alpha\sigma_{e_1}^2 + 2(1-\alpha)\sigma_{e_1 e_2} - 2\sigma_{e_1 e_2}].$$

As it has been shown in (6), the risk aversion coefficient has to be

$$(7) \quad Q = 2 \frac{U_2}{U_1}.$$

Substituting U_1 and U_2 in (6') by (7) we gain:

$$(8) \quad (\bar{s}_1 - \bar{s}_2) + Q[-(1-\alpha)\sigma_{e_2}^2 + \alpha\sigma_{e_1}^2 + (1-\alpha)\sigma_{e_1 e_2} - \sigma_{e_1 e_2}\alpha] \stackrel{!}{=} 0.$$

Solving for α , we get the optimal share of debt denominated in currency 1:

$$(8') \quad \alpha^{\text{opt}} = \frac{i_2 - i_1 + \bar{e}_2 - \bar{e}_1}{\Delta Q} + \frac{\sigma_{e_2}^2 - \sigma_{e_1 e_2}}{\Delta},$$

$$\text{with } \Delta = \sigma_{e_1}^2 + \sigma_{e_2}^2 - 2\sigma_{e_1 e_2}.$$

The first fraction in equation (8') is equivalent to the speculative share whereas the second one reflects the case when the debtor is infinitely risk averse (minimum variance share).

From equation (8') we can derive the following conclusions: It is advisable for debtors to prefer soft currencies as a high e_2 or e_1 increases the cost of borrowing. The higher the differential between e_2 and e_1 , the higher will be the share of currency 1 in the optimal debt portfolio.

However, it is obvious that this is not possible when the interest rate differential reflects the differential of the exchange rate appreciation (Fisher-Open condition). As far as the riskiness is concerned, we can

argue that a higher variance of e_2 favors a larger share of currency 1 in the optimal debt portfolio.

2.3. *Debt Management and the Ability to Pay*

The basic presumption in the previous section was that the real debt service is the only target of the debtor because it shows the real burden for the economy caused by the obligation to service the debt. Apart from that debtors are interested in settling their debt service and export earnings in such a way that they constantly maintain their ability to pay. If a debtor suspends interest payments, he might face severe consequences since cost of default might be high. For this reason, debtors are not likely to expose themselves to a speculative risk as it was presumed in the preceding section, but they would rather minimize the risk of going bankrupt. As the small economy exports, it can rely on a certain inflow of various foreign balances.

In this section we want to approach the issue to what extent an adjustment of the currency composition to the trade structure leads to a reduction of the risk of bankruptcy. In addition to that, this adjustment could have some implications for the fluctuations of the total real debt service.

If the nominal debt service and the trade surplus both denominated in domestic currency, are affected by exchange rate changes in such a way that they fluctuate in the same direction, this would imply that an adjustment of the currency weight α to the percentage weight of export earnings in the same currency (ε) reduces the risk of the debt portfolio. For this reason, we regard the export earnings of our small economy as an asset giving us positive returns, which are required to settle the negative returns of the debt.

In the short run the small country faces a given trade structure:

- (9) $X = \varepsilon X + (1 - \varepsilon) X$, where X is the total export denominated in the home currency. However, the invoicing currency is always that of the importing country. ε is the percentage weight of exports to country 1.

The positive return of exports in currency 1 related to the total debt in currency i can be derived as follows:

From t_0 to t_1 exports are subject to two kinds of fluctuations.

The value of exports denominated in home currency depends on the development of the exchange rate:

$$(10) \quad X_{i.1}^e = \frac{E_{i.1}}{E_{i.0}} X_{i.0}$$

It can be seen that the exports are affected in the same way as the debt service. Again we have to take into account that export earnings can be achieved in two countries ($i = 1, 2$).

On the other hand, the relative price of export goods on the world market might lead to a change in export revenues.

$$(11) \quad X_{i.1}^p = X_{i.0} + \pi_i X_{i.0},$$

where π_i is the relative rate of export price changes.

In this context we assume that the small country produces a constant quantity of export goods. The argument of inelastic supply curves may be justified for the short run. For this reason export earnings cannot change by a variation of export quantities.

Taking into account these two sources of fluctuation the total volume of exports can be expressed as:

$$(12) \quad X_i = X_{i.0} + (X_{i.1}^e - X_{i.0}) + (X_{i.1}^p - X_{i.0}).$$

The second term of equation (12) is the export differential due to changes in the exchange rate, while the third term stands for the export differential due to changing export prices.

Since export earnings are used to service the debt, we can formulate the following objective function:

$$(13) \quad X_{i.0} = D_{i.0} + r_i D_{i.0},$$

where r_i is the real interest rate, since interest payments are performed in terms of export goods in this context.

Substituting (13) for (12) we gain:

$$(14) \quad X_i = (D_{i.0} + r_i D_{i.0}) + [(D_{i.1} - D_{i.0}) + r_i (D_{i.1} - D_{i.0})] + \pi_i (D_{i.0} + r_i D_{i.0}).$$

Dividing (14) by $D_{i.0}$ we get the positive return of the asset called "ex-ports":

$$(14') \quad X_i = \frac{X_i}{D_{i,0}} = r_i + e_i + r_i e_i + \pi_i + r_i \pi_i + 1.$$

As a matter of convenience we can reduce (14') by neglecting the repayment of $D_{i,0}$ and the fluctuations of the interest payments, as we have already done it in section (3).

$$(15) \quad X_i = r_i + e_i + \pi_i.$$

With respect to equation (9), the total return of the asset called "exports" can be expressed as:-

$$(16) \quad X = \varepsilon X_1 + (1 - \varepsilon) X_2 = \varepsilon (r_1 + e_1 + \pi_1) \\ + (1 - \varepsilon) (r_2 + e_2 + \pi_2).$$

The negative asset "debt" gives the following returns:

$$(4') \quad s = \alpha s_1 + (1 - \alpha) s_2 = \alpha (i_1 + e_1) + (1 - \alpha) (i_2 + e_2).$$

The only stochastic variables in equation (10) and (4') are e_i and π_i because i_i and r_i are constants, as it can be derived from (3) and (10).

Our main objective in this section was to settle the positive and negative returns of the assets considered in such a way that the debtor is always able to pay. With respect to the consequences, the debtor is reluctant to speculate, which leads us to the following utility function:

$$(17) \quad U = U(\sigma^2_{\bar{x}-\bar{s}}), \text{ with } \frac{dU}{d\sigma^2_{\bar{x}-\bar{s}}} < 0, \text{ where the mean return of } \bar{x}-\bar{s} \text{ is:}$$

$$(18) \quad \bar{x}-\bar{s} = \bar{x} - \bar{s} = \varepsilon (r_1 + \bar{e}_1 + \bar{\pi}_1) + (1 - \varepsilon) (r_2 + \bar{e}_2 + \bar{\pi}_2) \\ - \alpha (i_1 + \bar{e}_1) - (1 - \alpha) (i_2 + \bar{e}_2).$$

The variance of $\bar{x}-\bar{s}$ is:

$$(19) \quad \sigma^2_{\bar{x}-\bar{s}} = E[\varepsilon (\hat{x}_1 - \bar{x}_1) + (1 - \varepsilon) (\hat{x}_2 - \bar{x}_2) \\ - \alpha (\hat{s}_1 - \bar{s}_1) - (1 - \alpha) (\hat{s}_2 - \bar{s}_2)]^2$$

$$= E \left\{ \varepsilon [(\hat{e}_1 - \bar{e}_1) + (\hat{\pi}_1 - \bar{\pi}_1)] + (1 - \varepsilon) [(\hat{e}_2 - \bar{e}_2 + \hat{\pi}_2 - \bar{\pi}_2)] \right. \\ \left. - \alpha(\hat{e}_1 - \bar{e}_1) - (1 - \alpha)(\hat{e}_2 - \bar{e}_2) \right\}^2,$$

since i_i and r_i cancel out. An i_i being greater than r_i gives an indication for solvency problems. As a matter of convenience we assume i_i and r_i to be equal.

Differentiating (19) with respect to,

$$(20) \quad \frac{d\sigma_{\bar{x}-s}}{d\alpha} \stackrel{!}{=} 0 \text{ with } \frac{d^2\sigma_{\bar{x}-s}^2}{d\alpha^2} > 0,$$

we get the optimal α :

$$(21) \quad \alpha^{opt} = \varepsilon \left(1 + \frac{(\sigma_{\pi_1 e_1} - \sigma_{\pi_1 e_2}) - (\sigma_{\pi_2 e_1} - \sigma_{\pi_2 e_2})}{\Delta} \right) \\ + \frac{\sigma_{e_1 \pi_2} + \sigma_{e_2 \pi_2}}{\Delta},$$

where $\Delta = \sigma_{e_1}^2 + \sigma_{e_2}^2 - \sigma_{e_1 e_2}$.

Equation (21) confirms our previous assumption that the optimal composition of debt depends on the covariances of the exchange rates and the rates of export price changes. Furthermore, we should ask under which conditions a perfect adjustment of the debt composition to the trade structure is advisable. If the fluctuations of the rates of export price changes are considerably small and close to 0, the optimal α will tend to be:

$$(21') \quad \alpha^{opt} = \varepsilon.$$

Substituting ε for α in (19), we can show that in this case the risk of our debt portfolio is 0 so that the debtor will always be in a position to service his debt.

Apart from that, the differential $(x-s)$ also reflects the real burden of debt service. If we denote s^r as the percentage rate of change of the real debt service over time, we can derive the following relationship:

$$(22) \quad s^r = - (x-s).$$

An increase in differential ($x-s$) reduces the real cost of borrowing, which is caused by rising export prices. This leads to the conclusion that an adjustment of the debt composition to the trade structure can reduce the permanent fluctuations of the real debt service by reducing the exchange risk to a large extent.

If a developing country faces large fluctuations of its export prices denominated in foreign currency vis a vis exchange rate changes, there is still a large risk even if the country acts out the proposed adjustment according to (21). In order to cancel out such costly variations, the debtor may try to settle a loan with a negative return depending on the export price.

$$(23) \quad s_i = i_i + e_i + \pi_i.$$

Equation (19) is a modification of (2'') implying that an increase in the export prices of the developing country leads to an increase in the nominal debt service and v.v.. If we perform the same procedure as in the preceding section using (19) instead of (2''), the minimal σ_{x-s}^2 gives us an α which is:

$$(24) \quad \alpha^{opt} = \varepsilon.$$

In this case the debtor does not run any risk at all since both, the exchange risk and the corresponding risk of export price changes, are cancelled out ($\sigma_{x-s}^2 = 0$). On the other hand, the creditor might ask for a higher risk premium in order to be compensated for his willingness to expose himself to this risk. However, even the creditor may be in favor of an inflow depending on commodity prices in order to be compensated for his risk of high costs for raw materials, as it is obvious in the so-called Petro-Bonds.

3. The Real Cost of Borrowing in the Case of Korea

After the theoretical considerations of the previous section we now try to analyze empirically the RDS of borrowing in different currencies and possible implications for structuring the currency composition of external debt.

3.1. Measuring Real Debt Service (RDS)

In section 2 we already derived a measure for RDS. It will now be developed further to apply it for empirical testing. First we derive a formula for nominal debt service (NDS). NDS consists of two components: the interest payments and the change in the value of the loan during its duration due to exchange rate changes. We assume that for a loan taken at the beginning of a period at given exchange and interest rates, the relevant exchange rate for interest rate payments and debt repayment at the end of the period is not known. Therefore the debtor incurs an exchange rate risk with respect to both the interest and debt payments.

\bar{D} is the value of the loan in domestic currency at the beginning of the sample period and is held constant over time. Dividing by the exchange rate at the beginning of the loan period E_0 , we receive the actual amount of foreign currency borrowed in the market. \bar{D}/E_0 multiplied with the interest rate on foreign currency (i^{for}) and the exchange rate at the end of the loan period (E_1) yields the interest payment measured in domestic currency. The change in the value of loan, also in domestic currency, is equal to $\bar{D}/E_0 \cdot E_1 - \bar{D}$. Therefore NDS can be expressed as:

$$(25) \quad NDS = \frac{\bar{D}}{E_0} \cdot i^{for} \cdot E_1 + \frac{\bar{D}}{E_0} \cdot E_1 - \bar{D}.$$

Collecting terms and introducing the time index t :

$$(25') \quad NDS = \bar{D} \left[(1 + i_t^{for}) \frac{E_t}{E_{t-1}} - 1 \right].^3$$

It has to be considered that \bar{D} is decreasing over time in real terms as the domestic currency depreciates. To obtain a constant real value of the loan in each period we adjust \bar{D} by the index of the unit import value (P_{M_t}) based on the starting period 1975Q1 $\left(\frac{P_{M_t}}{P_{M_0}}\right)$. Since we

define RDS to be a measure of the actual quantity of goods transferred to foreign countries for their provision of capital, we deflate by the index of unit export value (P_{x_t}).

3. We set the exchange rate at the end of a period equal to the exchange rate at the beginning of the subsequent period.

Therefore,

$$(26) \quad RDS_t = \frac{P_{M_t}/P_{M_0} \cdot \bar{D} [(1 + i_t^{for}) \frac{E_t}{E_{t-1}} - 1]^4}{P_{x_t}}$$

We investigated the real cost of borrowing in six major currencies (US-\$, DM, SFR, Yen, FF, £) for the case of Korea. RDS was calculated for each quarter in the period of 1975Q1 – 1983Q4 using the formula derived above.⁵

We found that over the entire sample period RDS was highly correlated with the interest rates. Except for the FF the correlation coefficients were always above 0.87 up to 0.94. The correlation coefficients between the exchange rates and RDS, however, were generally much lower and never above 0.46. The figures could be result of higher variation coefficients of interest rates over those of exchange rates.

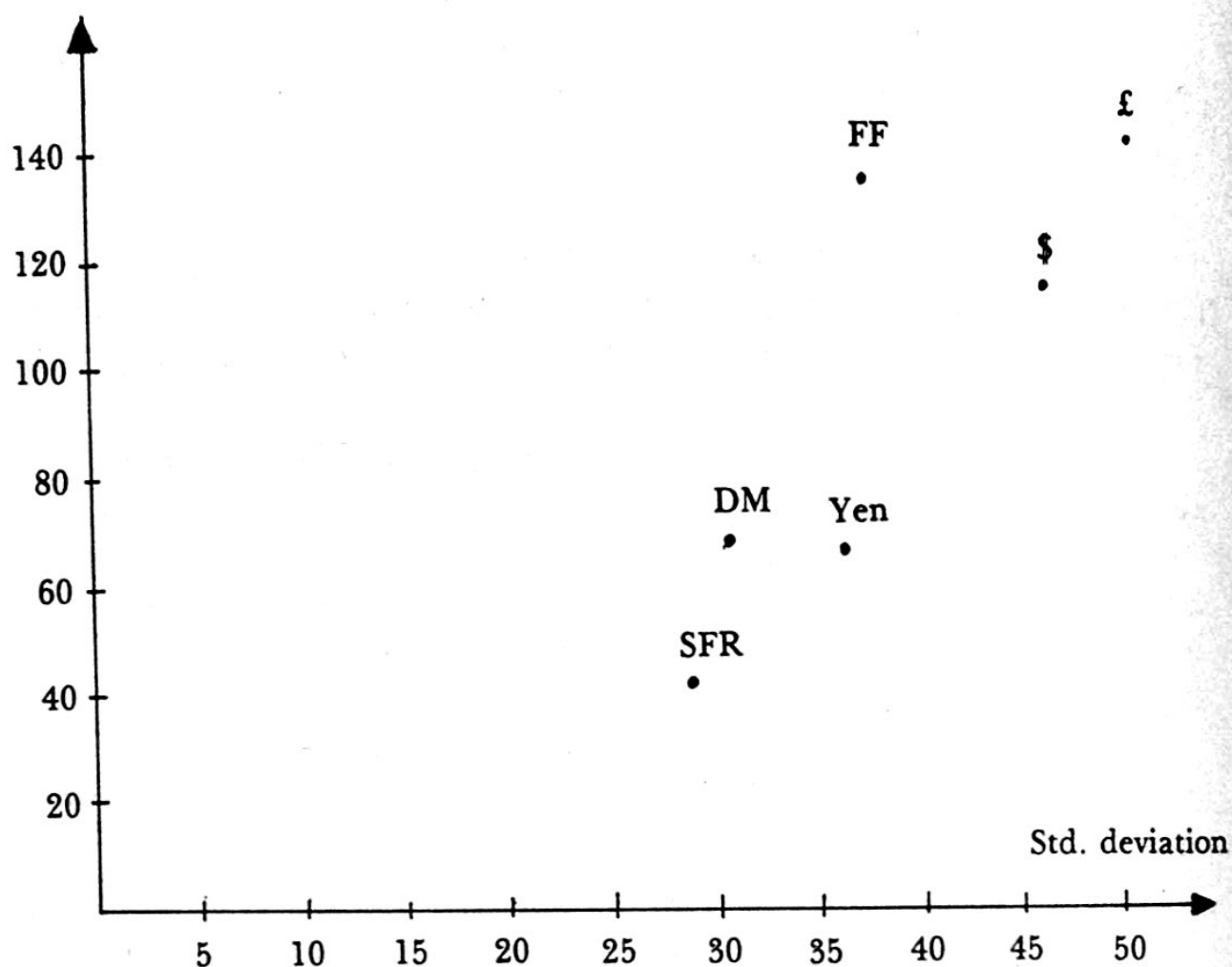
The relationship between the unit export values and RDS, however, is quite unstable for the various countries tested. Correlation coefficients range from -0.16 to 0.46. Unit export values seem to reflect changes in the \$-exchange rate as indicated by a correlation coefficient of 0.95. These findings lend support to the hypothesis that the fluctuation of interest rates rather than those of exchange rates or unit export values is the main determinant of the variability of RDS.

3.2. The Portfolio-Diversification Approach

What are the objectives of a country in constructing a debt portfolio? Generally speaking, it will aim at minimizing the real cost of borrowing as well as its variability. We calculated mean and standard deviation of RDS in all currencies considered. The results can be summarized in the following graph:

-
4. Note that in contrast to section 2, RDS_t here measures real debt service of debt portfolios containing loans denominated in a single currency only. The formula could easily be extended, however, to be used for multi-currency debt portfolios.
 5. Due to data availability we used the average values of the first month of each quarter for both, interest rates and exchange rates. The interest rates were taken from OECD Financial Markets and Morgan Guaranty Trust, World Financial Markets. The other time series were taken from the IMF International Financial Statistics. For further details see the Appendix. \bar{D} was set to unity. Plots of RDS, interest and exchange rates for borrowing in the currencies considered can be found in the appendix together with the RDS correlation matrix.

Mean RDS



The graph does not only show that there are substantial differences in RDS for borrowing in various currencies but also that the SFR is the only efficient currency, i.e. taking a loan in SFR is less costly on average and less risky than in any other currency considered. An optimal portfolio would therefore have to consist solely of SFR denominated loans.

To take into account the fact that the Korean currency (Won) was pegged to the US-\$ up to 1979Q4 we computed and compared mean and variance of RDS for the two subperiods prior and subsequent to the end of 1979. However, there was only a very slight change in the relative position of each currency. The standard deviation of the US-\$, in particular, increased by only about 2% in the second subperiod which can be explained by the fairly steady rate of depreciation of the Won against the US-\$.

These results must not be overinterpreted, however. First, the calculations were performed ex post when we knew the exact means and variances for the respective sample periods, and it is always easy to pass judgement in hindsight. Ex ante several problems arise in selecting the

base period for diversification policy: Do past patterns have any predictive power? Is there any relevant information available that is not reflected in past patterns? For how long can variances and covariances be expected to remain stable? Second, relaxing the small country assumption, it will probably not be possible for institutional reasons to borrow all funds in one or two currencies. And even if it were possible to acquire all the capital in SFR, for instance, this would have some influence on RDS of SFR-denominated loans, e.g. via rising interest rates. Third, it would be necessary to take more samples across various debtor countries to draw final conclusions about the relevant advantages and disadvantages of borrowing in different currencies.

3.3. Trade-Weighted Portfolios

Are there any other guidelines for diversifying debt portfolios? One rule of thumb for structuring minimum-risk debt portfolios suggests that they should be composed according to the structure of foreign trade. What is the rationale behind that? Assume three countries: Korea, USA and FRG. Korea wants to take a loan in the USA. It earns the foreign exchange by exporting goods to FRG. First, if the invoicing currency is DM, Korea converts its export earnings to \$ to service its debt. Thus, it is subject to the risk of changing exchange rates. It may want to avoid this by requesting German importers to pay in \$. If the \$ appreciates, however, Korea's goods become more expensive in FRG. The \$-price of exported goods would have to fall to compensate for the increased value of the \$. Obviously this measure may not succeed in eliminating exchange rate risk. It could be avoided, however, by taking a loan denominated in the currency of the trading partner, in our case in DM. This example demonstrates that it is the currency of the trading partner that is the most relevant for the loan decision rather than the invoicing currency. A minimum-risk portfolio should therefore reflect the export structure of the debtor country.

We constructed two trade-weighted portfolios for 1975Q1 to 1979Q4 and 1980Q1 to 1983Q4, where the percentage shares of the 5 currencies (\$, £, DM, FF, Yen)⁶ are derived on the basis of their respective countries' shares of Korea's exports. Thus we implicitly assumed that the export share of the other countries besides the 5 in question should have no further impact on the currency structure of debt portfolio. We used the

6. SFR is irrelevant since there is no trade with Switzerland.

industrial countries' share of Korea's total exports in the year prior to the one where the loan was taken.

How did these trade-weighted portfolios perform? First of all, we found that in the case of Korea SFR would not be considered when structuring the debt portfolio since there were practically no exports to Switzerland. This was in spite of the fact that the SFR should have played a major role in Korea's external debt, as we have shown above. The trade-weighted portfolio still performed better than one consisting only of a \$-denominated loan, which would reflect the structure of Korea's foreign exchange receipts.⁷ It succeeded in reducing risk and average RDS in both sample periods. In the period from 1980Q1 to 1983Q4, for instance, average cost of the trade-weighted portfolio was 17% lower than that of the \$-loan and risk could be reduced by 24%.

The optimal portfolio according to the mean-variance approach, however, which would consist of a single SFR-denominated loan, was by far superior to the trade-weighted portfolio, as far as both average cost and risk are concerned.

Still the trade-weighted portfolio demonstrates, nonetheless, that some diversification away from the \$ should generally improve portfolio performance. It does not necessarily, however, come close to the optimal portfolio according to the mean-variance approach. A major set-back is the fact that one might neglect to consider borrowing in currencies of countries that are not trading partners of the debtor, even though these currencies could have substantially improved portfolio performance.

But there are other problems with this approach as well. First of all, the trade patterns are subject to change over time which makes it difficult to determine the relevant shares that should be the basis for the portfolio decision. For instance, the year-to-year share of Korea's exports to the USA fluctuated between 26% and 47% of the total exports in the period of 1972 to 1984. And then, of course, there is the question of what to do with those trading partners, usually LDCs, whose currencies have not been considered because borrowing in these currencies would not seem to be possible.

As a final note it should be mentioned that RDS can also be influenced by other economic variables. It should be considered, for instance, that debtor countries incur costs by intervening on foreign exchange and capital markets and by holding reserves. This should have some bearing on RDS.

7. During 1973 to 1984 the \$ accounted for 95-99% of Korea's total foreign exchange receipts.

Another shortcoming of the considerations above might be that the current institutional framework may not permit diversification to the desired extent, as was already mentioned above. Especially poorer LDCs have debt portfolios that contain a large proportion of loans that were obtained in connection with developing projects where the currency of denomination often cannot be freely chosen. The share of Euromarket loans in the debt portfolio of Sri Lanka, for instance, makes up for only about 8% of total public external debt in 1981. In recent times, however, there has developed a secondary market for foreign loans. Two debtors may engage in a currency swap and exchange debt servicing obligations denominated in different currencies to improve the currency structure of their debt portfolios.⁸ A further deepening of this market would succeed in making the diversification of debt portfolio with respect to the currency composition more feasible for all debtor countries.

4. Conclusion

In this paper we tried to develop some criteria for the optimal currency composition of external debt in light of the high indebtedness of LDCs.

In the theoretical section we applied two strategies taking account of exchange rate and export price fluctuations. In the ordinary portfolio approach the country exposes itself deliberately to foreign exchange risk, which might be manageable under stable export prices. Removing this assumption it is advisable for the country to minimize the risk of default by adjusting its debt composition to the export structure.

Empirical evidence for the case of Korea shows that the dominant role of the \$ as the major currency for foreign loans seems to be inappropriate. The SFR, the DM and the Yen should be granted a larger share in debt portfolios.

Choosing the currency composition of debt according to the export structure of the debtor country was superior to borrowing only in \$.

However, it has to be noted that the lack of predictive power in these models, though commonly used in literature, calls for further research in order to derive useful instruments for financial planning.

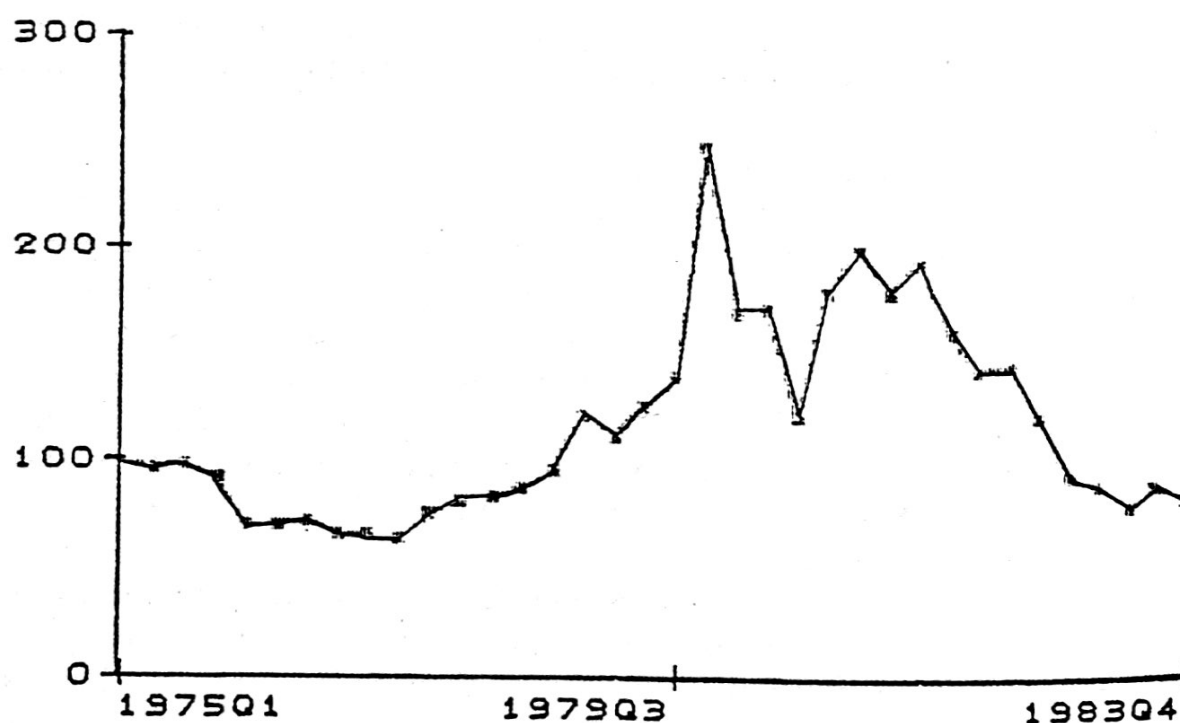
8. World Bank, Research News Vol. 6, No. 1, 1985.

Appendix

RDS Correlation Matrix

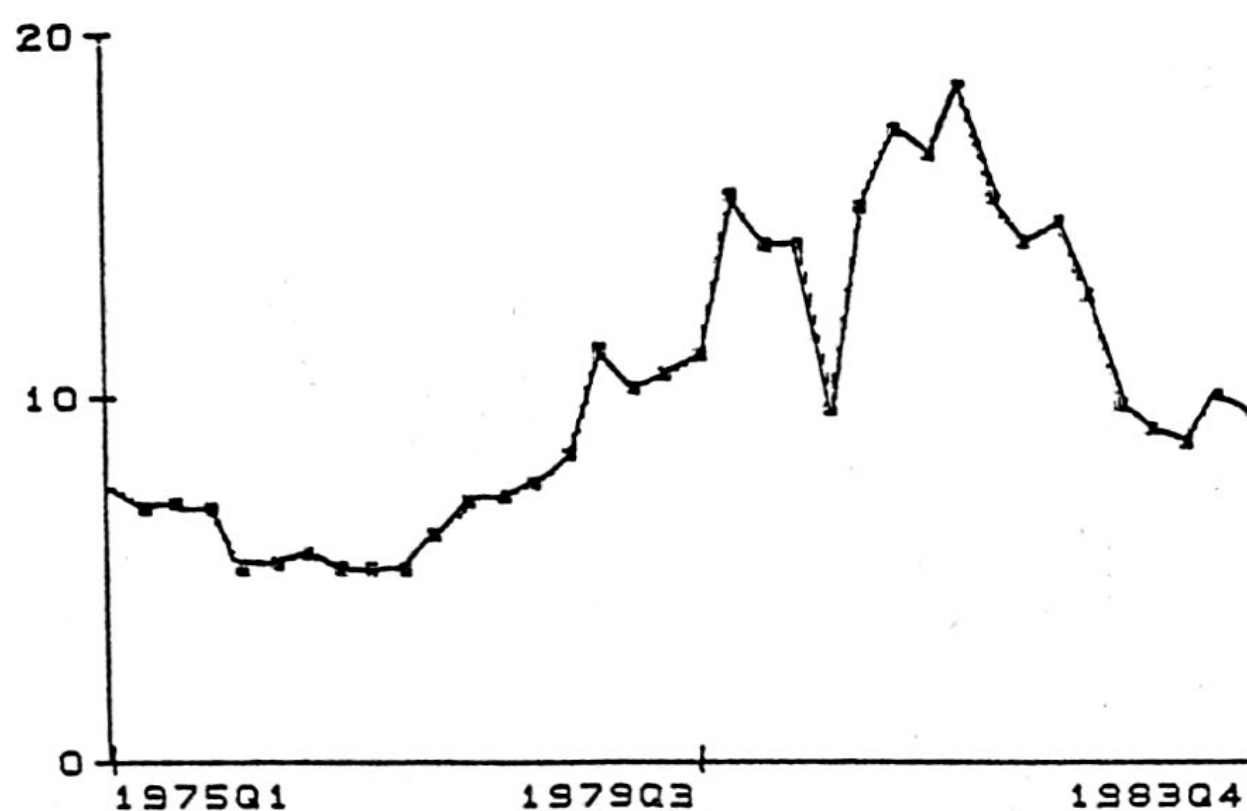
	\$	DM	SFR	Yen	FF	£
\$	1	•	•	•	•	•
DM	0.86	1	•	•	•	•
SFR	0.64	0.81	1	•	•	•
Yen	0.34	0.55	0.56	1	•	•
FF	0.43	0.65	0.53	0.39	1	•
£	0.47	0.54	0.31	0.58	0.32	1

Fig. A.1a.: Real Debt Service for Borrowing in US-\$ from 1975Q1 to 1983Q4



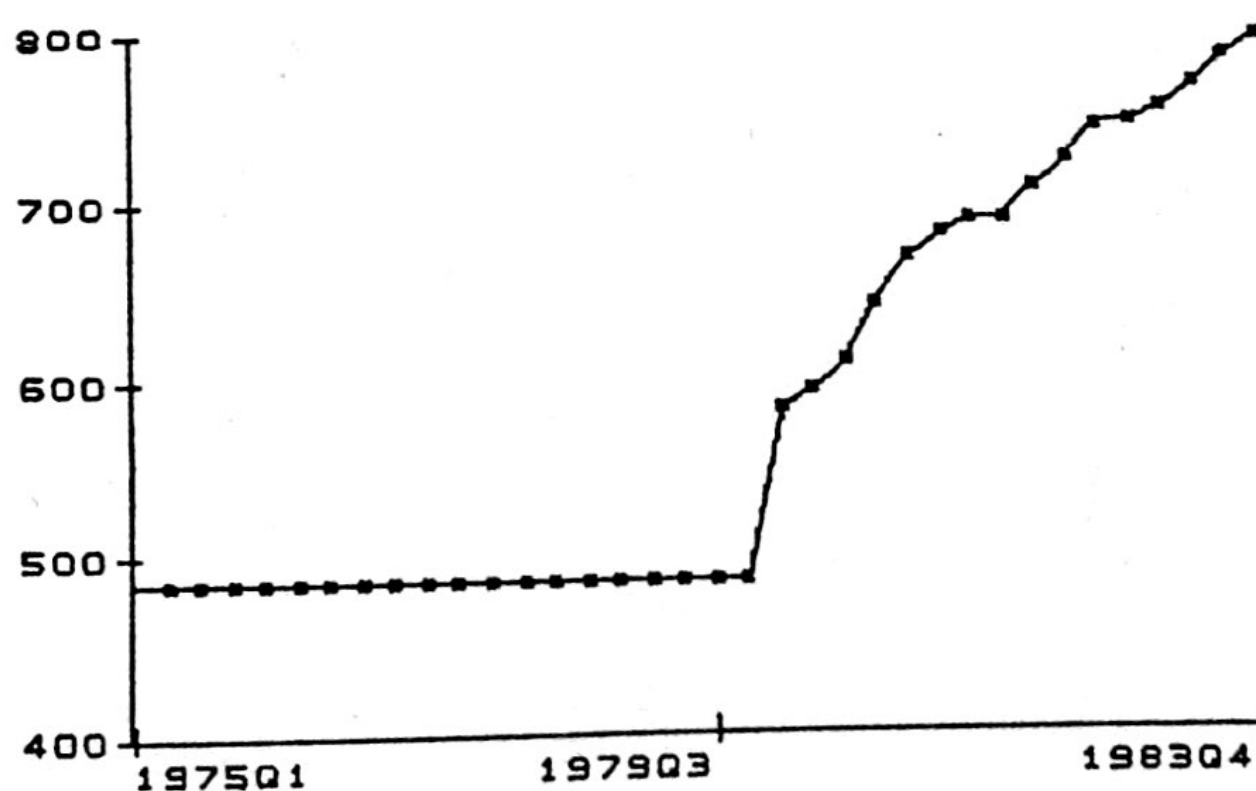
RDS values adjusted so that RDS for borrowing in US-\$ equals 100 in 1975Q1. RDS was calculated according to equation (26) in section 6.1. See footnotes for data sources No. 4 on page 29.

Fig. A.1b.: Beginning-of-quarter 3-Month Euromarket Interest Rates for the US-\$ from 1975Q1 to 1983Q4 (in %).



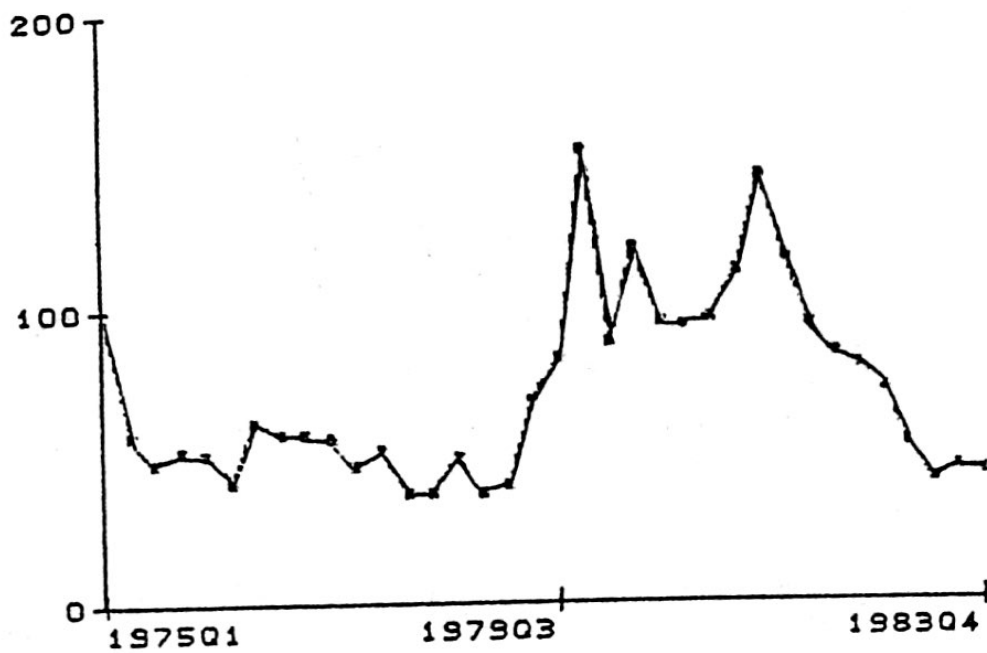
The average rate of the first month of each quarter was taken. The interest rates for 1975 were taken from OECD, Financial Markets. All other rates are 3-month Euro bid rates from Morgan Guaranty Trust, World Financial Markets.

Fig. A.1c.: Beginning-of-Quarter Exchange of the \$ (Won per \$) from 1975Q1 to 1983Q4.



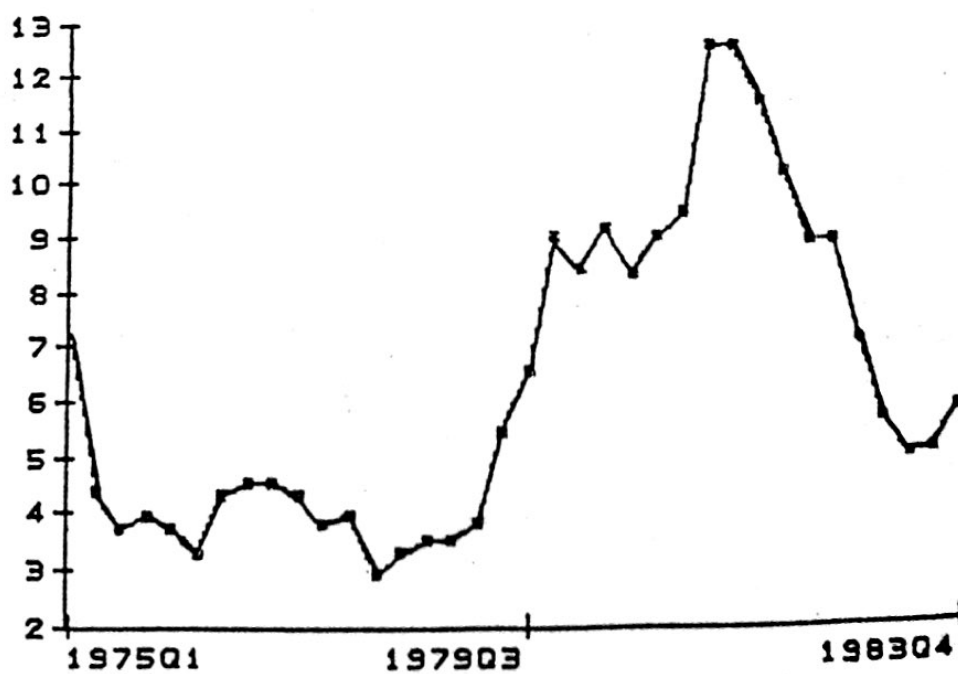
The average spot rate of the first month of each quarter was taken. All data from IMF, International Financial Statistics.

Fig. A.2a.: Real Debt Service for Borrowing in DM from 1975Q1 to 1983Q4.



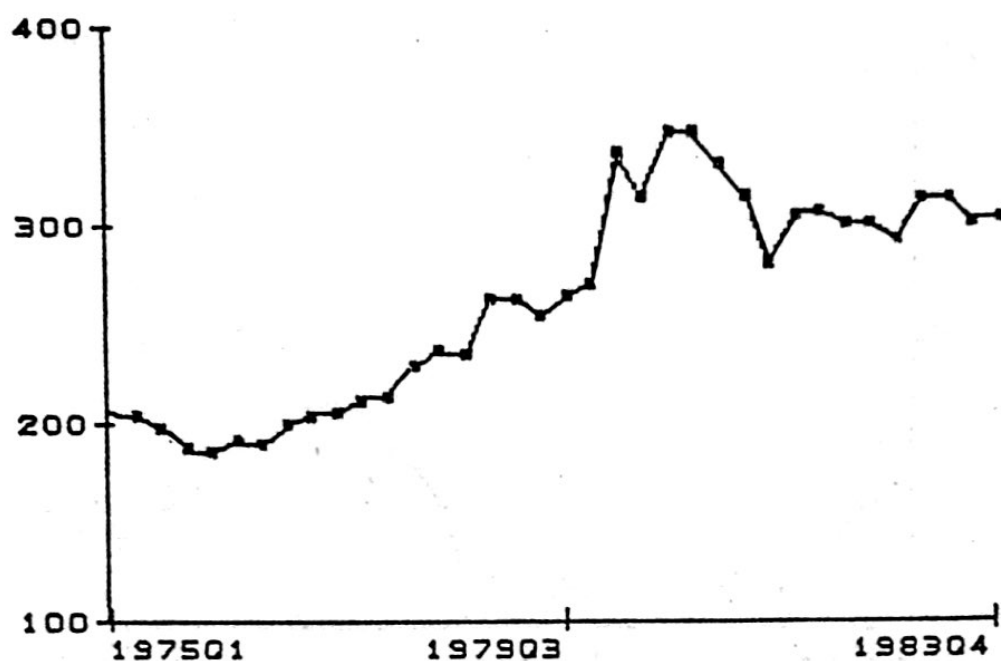
(Footnotes same as the Fig. A.1a.)

Fig. A.2b.: Beginning-of-Quarter 3-Month Euromarket Interest Rates for the DM from 1975Q1 to 1983Q4 (in %).



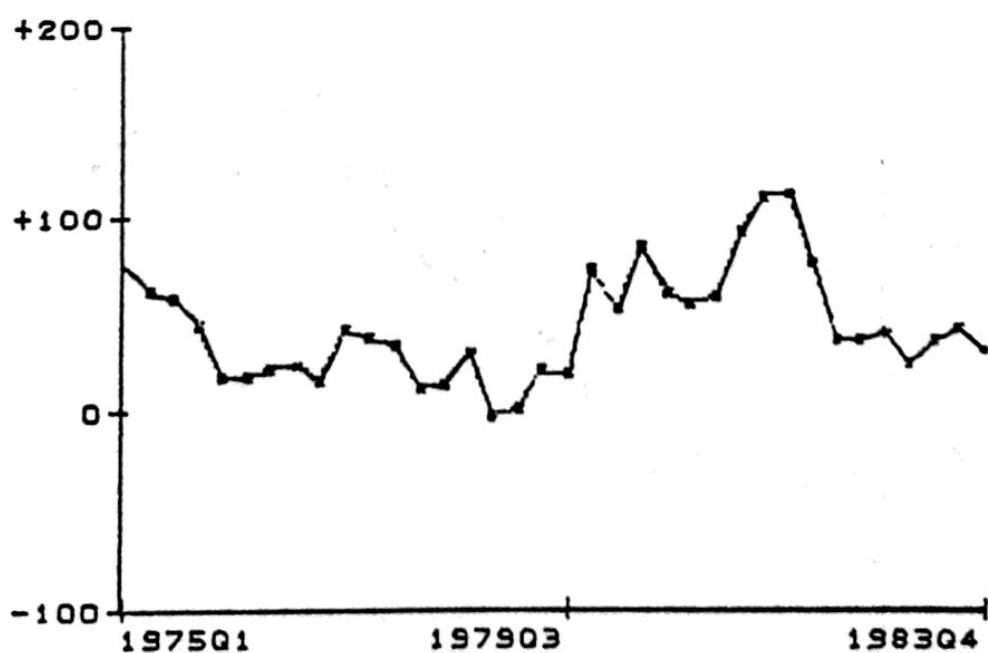
(Footnotes same as for Fig. A.1b.)

Fig. A.2c.: Beginning-of-Quarter Exchange Rate of the DM (Won per DM) from 1975Q1 to 1983Q4.



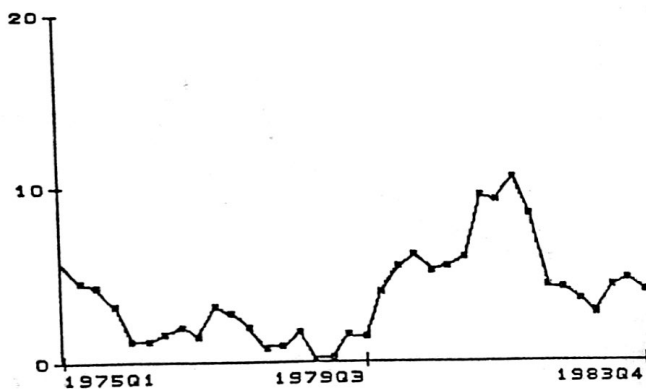
(Footnotes same as for Fig. A.1c.)

Fig. A.3a.: Real Debt Service for Borrowing in SFR from 1975Q1 to 1983Q4.



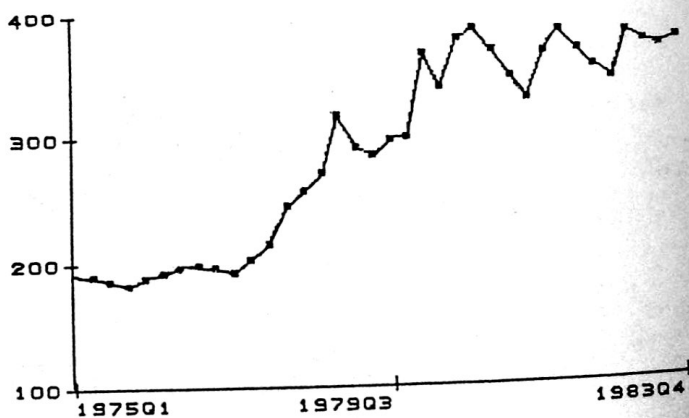
(Footnotes same as for Fig. A.1a.)

Fig. A.3b.: Beginning-of-Quarter 3-Month Euromarket Interest Rates for the SFR from 1975Q1 to 1983Q4 (in%).



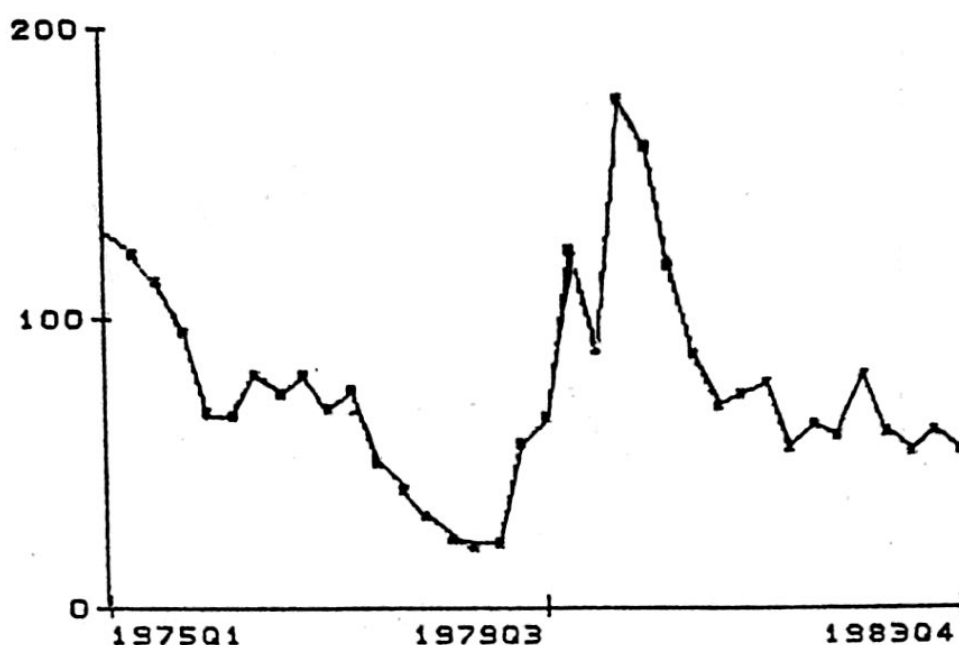
(Footnotes same as for Fig. A.1b.)

Fig. A.3c.: Beginning-of-Quarter Exchange Rates of the SFR (Won per SFR) from 1975Q1 to 1983Q4.



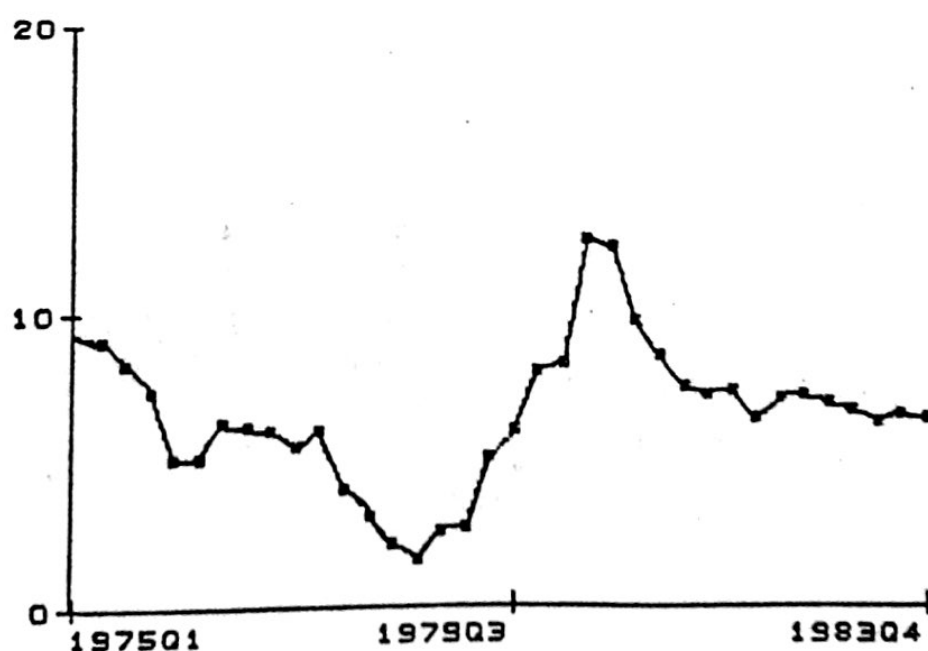
(Footnotes same as for Fig. A.1c.)

Fig. A.4a.: Real Debt Service for Borrowing in Yen from 1975Q1 to 1983Q4.



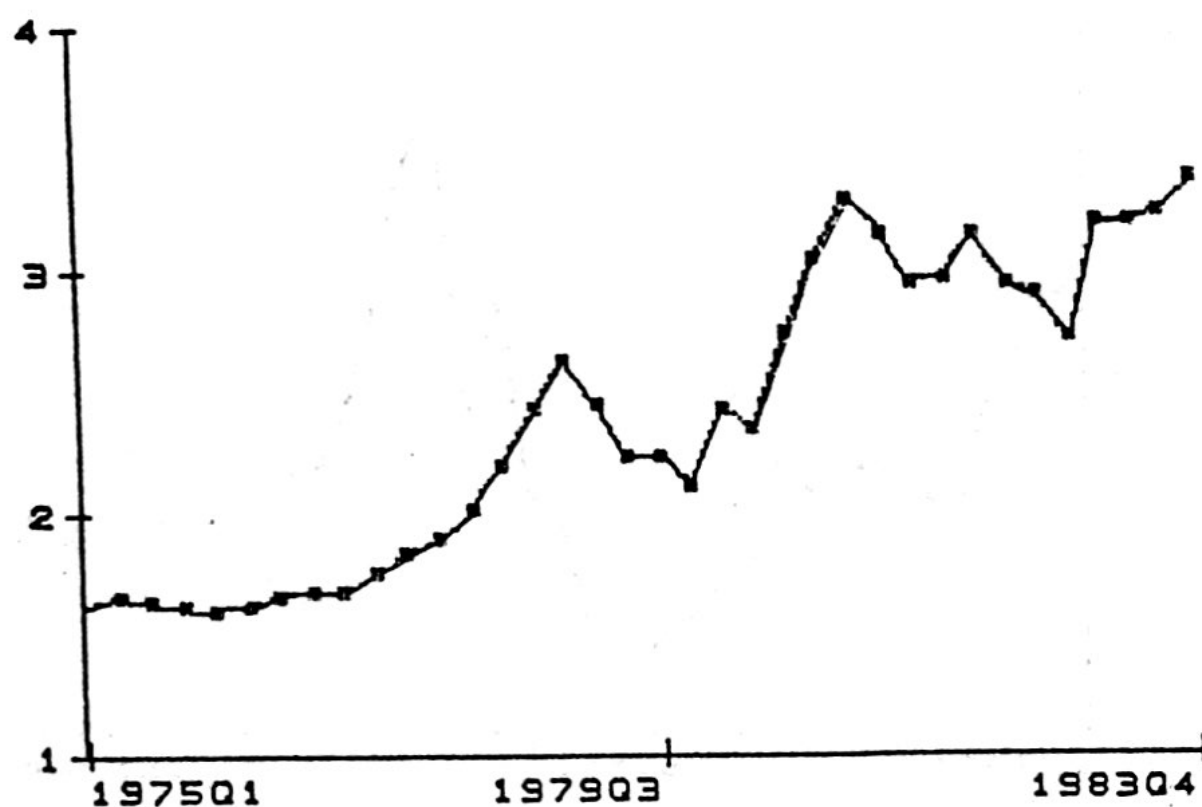
(Footnotes same as for Fig. A.1a.)

Fig. A.4b.: Beginning-of-Quarter 3-Month Euromarket Interest Rates for the Yen from 1975Q1 to 1983Q4 (in %).



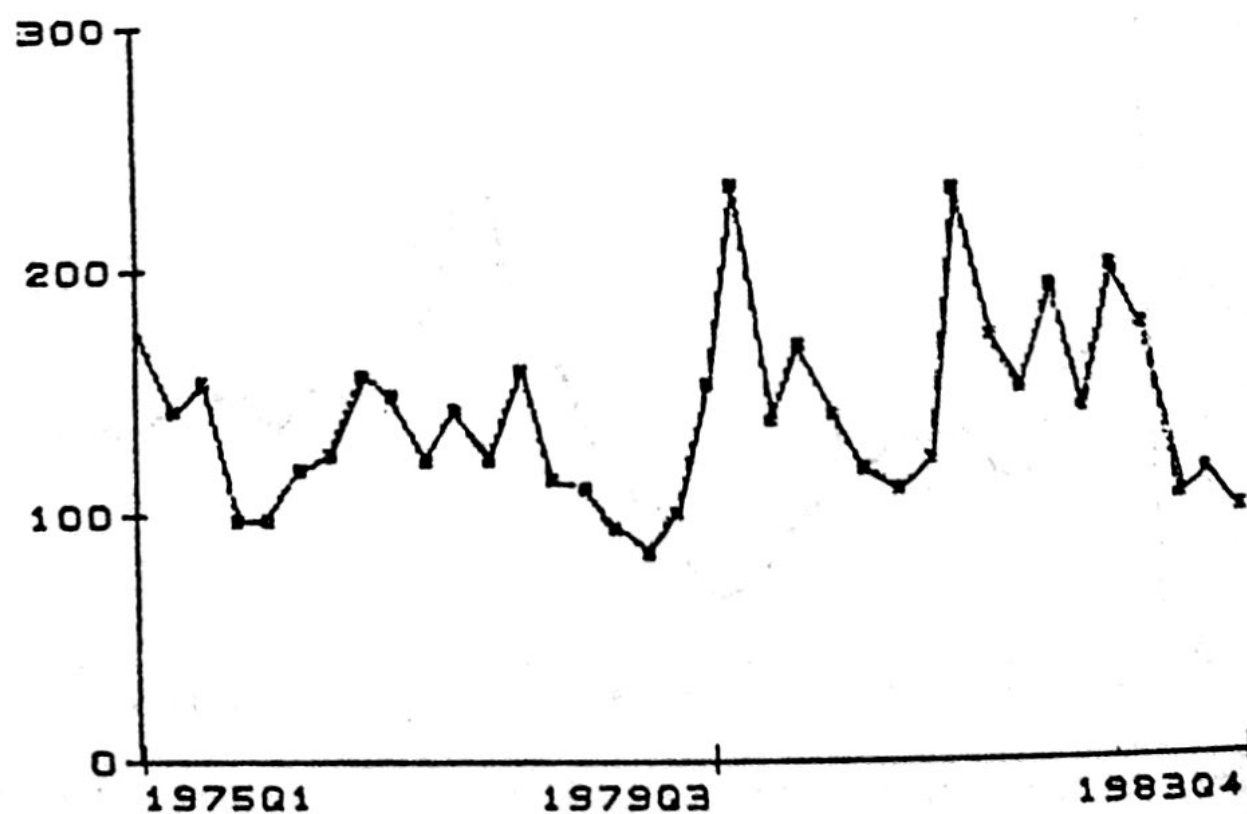
The average rate of the first month of each quarter was taken. Data for the period of 1975 are "standard rates" from Fed. Reserve Board, New York, Monthly Bulletin. All other rates 3-month Euro bid rates as reported in Morgan Guaranty Trust, World Financial Markets.

Fig. A.4c.: Beginning-of-Quarter Exchange Rates of the Yen (Won per Yen) from 1975Q1 to 1983Q4.



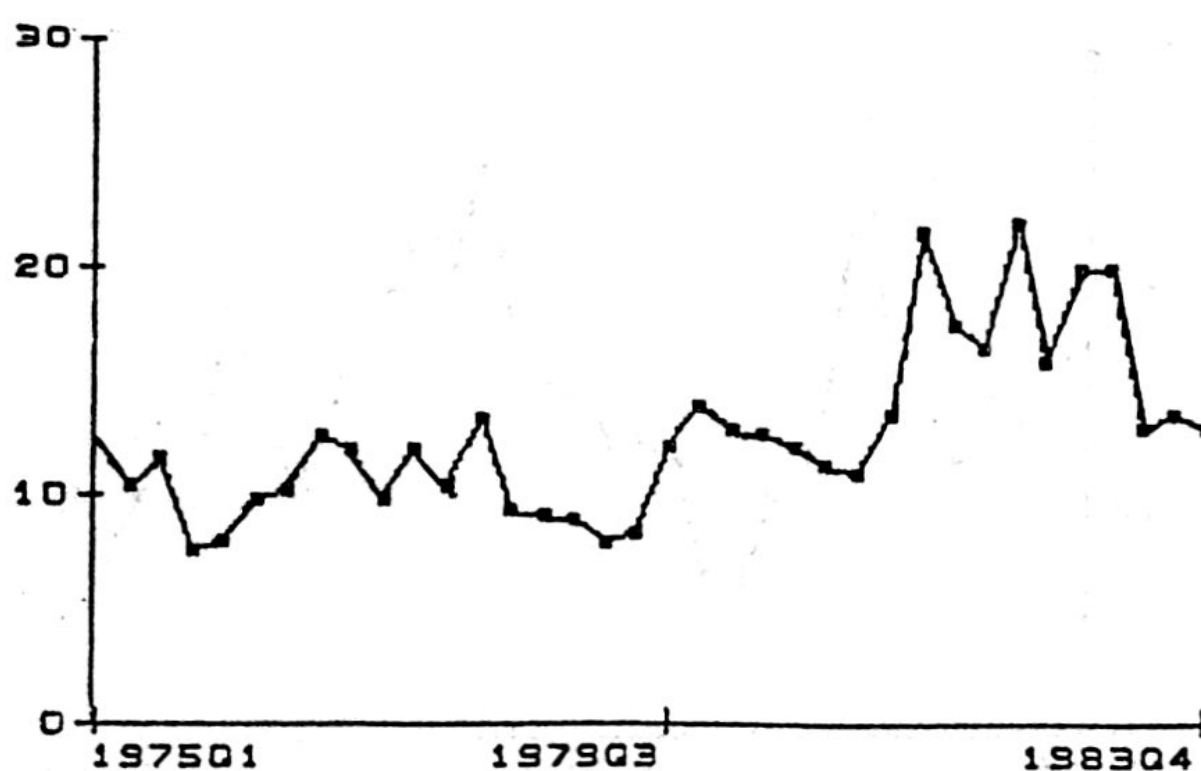
(Footnotes same as for Fig. A.1c.)

Fig. A.5a.: Real Debt Service for Borrowing in FF from 1975Q1 to 1983Q4.



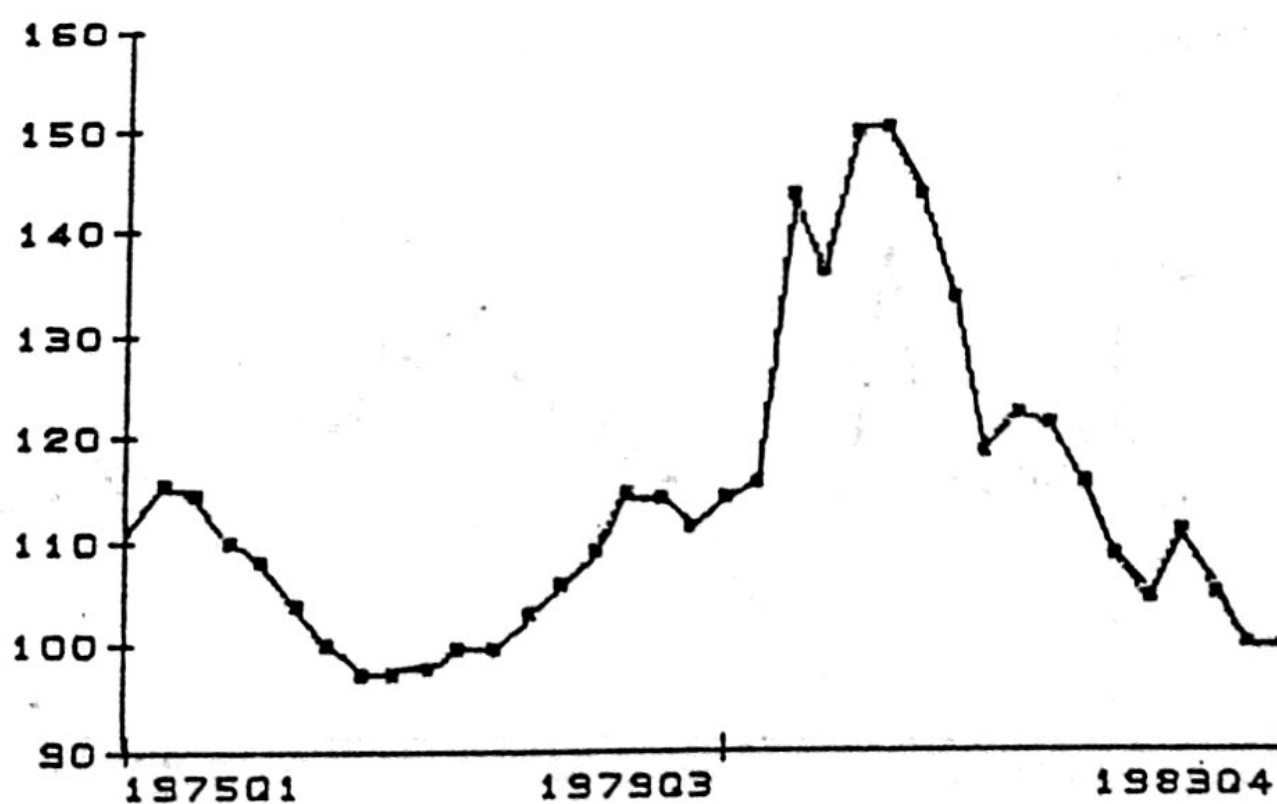
(Footnotes same as for Fig. A.1a.)

Fig. A.5b.: Beginning-of-Quarter 3-Month Euromarket Interest Rates for the FF from 1975Q1 to 1983Q4 (in %).



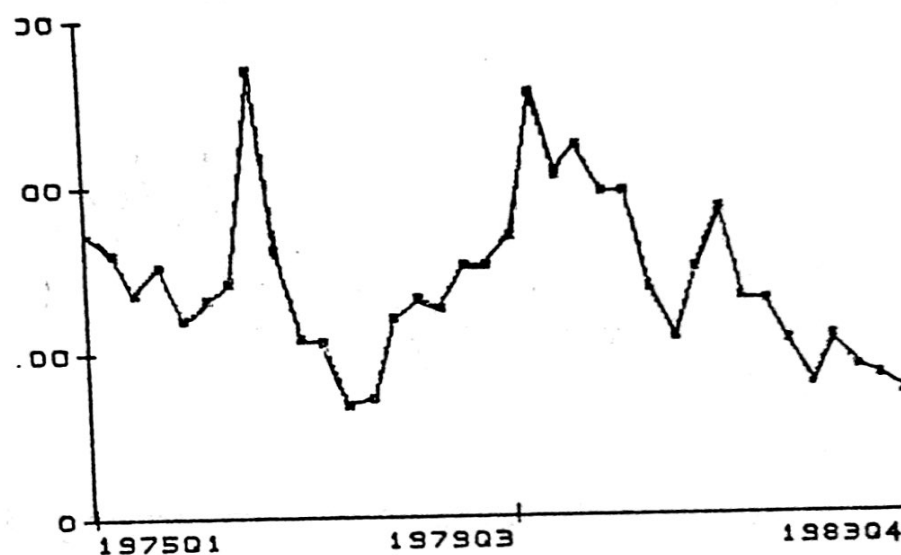
(Footnotes same as for Fig. A.1b.)

Fig. A.5c.: Beginning-of-Quarter Exchange Rates of the FF (Won per FF) from 1975Q1 to 1983Q4.



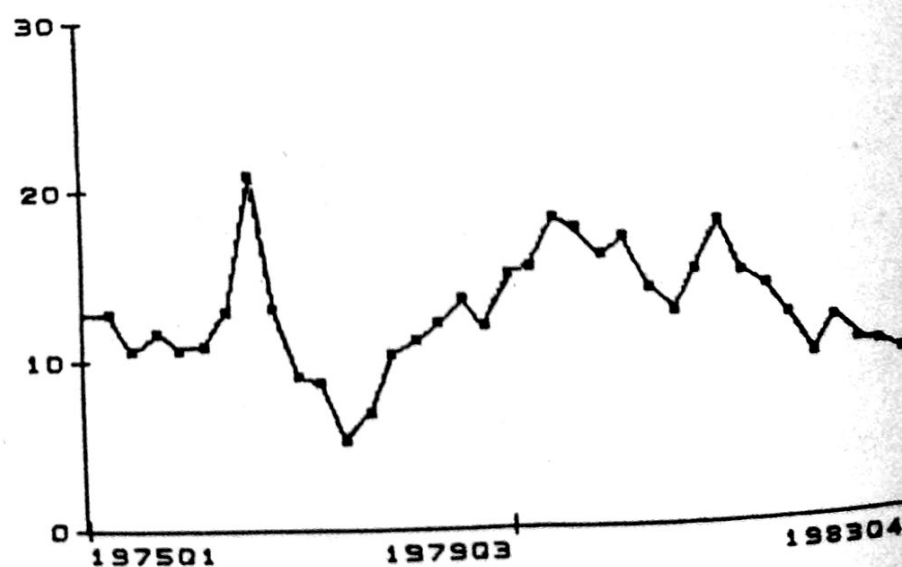
(Footnotes same as for Fig. A.1c.)

Fig. A.6a.: Real Debt Service for Borrowing in £ from 1975Q1 to 1983Q4.



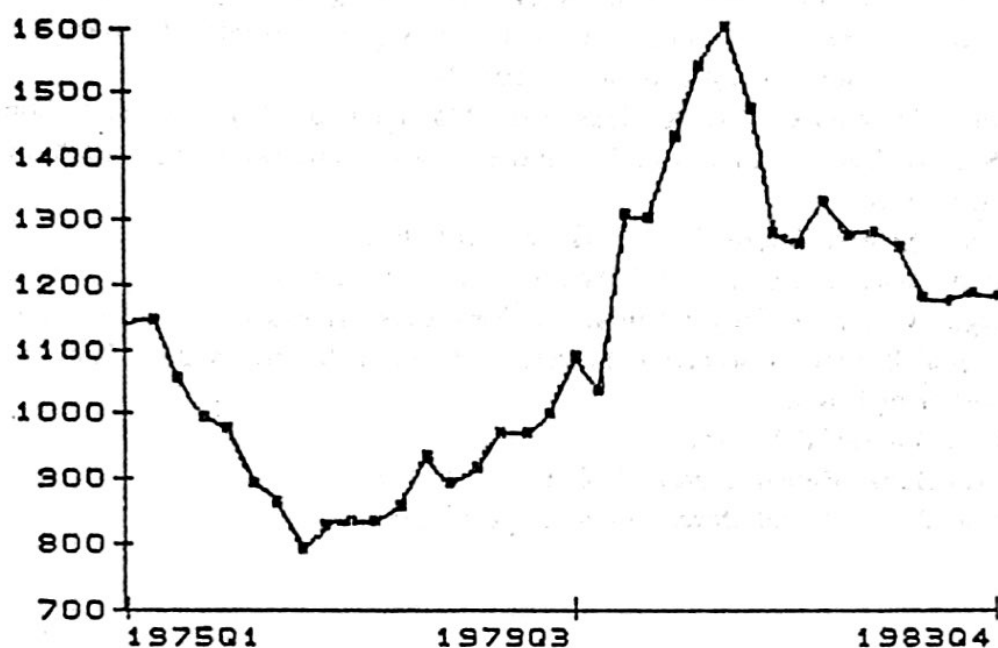
(Footnotes same as for Fig. A.1a.)

Fig. A.6b.: Beginning-of-Quarter 3-Month Euromarket Interest Rates for the £ from 1975Q1 to 1983Q4 (in %).



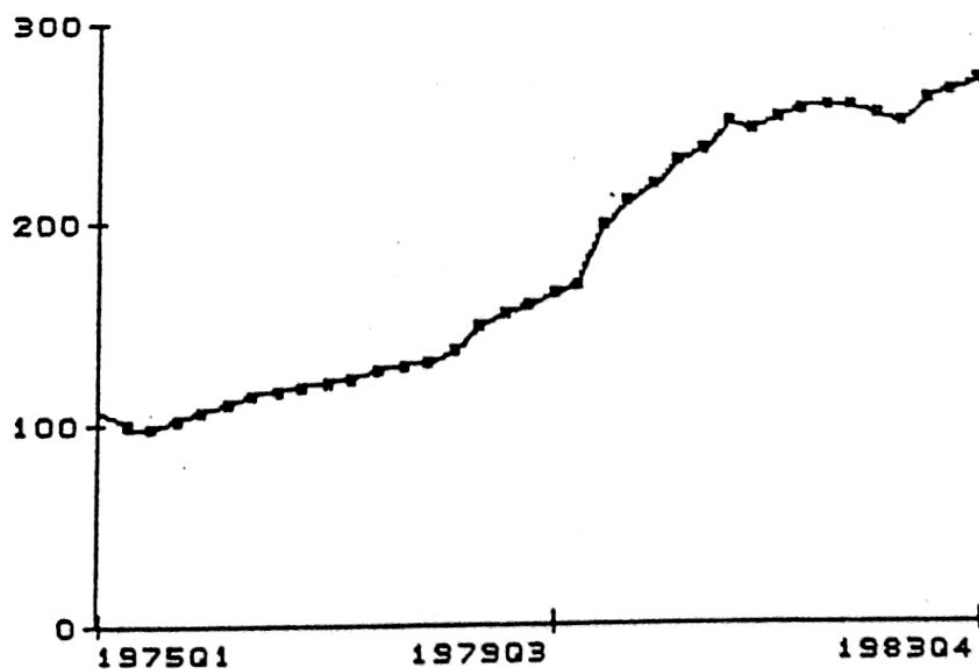
(Footnotes same as for Fig. A.1b.)

Fig. A.6c.: Beginning-of-Quarter Exchange Rates of the £ (Won per £) from 1975Q1 to 1983Q4.



(Footnotes same as for Fig. A.1c.)

Fig. A.7.: Unit Export Value Index for Korea from 1975Q1 to 1983Q4. (1975 = 100)



Data taken from IMF, International Financial Statistics.

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