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OPTIMAL CURRENCY COMPOSITION OF FOREIGN DEBT: THE CASE OF FIVE DEVELOPING COUNTRIES

by

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RÉSUMÉ

De nombreux pays en développement manquent d'accès aux marchés à terme et d'options pour se protéger des énormes risques liés à la précarité de leur monnaie due à leur dette extérieure. Même quand ces marchés leur sont accessibles, les échéances sont souvent trop brèves au regard de celles de leur dette à long terme. L'association de différentes monnaies constitue cependant un efficace moyen de protection pour tous ces pays. Cette étude présente une analyse de la composition monétaire idéale de la dette extérieure pour les pays en développement contraints de la négocier sur le marché financier. Elle définit également une méthodologie empirique destinée à déterminer la composition monétaire optimale. Son application au Brésil, à l'Indonésie, au Mexique, aux Philippines et à la Corée du Sud permet de comparer cette composition optimale à d'autres compositions monétaires, à la fois sur le plan des gains et des pertes dans le domaine des échanges extérieurs et sur celui des variations de flux pour la balance des paiements.

SUMMARY

Many developing countries lack access to future and option markets to hedge the enormous risks arising from the currency exposure of their foreign debt. And even if these markets are accessible, their maturities are often too short compared to the maturities of long-term debt. The important hedging instrument available for any country, however, is the currency mix of foreign debt itself. This paper provides a theory for the optimal currency composition of foreign debt for market constrained developing countries. It also develops the empirical methodology to determine the optimal currency mix which is then applied. Applying the method to Brazil, Indonesia, Mexico, the Philippines and South Korea, the optimal mix is compared to alternative currency compositions, both in terms of foreign exchange gains and losses as well as variability of balance of payments flows.

PREFACE

Since the debt crisis befell developing countries in the early 1980s, analysts at all levels have tended to concentrate on the interest rate element of the debt service issue. One not unimportant consequence of this has been the spate of claims and counter-claims of blame between lenders and borrowers. Neither side, however, has sufficiently considered the effect on debt service payments of fluctuations in the exchange rates of the major international currencies in which debt is normally held.

Savings in key exchange rates, of the dollar and yen, for example, affect the level, the structure, and the economic cost of developing country debt. When these savings become as important as those experienced in the 1980s, the currency composition of foreign debt can be shown to dwarf interest rates as a determinant of debt service costs.

Most developing nations are unhedged against the risks of exchange rate changes between key currencies. They may face institutional barriers or too high transaction costs which prevent them from participating actively on the future markets. This paper by Pier Giorgio Gawronski, now with Banca Nazionale del Lavoro, shows how countries can nevertheless minimise their exchange risk exposure by matching the currency mix of their debt with the currency mix of their cash flows. It is an important contribution to foreign debt management in a world of often wildly floating rates.

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INTRODUCTION *

We live in a world of increasing interdependence. Continuing technological and economic progress today make this process appear irreversible. This generates a growing demand for international co-ordination and management of policies which ultimately affect a number of countries. At a national level, policy makers face the challenge of fostering the benefits arising from this international integration while maintaining a reasonable amount of national control on the main features of social and economic evolution, minimizing the negative effects of this integration and the risks of foreign-induced instability on the domestic social systems: this requires a profound knowledge of the channels of international interdependence. As far as economic relations are concerned, the Balance of Payments reflects the quantitative aspects of a country's most important links with the rest of the world.

With regard to developing countries, it is widely recognised that the 1982 debt crisis was partly determined by exogenous shocks stemming from the industrialized countries (E.V.IGLESIAS, 1988). The major one was the sharp increase in US interest rates which raised the cost of the repayment of debt (see UNCTAD, 1988, p.37). The second was the simultaneous deterioration in the terms of trade of many developing countries (LDCs), which reduced their debt servicing capacity. These shocks were particularly harmful because many LDCs (and their creditors) were unprepared for both of them. A vast literature has since dealt with the problems of interest rate exposure[1]. As regards the terms-of-trade shocks, the efforts to stabilize export prices of LDCs go back at least to World War II, but with modest results[2]. A third way in which this interdependence manifests itself has been somewhat neglected, however, and that is the exposure of debtor countries to medium-term fluctuations of the main currencies' exchange rates. This omission proved to be a serious mistake after 1983 in the case of some apparently well-managed LDC debtors who had to face wide fluctuations of the $/Yen and $/DM exchange rates.

In a global perspective the problem never gained the same importance as the 1979-81 rise in world interest rates, since gains and losses were offset on average across debtors and since the problem was not felt in the largely "dollar-linked" South American economies. On individual LDCs, however, the impact of these exchange rate movements was often substantial: Indonesia, for example, saw its 1984 debt burden increase by 45 per cent in three years in dollar terms, while South Korea benefited from an exchange rate-induced discount. These destabilizing events were often reduced, but sometimes amplified (as in the case of the above mentioned countries), by the effects of major OECD exchange rate swings on domestic trade balances.

(*) Helmut Reisen has made a major contribution of ideas to this paper; Bert Hofman, Pierre Labouerie and Paolo Manasse have provided helpful comments; Florence Contré and Ranwa Safadi assisted in the quantitative work. I am grateful to all of them, and to the many colleagues of the OECD Development Centre with whom I happened to discuss the issues of common interest. I bear alone all responsibility for the contents of the paper.

Macroeconomic theory has tended to underestimate this foreign originated exchange rate risk. In a purely neo-classical approach, for example, where "money is just a veil", the exchange rate swings of foreign currencies would be expected to have no real effect on the economies. Not on the trade flows, because the assumptions of flexible prices and perfect international competition would imply price movements exactly offsetting these exchange rate swings in the world markets, so that the "law of one price" would continue to hold internationally. Nor on debt and debt service flows either, unless they arrive unexpectedly (because the "interest parity condition" would equalize the cost of borrowing across currencies); but in a monetarist approach where exchange rates depend strictly on inflation rates, which in turn depend on money supply, unexpected inflation and devaluation would not exist in a country where all economic agents (the authorities and the public) are "rational". Price rigidities and large, persistent *ex-post* deviations from the interest, parity condition, however, have made the major currencies' swings a real problem in the 1980s for developing countries.

The purpose of this study is to discuss the exchange rate risk faced by LDCs because of unexpected OECD currencies' movements, illustrating what happened during the past four years in the case of five of them, and indicating the possible solutions. The issue is relevant for risk-averse developing countries and their creditors: debt restructuring programmes could start, and are indeed starting, to take this issue into account; the swap market among LDCs has scope for development. It is relevant also for partial debt relief programmes, currently implemented to re-establish the solvency of some high-debtor countries: in fact, neither creditors nor debtors would like to see such debt-reduction schemes nullified by subsequent exchange rate shocks.

The paper is divided into five sections. The first section briefly discusses the relevance of the standard portfolio analysis for developing countries, and reviews the available hedging instruments, including the currency composition of foreign debt. The second section discusses what in theory is the optimal currency composition of foreign debt for market constrained developing countries. The third section describes the empirical methodology used in order to estimate the "optimal" currency composition of the foreign debt of Brazil, Indonesia, Mexico, the Philippines and South Korea in 1984-88. The actual 1984 debt currency composition of the five countries is estimated and discussed. The fourth section compares the performance of the optimal currency composition of debt with alternative compositions, both in terms of currency gains/losses and of higher/lower variability of the Balance of Payments (BoP) flows. The last section presents some concluding remarks.

PART I

THE OPTIMAL CURRENCY COMPOSITION OF FOREIGN DEBT

1. RISK AVERSION AND FOREIGN BORROWING STRATEGIES FOR LDCS

There are conceivably two major objectives of a foreign currency borrowing strategy, namely, to minimize the cost of borrowing ("speculative strategy") and to minimize the exogenous and unexpected variations in the debt burden ("hedging strategy"). These two goals are incorporated into the standard theory of optimum portfolio, where a "risk aversion" function and the expected yields and riskiness of each asset all concur to determine the optimal portfolio for every agent. In this section we argue that, under normal conditions, only the second goal can be successfully pursued by developing debtor countries.

Currency savings are difficult to achieve in principle. In a Mundell-Fleming world with perfect capital mobility and perfect substitution between domestic and foreign assets, risk-neutral and equally informed "rational" investors behave according to an "uncovered interest parity condition" (MUNDELL,1968) of the type

$$i_t = i^*_t + D_t^{exp} + B_t + U_t. \qquad (1)$$

where

i_t = nominal \$ interest rates,

i^* = nominal DM interest rates on equivalent liabilities,

D^{exp} = The expected devaluation of the dollar between time t and the time of the maturity of the financial liabilities,

B_t = a risk premium, whose expected value is assumed to be zero for major OECD countries[3].

U_t = a "white noise", uncorrelated error term.

If financial markets do not behave "rationally", equation (1) would not hold and there should be room for a successful speculative strategy among the major OECD currencies.

Ex-post, the "uncovered interest rate parity" condition has not held for any of the years under examination, nor for the entire 1984-88 period, on average, although in the latter case the deviations were much smaller. Table 3 shows the six-month (LIBOR) interest rate on deposits in various currencies, while Table 2 shows each year's nominal appreciation of various currencies against the US dollar. The two tables are added together in Table 4 to give a rough indication of the total cost of borrowing in the various currencies: it appears that the costs of borrowing have been notably different for the different currencies, and that, if these costs had been known in advance, debtors could have successfully switched from one currency to another.

The question is, of course, whether it is possible to guess "*ex-ante*" the direction of these deviations. A speculative type of behaviour is rational only if the expected gains are larger than zero, or if the agents are risk-loving. We exclude by assumption that indebted LDCs are risk-lovers[4]. Therefore, a speculative policy is rational only if the indebted country has more information than the markets, or if there is a (long-term) systematic bias in the cost of borrowing among different currencies (i.e., if the theory of the covered interest rate parity condition does not hold true).

More information than is available to the market could only be provided (but is not actually provided) to debtor countries by industrial countries' policy-makers on the future management of the economic variables under their control. Could LDCs reasonably expect to get more information than the market, for example, the contents of the G-7 agreements on target zones, in order to be able to implement speculative policies on their foreign debt? It seems unlikely. These would, in fact, be disguised attempts to transfer the debt burden of LDCs onto the OECD countries' financial sector. If this is the goal, then it is probably better to do it openly and neatly, unless there are political reasons for implementing disguised procedures of partial debt relief. In any case, unless DC governments provide LDC authorities with confidential information, LDCs cannot expect to implement successful speculative strategies on the grounds that they can forecast the exchange rates movements better than the market.

Is there a systematic bias on the cost of borrowing across currencies? The issue is constantly debated, both in theoretical[5] and in empirical terms[6]. We will not therefore venture to take part in the current discussion, but will simply present some *ex post* evidence. From Table 4, it is clear that such a bias across currencies is inconsistent from year to year, but that there is an average bias for the whole period considered (1984-88). Any extrapolation, however, especially from such a short period, does not seem justified. For example, the ten-year average gives opposite results. The only observation that can be made is that when we separate the interest cost from the exchange rate cost (Tables 2, and 3), it emerges that the latter has been constantly underestimated by the markets in recent years. For the rest, it seems that the existence of a systematic bias, or investor's "preference", across currencies has yet to be proven.

For the above reasons, a "speculative" approach does not seem to be justified. Furthermore, there are two other reasons why speculative approaches to debt management are bound to be unsatisfactory. First, the existence of transaction costs raises the cost of speculative policies (which are likely to require a higher number of transactions). Second, most indebted LDCs are likely to be risk-averse rather than risk-neutral, which further raises the utility cost of a speculative approach to debt management for any single debtor country. Thus, lowering the cost of borrowing is a goal that must be pursued by seeking better marginal borrowing conditions (interest rates, fees and charges, risk premiums) rather than through speculative behaviour.

If debtor countries are risk-averse, however, a hedging policy against "exogenous" shocks becomes desirable. In particular, LDCs are more exposed to unexpected foreign exchange rate movements because most of their commercial and financial transactions are denominated in a variety of foreign currencies, much more than is the case with developed countries' transactions. Consequently, the exchange risk is structurally shifted from OECD to LDC economies. Option and future markets are of little use in this respect, since they are hardly available to developing countries currencies for longer-than-six-month maturities and at reasonable cost[7].

Forward exchange rate contracts are becoming increasingly available in LDC's economies. Their effect, however, is simply to shift the risk from risk-averse to risk-loving domestic agents; but the risk stays in the LDC's economy. The development of these markets in LDCs involves the redistribution of the microeconomic risk within the economy, but the macroeconomic risk remains virtually unaffected. In developed countries' financial markets, forward and futures financial instruments are available on the open market only for about 18 developed countries' currencies, although the Singapore dollar has been recently added in the Amsterdam market. For example, the forthcoming "Globex" system of the Chicago Mercantile Exchange which will offer a single continuous worldwide trading system for futures will offer futures and options on Eurodollars and five other currencies: Yen, British pounds, Deutschmarks, Swiss francs and Canadian dollars. Over-the-counter forward contracts can be agreed with any major bank for any currency, but at extremely high costs, especially for longer maturities; furthermore, these instruments are not liquid, due to the thinness (or non-existence) of a market for them, which makes a dynamic management of the foreign debt impossible. Finally, "futures" are useless when exporters are "locked" into long term commitments arising from fixed investments in productive capacity or from marketing efforts targeting a specific country; the short maturities of financial futures make them unsuitable for hedging against medium-term exchange rate fluctuations.

The currency composition of the foreign debt, however, can be used as a hedging device. It seems reasonable to try to match the debt-service and other outflows with inflows from abroad so that the changes in the value of the former are matched by changes in the value of the latter. We suggest that stabilizing the whole current account is the objective that LDC authorities should have in mind when given the choice of alternative currency liabilities. We therefore develop the relevant mathematical formalization of this idea in the following section before attempting to determine in practice the optimal 1984 debt structure for our five LDCs, and compare its performance with that of the actual structure chosen and that of some possible alternative currency structures.

2. RISK-AVERSE PORTFOLIO MODELS FOR BORROWING COUNTRIES

Can an appropriate currency composition of foreign assets and liabilities stabilize *ex ante* the whole external position of a developing country, against unexpected exchange rate variations of the major currencies? Under what circumstances can these exchange rate risks be eliminated completely? A growing literature on the subject, drawing on the theory of optimal portfolio composition, is beginning to provide relevant insights into the issue. The basic idea consists of creating an automatic stabilizer of the whole BoP[8] by taking a debt/assets currency structure that is able to offset the changes in the domestic value of trade flows induced by the major currencies' exchange rate movements, given an estimated pattern of the domestic real effective (trade-weighted) exchange rate (REER).

2.1. Modelling Issues

Some sophisticated models produced up to now (CLAESSENS, 1988; KRONER,1988), however, fail, to a certain extent, to reproduce the situation faced by LDCs, inasmuch as they assume the ability (and the will) of LDCs to set their total foreign debt at the level required to minimize foreign shocks; no constraints on total amounts are usually considered, so that these models are almost always inapplicable. On the other hand, the assumption that LDCs do take a view on the future trend of major exchange rates and try to save foreign reserves through speculative behaviour does not seem to describe the LDC authorities' behaviour; or at least it is not clear whether the gains in realism are worth the implied loss of simplicity.

In our analysis, the optimization is carried out only with the goal of stabilizing the current account, as no capital gain is assumed to exist on average through currency diversification; this avoids the technicalities of specifying a utility function for the country concerned, the optimal amount of debt, and, up to a certain stage, the risk aversion function[9]. On the other hand, the case of a constrained amount of foreign assets and debt is explored, which makes the analysis more relevant for the current state of the world[10].

The model is a one-period model because a dynamic intertemporal optimization of the currency composition of foreign debt would depend heavily on the degree of flexibility of the currency structure of the debt, which probably includes marked discontinuities (caused by the rescheduling prospects, different maturities of the different currency "tranches", etc.) that differ from country to country, and for which there are no available data. If, however, there were no constraints at all on (changing) the currency structure at every point in time, such an intertemporal optimizing model would not be needed because the debt structure could always be adjusted to the changing current account. This would also hold in the more plausible case that the changes in the debt structure at the end of every year can be larger than, or equal to, those occurring in the trade currency flows[11]. This depends mainly on the existence of an efficient swap market, on the relative dimensions and the maturities of the foreign debt, etc.

The focus of the study is on the effects of unexpected, medium-term swings of foreign exchange rates on the BoP of developing countries. As exchange rates move simultaneously in a floating-rates world, the response of the domestic exchange rate has to be somehow estimated, as it crucially affects the volume and the domestic value of the balance of payments flows denominated in foreign currencies[12]: the optimal debt composition will therefore be a function of the expected domestic exchange rate reaction. For isolating the foreign exchange rate shocks from other shocks - in particular from domestic (exchange rate) policies we make a crucial assumption: we assume that the domestic nominal exchange rate moves automatically so that the REER is kept constant, at an "equilibrium level" that guarantees a desired trade balance[13]. Volume changes of trade flows as a consequence of the exchange rate originated terms of trade shocks are not considered since they are already part of the country's adjustment effort: in this paper we only try to find ways to minimize the shocks themselves. However, one could in principle integrate into the model the traditional "elasticity approach" in order to have a disaggregated analysis of volume responses (see BLACKHURST, 1983).

Even apart from the volume responses, the empirical estimation of changes in the value of trade flows due to foreign exchange rates fluctuations is rather complex. In the short run: fixed price contracts denominated in foreign currency; the equivalence of the currency of invoice and the numeraire currency for pricing; no financial futures in foreign markets for the developing country's currency (to shift the exchange risk onto foreign agents): imply that the whole amount of the exchange rate movements will be reflected in equivalent changes in the value of the trade balance flows[14]. In the longer run, exporters will react by eventually changing the price (in foreign currency) and/or the volume of traded goods, and there will be the well-known reshaping of production and trade flows: the one-to-one relation between the change in the value of the traded good and the exchange rate movement will weaken. Financial flows, on the other hand, will increase or decrease in domestic terms by the same percentage of the domestic exchange rate movement. Although in some cases the exchange rate movement will indeed affect the level of foreign interest rates, this is more likely to happen in a system of fixed exchange rates. The *stock* of foreign assets and liabilities will also change its value in domestic terms by the amount of the debt-weighted movement of the domestic effective exchange rate. This will cause the usual wealth effect on the domestic aggregate demand, and the debt/export and debt/GDP ratios will also change, affecting the country's creditworthness.

To see how the optimal currency distribution can be achieved in a one-period model, let us assume at first, as in the short-run hypothesis, that the "pass-through" coefficient of foreign exchange rate movements on foreign prices is equal to 0: prices of traded goods are fixed in foreign currencies. Let us also reduce all Balance of Payments flows to debt service and trade flows. As far as the trade balance is concerned exchange rate movements will then be reflected in equivalent changes in the value of exports and imports. While changes in the domestic value of trade flows invoiced in the same foreign currency with an opposite sign will offset each other, the net imports (exports) of every currency share of the trade balance will have an impact on the total trade balance equal, in percentage terms, to that of the exchange rate movement. If both the total amount and the currency structure of foreign debt and the related financial flows could be freely chosen at the beginning of the period, a simple hedging foreign debt/assets structure would be the one where the debt service flows in each currency is equal to the net trade *surplus* in that currency; and, conversely, the income flow arising from foreign assets in that currency is equal to the net **deficit** (net imports) in that currency. We start from this simple case to move to more realistic models in the following pages. We provide a summary of the modelling effort at the end of this section for those uninterested in the details.

2.2. The "Minimizing Exposures" Model

Formally, the Current Account (composed of both trade and debt flows denominated in n currencies) is always equal to

$$X_1 + X_2 + \dots + X_n = K\,(Y_1 + Y_2 + \dots + Y_n). \qquad (2)$$

where:

X_i = expected "trade" surplus in currency i (in absolute terms)

$-X_i$ = expected "trade" deficit in currency i (in absolute terms)

$Y_i = d_i - a_i$ = estimated net debt "flows" in currency i

$(Y_i - X_i)$ = country exposure in currency i

ΣY_i = total net foreign debt service "flows"

d_i = estimated negative financial flows in currency i

a_i = estimated positive financial flows in currency i

K = scalar equal to $\Sigma Xi / \Sigma Yi$

and

Σd_i = D = total foreign debt flows

Σa_i = A = total foreign assets flows.

The objective function to be minimized is

$$|Y_1 - X_1|^{\beta} + | Y_2 - X_2 |^{\beta} + ...+| Y_n - X_n|^{\beta} \text{ for } \beta>1 \qquad (3)$$

Equivalently, we can minimize the function

$$(Y_1 - X_1)^2 + (Y_2 - X_2)^2 + ... + (Y_n - X_n)^2 \qquad (3a)$$

where Y_i are the policy variables.

This function describes (the square of) the country exposure to exchange rate shocks disaggregated by currency[15]. Equal weight is given to each currency.

The minimization of this objective function is somewhat complex, but some observations are proven immediately. First of all, this objective function shows that only in the case where all its elements (Yi - Xi) are zero is the country exposure zero. A necessary condition for this is that the Current Account is in equilibrium, i.e.,

$$\Sigma X_i - \Sigma Y_i = O \qquad \text{(or} \quad K = 1).$$

In this case, complete hedging is possible (through a perfect matching of all flows in each currency), and is equal to

$$KY_i = Y_i = X_i \qquad i = 1, ..., n. \qquad (4)$$

If we extend the result to the more realistic cases where there is a current account imbalance[16], or where there are constraints on A+D or on A and/or D, but not on their currency composition, it is clear that the minimal value of the function is found by (if possible) equalizing the exposure in every currency, or at least setting the debt flows in such a way as to minimize the differences of exposure among currencies: in this way the risk will be spread as much as possible.

It can be proven that, introducing the constraint

$\Sigma Y_i = T$ where T stands for any number, the optimal debt flows in every currency will be given by the formula

$$Y_i = T - X + X_i \qquad \text{for } i = 1, ..., n$$

$$\text{and } X = (1/n)\, \Sigma\, Xi .$$

However, under this formulation, Y_i can have any sign.

Assuming that our LDCs are market constrained, for example that assets are constrained to equal zero[17], and concentrating only on the given debt, we will have to minimizing the **objective function**

$$(d_1 - X_1)^2 + (d_2 - X_2)^2 + ... + (d_n - X_n)^2 \qquad (5)$$

under two constraints:

$\Sigma d_i = D \qquad i = 1, ..., n \qquad (6)$

$d_i > 0 . \qquad i = 1, ..., n \qquad (7)$

In this case, it can be proven that, as there is at least one currency g < n such that

$$\sum_{i=1}^{g} (X_i - X_g) < D < \sum_{i=1}^{g+1} (X_i - X_{g+1}) \qquad (8)$$

the optimal hedge is given by

$$d_j = X_j + \bar{D} - X \qquad j = 1, ..., g \qquad (9)$$

where: d_j = the debt amount for currency i

D = total debt flows in the period considered

$\bar{D} = D/g$

X_j = the trade surplus of currency j

$X = (1/g)\ \Sigma X_j$.

The proof of equation (9) is given in Appendix 1.

The intuition is presented in Graph 1, which, in the case of the Philippines represents, for a given year, the expected net trade balances in six currencies of invoicing. Assuming that there are only trade and debt flows, to minimize the countries' exposure the debt (flows) should fill, starting from the bottom, the area X-X1-B-C-D-E-F-G-H-I-L-M-N-O, which is unbounded on the upper side. If the total debt flows are high enough, exposures (debt and trade flows) will be equalized across all currencies. If there are assets, the debt flows should ideally fill the area O R D C B X1, and positive financial flows should fill the area Q R E F G H I L M N.

By adding a constrained amount of foreign assets on top of the debt, treated as equivalent to liabilities but with opposite signs, we have the optimal currency composition of foreign assets given in a similar way, by:

$a_i = X_h - X_i + d_i + (R/n)\ A^*$

where: $A^* = A - D$ = net foreign wealth

$R = 1$ when $A^* => 0$

$R = 0$ when $A^* < 0$.

Having found the optimal d_i and a_i in such a way under constrained D and A, the optimal net debt composition here is given by $Y_i = d_i - a_i$. If the debt that can be partitioned into different currencies is not equal to total debt, then all the X_i should be considered as the net currency positions including both trade and outstanding "stuck" debt flows. Therefore, this frame can be used in renegotiations and partial debt restructuring to determine the "best" currency composition of the new debt. It should be kept in mind that the X_i are the expected net currency positions of the trade balance; all possible information on future developments on the trade balance should be used to determine their value.

2.3. The "Variability Corrected" Model

Minimizing the exposures in every currency is only a first step in the direction of minimizing risk. For some currencies are more "risky" than others because the cost of borrowing in these currencies is more "variable" than the cost of borrowing in the other currencies. The net exposures must therefore be "weighted" according to their (forecast) variability[18].

The "variability-corrected" model can be formalized in the following way:

$$T_{i,t+1} = T_{i,t}\,[1+(1-P_i)s_i\,] \qquad i = 1,\dots n \qquad (15)$$

$$d_{i,t+1} = d_{i,t}\,(1+s_i) \qquad (16)$$

where all right side parameters are exogenous and

$T_{i,t+1}$ = Expected Trade Balance in currency i, next period.

$T_{i,t}$ = Trade Balance in currency i at time t.

P_i = "pass-through coefficient" of exchange rate percentage changes on prices

B_i = $1 - P_i$

s_i = Standard deviation of the exhange rate of currency i with the domestic currency.

n = the number of OECD currencies in which the current account flows of our developing nation are invoiced.

$d_{i,t+1}$ = expected debt service in the next period in currency i.

Objective Function

The objective function is derived from the n x 2 equations (n trade equations and n debt service equations) of the model described by (15) and (16). If the goal is that of minimizing the expected shock, then

$$\Sigma[(d_{i,t+1}-d_{i,t})-(T_{i,t+1}-T_{i,t})]^2 = \text{min.}$$

Using eq. 15 and 16 we obtain

$$\Sigma\ [(d_{i,t} + s_i d_{i,t} - d_{i,t})-(T_{i,t+1}(1-P_i)s_i T_{i,t} - T_{i,t})\ ]^2 = \text{min.}$$

$$\Sigma\ [s_i(d_{i,t}-B_i T_{i,t})]^2 = \text{min} \qquad (17)$$

Constraints

1) $\Sigma d_i = D$

2) d_i > = 0 for all i

where the given parameters are D, $T_{i,t}$, P_i, s_i and hence $T_{i,t+1}$, and the policy variable is d_i, under the given constraints.

Note that further "information" (P_i) concerning the correlation between exchange rates and the prices of traded goods has been introduced in this model. If this correlation does not exist, the pass-through coefficient of exchange rate movements on prices (P) is zero. If, on the other hand, money is just a "veil", then P = 1, and exchange rate movements have no real effect on the value of trade flows, as in the neoclassical hypothesis.

The mathematical solution of this problem (eq. 17) when n>3 becomes unbearably complex. However, we can use some computer packages using non-linear programming methods to solve the numerical problem (although not the analytical problem) with some iterative procedures. The risk usually involved in these methods is the existence of local optima, which might be taken by the computer for a global optimum. The proof that this particular objective function has no local minima is given in Appendix II. A short programme designed to solve this problem using the software "GAMS" is presented in Appendix III.

The choice of the standard deviation s_i in the above formula is valid if the risk-aversion function is constant for an increasing value of the strength of the shock. If however, the aversion increases for an increasing value of si, then one might want to select a value that is not the one most likely to occur (i.e. s_i) but, rather, a value of the deviation that has the highest weighted probability of occurring (where the weights represent the degree of risk aversion). We do not feel we have to model this here, but we would simply warn the reader of the connection that arises at this stage between the objective function of our model and the risk-aversion function.

In graphic terms, the "variability-corrected" model can be illustrated in the following way (see Graph 2). Suppose our LDC's debt is too small to hedge trade imbalances completely (K> 1); it has two surplus currencies, £ and DM, with equal net trade flows (indicated on the vertical axes by the 0), whose changes of value as a function of the foreign currency's value are given (for both currencies) the same schedule TB; and equal debt flows, whose changes are described by the same schedule DD we draw and utilize its inverse D'D'.

At the beginning of the period, we are in A, (as no changes have yet occurred.) Suppose, however, that the Pound's variability, V(£)=AB, is double the DM's variability V(DM)=AF. The expected absolute value of the Current Account change of value is given by the expected trade shock minus the expected offsetting change of value of the debt service: for the Pound by 0 BC-BD = DC; for the DM by HF-GF = HG.

Since the pound is expected to be a "more risky" currency (CD>HG), our risk averse LDC will want to move the D'D' function higher in the case of the £ and (assuming a given amount of debt) lower it in the case of the DM until the expected shocks are equalized (HG=CD). In other words, it is convenient to give a better hedge to the flows denominated in pounds even if this diminishes the hedge of the DM flows.

CD> HG, our risk-averse LCD will want to move the D'D' function higher in the case of the £ and lower it (assuming a given amount of debt) in the case of the DM until the expected shocks are equalized (HG=CD).

2.4. The "Correlation Model"

The correlation of exchange rates too changes the optimal currency distribution, and has to be taken into account in the following way. Suppose one currency, X_1, is correlated with currency X_i with a correlation coefficient[19] of +0.3 and a regression coefficient of 2.8. This means that every time currency one flows increase their value by one per cent, currency i flows increase their value by 2.8 per cent on average, with a precision of 30%. Using this further information, we will no longer try to minimize the single exposures, (eventually weighted by their relative variability), cutting down the highest and increasing the smallest. We will instead try to minimize the risk described by the whole objective function by taking into account the relation between the different (currency) exposures.

This is done with

$$\Sigma E_i b_{ij} = \min \qquad (18)$$

where

$E_i = (d_i - X_i)$

b_{ij} = the regression coefficient of currency j on currency i (j is any currency, chosen as a numéraire).

Proof

The expected shock to be minimized is given by the difference between the current account at time t and the current account at time t + 1. Hence

$$\Sigma \ \{ [(d_i-X_i)(1+s_j b_{ij})] - [d_i - X_i] \} =$$

$$\Sigma \ (E_i + E_i s_j b_{ij} - E_i) =$$

$$\Sigma \ E_i s_j b_{ij} =$$

$$s_j \ \Sigma \ E_i b_{ij} \qquad (19)$$

or, introducing the pass-through coefficient,

$$s_j \ \Sigma(1-P_i) b_{ij} E_i = \min \qquad (20)$$

Note that s_j, which is the expected strength of the shock in currency j — the strength and direction of the shocks in the other currencies are determined automatically by b_{ij} once s_j is given — is irrelevant in this model for the determination of the optimal currency composition: s_j is just a scalar in equation (19) and disappears when we minimize our objective function.

Should the correlation coefficients r_{ij} play any role in the optimisation process? In other words should we further decrease exposures in those currencies whose correlation with other currencies is rather precise and hence increase it in these currencies which are rather vaguely correlated? Further research is needed to model this issue, which is linked to the risk aversion function of the borrower.

2.5. Summary of Section 2

Summing up the results of Section 2, under the basic assumption (see section 1), that

$$i_t = i_t^* + D_t^{exp} + u_t \qquad (1)$$

and therefore that for $i_t = i_t^*$, $Exp(u_t) = 0$, and e = any exchange rate,

$$Exp\,(e_{t+1}) = e_t + i_t - i_t^* + u_t = e_t + u_t = e_t$$

$$Exp\,(e_{t+1}) = e_t \text{ for every currency,}$$

we have developed three possible models to optimize the debt currency composition of a risk-averse, market-constrained developing country.

Model 1 The first model is an Exposure Minimizing Model. If the future exchange rate shocks are totally unexpected, the best one can do is to match as precisely as possible, given the constraints, the positive and negative flows of the BoP.

Model 2 The "Variability Model" applies when countries have a view on the strength of the forthcoming exchange rate shocks, which are still assumed to have a totally unknown direction. If the domestic exchange rate is closely following say the US dollar, then a change in the dollar/Yen exchange rate will cause a greater shock (in domestic currency, in percentage terms) to the country exposure in Yen than on the exposure in US dollars.

Model 3 is the "Correlation Model", where countries have views on the relative directions and strength of the future exchange rate shocks, although not on the actual direction. The more major exchange rate movements are correlated, the better we can try to guess how much currency B will appreciate or depreciate for a given (unknown) appreciation of currency A. Model 3, however, is heavily dependent on the *ex-ante* estimated regression coefficients of major exchange rates. (For a brief discussion of the estimation problems involved, see Claessens, 1988, p. 28).

PART II

FOREIGN DEBT CURRENCY COMPOSITION: THE CASE OF BRAZIL, INDONESIA, SOUTH KOREA, MEXICO AND THE PHILIPPINES, 1985-88

3. THE EMPIRICAL METHODOLOGY

3.1. The measurement of the variability of exchange rates

To estimate the expected variability of major currencies/domestic currency exchange rates, previous papers have generally used data on observed past exchange rates (KRONER, 1987). An alternative approach, however, would be desirable.

First, observed domestic exchange rates can be influenced by domestic policies and other exogenous factors. These effects not only reduce the efficiency of the estimators, but can also introduce some bias if the underlying probability distribution of exchange rates is non-normal (as shown by many studies: see CALDERON-ROSSELL, 1982; SO, 1986; LEVICH,1985), or if the data show a symetric trend. In order to isolate the exogenous terms of trade shocks on the domestic economy caused by OECD exchange rate swings, we think it is better to foresee each OECD currency/LDC currency exchange rate on the basis of an *a priori* rule. As an "expected" exchange rate we have considered a "shadow" exchange rate with every OECD currency such as to keep constant the effective exchange rate (REER), trade weighted; this is supposed to yield a desired (or "given") trade balance for given absorption parameters. This is like assuming that the domestic exchange rate will be strictly pegged to a trade-weighted basket of currencies[20]. The variability of each OECD currency's exchange rate is calculated in Tables 6a/6e with relation to this "stable" (in terms of a trade weighted basket of foreign currencies) domestic currency.

A second criticism may relate to the arbitrariness of using the past experience on variability to make predictions about future variability[21]. Forecasts about future variability should therefore be improved for policy purposes introducing other variables.

Finally, the relevant variable to consider is not just exchange rates, but the whole cost of borrowing, which includes interest rates. The assumption that $i^*_t = i_t$ is incorrect. The variability of the whole cost of borrowing in each major currency (i_t-D_t^{exp}) should therefore be compared. We are thus aware that the simplifying assumptions reported in section 2.5 can introduce a bias (see however the discussion of section 3.4.).

The most commonly used index of variability is the standard deviation, which we too have used[22]. To obtain the results in Table 6 we used quarterly data on OECD currencies' prices in terms of the constant LDCs' REER data — a reasonably lengthy time to avoid any effect of short-term volatility. The real effective exchange rates of some key OECD currencies with the basket of currencies representing the LDCs' currency are calculated using the lines "rf" of IMF-IFS, deflated by the IPC: we consider this to be a more sensible price index than the GDP deflator because purchases and sales of LDCs are on the market of final manufactured products.

3.2. The measurement of the correlation of major currencies' exchange rates

In terms of what numéraire currency should the correlation and the regression coefficients of the foreign exchange rates be measured? Just as in the case of the measurement of variability we use as a term of reference the same basket of six OECD currencies, trade weighted, that represents our LDC's currency (say: "pesos"). By using these data on the exchange rate of each OECD currency considered with this representative basket of currencies we hope once again to pick up the effects of exogenous foreign exchange rates shocks isolating them from other effects. The correlation coefficients appear in Table 5.

The regression coefficients of six OECD countries' exchange rates with the LDC currency ($/"pesos", DM/"pesos", FF/"pesos" SF/"pesos", UK pound/"pesos" and Yen/"pesos") should be estimated with 3SLSQ: because of simultaneity problems, the usual OLSQ technique would yield biased and inconsistent estimates of the coefficients. We have estimated the coefficients with simpler corrected-OLSQ techniques, using a sample covering the 1980-88 period (quarterly data), therefore including among our observations those relative to the period 1984-88. The estimated coefficients, presented in Table 7, therefore, are not entirely *ex-ante* coefficients. For example, a -0.53 $/Won-DM/Won coefficient means that the US$/Won exchange rate depreciates by an estimated 0.53% every time the DM/Won exchange rate appreciates by 1%; conversely, a -1.90 DM/Won-$/Won coefficient means that the estimated depreciation of the Won towards the DM for a 1% appreciation of the Won towards the $ is 1.90%. Obviously the coefficients tend to zero and infinity when the LDC's currency tends to be more and more strictly pegged to one OECD currency in particular; this is the case of the dollar-linked Mexican economy.

3.3. The measurement of the correlation between exchange rates and the price of traded goods

The price response in OECD countries to major exchange rates movements[23] is currently receiving a great deal of attention, especially in the United States, following the recent sharp exchange rates swings of the 1980s and the recent developments in the theory of international trade under imperfect competition. Standard economic theory states that, since a small open economy is a "price taker" in the world market, the pass-through coefficient of changes in the domestic real exchange rate on the domestic prices of tradable goods is equal to one. However, the idea that there may be a less than complete pass-through is not new, and was studied in the case of the existence of an *ad valorem* proportional tax (VARANGIS and DUNCAN, 1988, p.1). When prices are set in advance, the currency of denomination of export prices becomes "an important additional source of non-neutralities" (GIOVANNINI, 1988, p.65) Non-competitive markets are another cause of "non-neutralities"; in this case it is conceivable and an empirically observed fact that the pass-through coefficient may be smaller, or even greater than one[24]. Let us therefore briefly examine the existing evidence in the case of both commodities and manufactured goods.

Commodities are almost universally priced in US dollars in highly integrated world markets, although a few are also priced in UK pounds (coffee and tea at the London Commodity Exchange), and Singapore dollars (soja, in Singapore). The existence of an efficient speculation arbitrating across world markets allows the law of one price to hold worldwide even in the short run. As a consequence, authors consistently refer to the dollar prices.

In recent years, some problems were raised by the behaviour of commodity prices because standard models have somehow been unable to forecast prices in a satisfactory way. While dollar prices of commodities may be expected to fall with an appreciating US currency and vice versa, some authors have maintained that dollar prices underreacted in the 1980s to dollar real movements[25]. Others have suggested that, if correctly estimated, the dollar prices percentage changes may actually have been greater than the dollar exchange rate change[26]. While, in the first case, the difficulty of correctly evaluating the time lags and of specifying the "stocks" variable may be part of the explanation, in the second case recent econometric estimates have suggested that the excess of sensitivity of dollar commodity prices may be due to the existence of a high LDC dollar- denominated debt. The related fall in the dollar prices may have forced real devaluations in LDCs, whose REERs are otherwise largely determined by their exchange rate with the US dollar — determining an increase in the production of commodities and a further fall of prices (GILBERT, 1988). As a consequence, the long-run elasticity of the World Bank aggregated index of the dollar prices of the commodities would be 0.9 if the debt effect is included and 0.7 if the debt effect is taken out. Specifically, the total pass-through would be 0.9-1.0 (0.7) for food; 1.1-1.2 (0.7) for non-food agricultural commodities; and 0.7 (0.7) for metals and minerals.

These differentiations appear to be even larger when further disaggregation is carried out. An econometrical study on the oligopolistic markets of coffee, cocoa and copper indicates that, when world dollar prices fall as a consequence of a real dollar appreciation, coffee producers protect themselves by devaluating and by raising prices by almost 60 per cent of the depreciation of their own currency towards the dollar; in the case of the second commodity the corresponding figure would be 28 per cent (VARANGIS and DUNCAN, 1988). This implies a rather small figure of the US dollar pass-through coefficient on dollar prices in these oligopolistic markets. As for the lags involved, C. Gilbert finds that the total effect of an exchange rate movement is passed in dollar prices in two years. However, as his sample goes back to 1967, the author suggests that a higher international integration has probably substantially reduced this time lag in recent years.

The above findings are consistent with the evidence produced by Dornbusch (1987) whose most interesting results, however, concern *manufactures*. This author finds that, during the dollar appreciation of 1980-1985, the dollar price of US imports of manufactures fell by less than dollar commodity prices, and in fact rose slightly in nominal terms (but inflation in the US was 40 per cent in the same period), while the prices of US exports of manufactures increased some 40 per cent, almost in line with the GDP deflator! This evidence can be interpreted either as a confirmation of the importance of exchange rate surprises (especially the different behaviour of US export and import prices) when prices are predetermined in a given currency; or as a low level of markets' geographical integration; as evidence of strategic behaviour and *ex-ante* price discrimination of firms between the domestic and foreign market (especially the less than complete pass-through coefficient on US imports: GIOVANNINI, 1988), or partly due to specific demand and supply[27] parameters in a sector with high product differentiation, where producers facing a downward sloping demand curve are able to protect themselves against adverse exchange rate variations by raising prices (DORNBUSCH, 1987; BRANDER, 1981). Finally, the share of imports within the manufactures sector must play some role in the price dynamics of the whole industry.

In conclusion, recent theory and preliminary empirical evidence suggest that, in the medium term, exchange rate movements determine to a large extent the relative prices of world manufactures. The pass-through coefficient of exchange rate movements on tradables seems rather low (0.2, or between 0 and 0.4 in the case of US exports; 0.6, or between 0.5 and 0.8, but with substantial lags, in the case of US imports), but these figures must be clearly considered as tentative; trade barriers, quality improvements and productivity gains are not taken into account, and there are no econometric studies to support them.

We are not aware of any thorough study on the pass-through coefficient in other OECD countries. On the one hand, the smaller dimension and greater "openness" of the other OECD countries (in terms of total trade/GNP) suggests a higher pass-through in these countries. On the other hand, greater market concentration and higher barriers to trade could reverse this result. Some empirical evidence suggests indirectly that, if markets were truly competitive, the US pass-though coefficient could turn out to be the smallest. According to a recent study by the Bank of Japan (August 1988), the US and Japanese trade *volume* elasticities to changes in prices are respectively 0.79 and 0.49 for manufactured imports, and 0.14 and 0.69 respectively for total imports. The pass-through coefficient is related to the volume elasticities, although in an ambiguous way: the higher the demand elasticities for foreign exports, the higher the propensity of foreign producers to adjust prices (i.e. the higher the pass-through coefficient); the higher the supply elasticities, the lower the price responses. If supply is rigid in the medium-term, the data above refer mainly to demand elasticities and, therefore, suggest that at least one of the determinants of the pass-through coefficient hints at a smaller US pass-through than a Japanese pass-through: this is consistent with Dornbush's findings on US imports and exports. A less recent estimation of volume elasticities for all OECD countries, based on the MERM model of the IMF volume and published by Artus and McGuirk (1981) all indicate higher US import elasticities in the manufactured and semi-manufactured sectors[28].

Calculations by Japanese official sources[29] estimate the pass-through of all the yen's appreciation on export prices to be around 0.52 after one year and 0.59 after two years in the period 1985:IV to 1987:IV. Since Japanese exports are almost exclusively manufactured, these figures roughly match the figures for US import prices of manufactured goods.

In the long run, productivity, wages and other costs may turn out to be more flexible, as well as the international location of production. The trade elasticities themselves and the pass through coefficients given above may therefore become rather meaningless, but this process can take many years to happen. The studies on the covariance of exchange rates and prices should in any case be developed and, if more valuable results are obtained, they should be applied to the trade data, disaggregated by sector and currency of invoicing, in order to obtain an aggregated "pass-through coefficient" for each developing country. For the time being, the available results are not reliable enough to serve as an input for our empirical estimations.

3.4. Interest rates, exchange rates and the invoicing currencies of trade flows

An *ex ante* optimization of the currency composition of foreign debt implies a forecast on future interest rates and exchange rates. As long as the Mundell-Fleming parity condition

$$[\, i_{\$} - i_{DM}] - Dev_{\$}^{exp} = 0 \qquad (1b)$$

between the two prices (interest rate and exchange rate) holds, however, it makes no economic difference whether the debt cost is expected to arise through higher interest payments or rather through a higher appreciation of the capital stock in domestic currency terms. We can therefore assume for the sake of simplicity that both the interest rate differentials and the expected exchange rate changes are equal to zero, and can focus on exchange rate shocks[30].

In Table 10, col.4, we estimate the theoretical (*ex ante*) optimal currency composition of the debt stocks (Model 1) as a function of the estimated currency structure of the foreign trade flows and as a function of the expected dimensions of the trade and financial flows. The (*ex-post*) comparative stability of this and other currency structures of alternative structures is examined in Tables 12a-e.

When, however, we estimate *ex-post* the profitability of holding liabilities in some currencies rather than in others, we use observed (*ex-post*) interest rates (and exchange rates) , decomposing the cost of borrowing into interest payments and capital losses, in order to provide (in Table 11) a precise account of what happened during the 1984-88 period. The interest rates used are a yearly average of the three month LIBOR in the London Euromarket for every currency, which appears in Table 3.

For both trade and debt flows we have considered only six major OECD currencies of invoicing, since these cover about 95-98% of these flows; we have aggregated the flows invoiced in the remaining currencies on one of the six considered (mainly US$ or DM). The value of the net exports in every currency (the Xs in our model; see Section 2) were calculated taking 1984 as the year base. The currencies of invoicing of the trade flows were estimated using U.N. trade statistics, on the basis of the indications and evidence presented in MAGEE and RAO (1980), KENEN (1983), PAGE (1988) and national sources.

3.5. Debt currency composition and alternative portfolios

We have attempted some simulations for the 1985-88 period based on the actual 1984 currency structure ("reference structure") of the debt and six possible alternatives, given the total 1984 debt. The actual debt was mainly in US dollars in the case of the two Latin American countries (85-90%), but with some relevant amounts in yen (up to 32% for Indonesia) in the case of the Asian countries (Table 10, col.1)[31].

The *first* scenario, or *alternative* that we consider, is what would have happened if all debt had been dollar-denominated. The dollar tended to be the dominant currency in the past for private international financial transacions. The share of US dollar denominated debt, however, tends to fall in an increasing number of countries as the weight of the US in the world economy and the role of the dollar as the international reserve currency both decline. The US dollar is usually the unit of account in international statistics on debt, which therefore include the effects of the other currencies' exchange rate movements against the dollar.

The *second alternative* considered is the current currency composition of the World Bank loans to developing countries. These are structured in the following fix shares: Yen: 28%, SF: 23%, DM: 21%, $: 17%, Dutch Gld: 8%, £: 2%, and FF: 1%[32]. By imposing this currency structure to all LDCs, "the Bank avoids exchange rate risks by holding or lending the proceeds of its borrowings in the same currencies in which they were borrowed ... All borrowers now owe to the Bank the Currencies in the Pool in the same proportions" (LONAEUS, 1988).

The *third alternative* we present is the "constant real" currency structure for the LDCs' debt. It is the currency structure that would keep the value of the debt constant in domestic terms assuming a constant (trade-weighted) real effective exchange rate.

We have finally considered *three optimizing strategies*, outlined in the previous section.

The alternative debt currency compositions for the five countries considered are presented in Table 10. The outcomes of the estimations of currency savings/losses and of the Current Account variability for 1985-88 are presented in Tables 11 and 12.

4. SIMULATED CURRENCY GAINS/LOSSES AND THE DEGREE OF INSTABILITY OF THE CURRENT ACCOUNT WITH ALTERNATIVE PORTFOLIOS: 1985-1988

4.1. Cost of alternative currency composition of foreign debt: (currency gains/losses)

We first compare the costs of both interest payments and capital losses of four alternative currency structures with the actual costs of the 1984 debt structure in the following four years.

As expected, the actual debt service was lower for some "low interest" currencies than for others; this is not inconsistent with the hypothesis of perfect foresight of the financial markets made in Section 1, as differentials in the debt service are expected to be the compensation for changes in the value of the principal. Therefore, each year's changes in the value of the principal have to be added up to each year's due interest payments in order to evaluate correctly the total cost of different currencies' liabilities. Table 11 shows the different performance of the *actual* end of 1984 debt structure when compared to the first *four alternatives*; a positive sign indicates that the alternative currency composition implied a greater debt burden.

Alternative 3 compares the actual structure with the one that stabilizes the domestic value of the debt; interestingly, it presents the smallest figures in all five countries considered. This means that the actual currency structure was very close to this third structure, whether by coincidence or by deliberate policy. Indonesia and the Philippines were the only countries that saw the real value of their actual debt stock increase as a result of the major currencies' exchange rate movements in three of the four years considered, and in the period as a whole.

On the contrary, *Alternative 2* has the highest figures in all five cases: the positive sign indicates that the World Bank currency pool would have inflicted dramatic capital losses on the countries adopting it in three of the four years considered, while granting some savings on the interest payments. This is obviously a consequence of its heavy reliance on currencies that happened to appreciate in the period considered. Although it is likely that the capital losses would not have been "realized" fully in the years considered, since the debts were not repaid, the underlying deterioration of the debt/export ratio and of the creditworthiness of the country would probably have cost the indebted country higher spreads on the LIBOR and thus higher interest payments than those considered in Table 11. Furthermore, the World Bank currency structure implies a marked variability in the debt burden, as will be shown.

The *highest* total savings would have been made if the debt had been all dollar denominated (*Alternative 1*). If the five countries had chosen the "optimal" simple strategy outlined in equation (9) above (*Alternative 4*), the Philippines and Korea would have had to bear capital losses and the three others would have enjoyed capital gains in the period as a whole[33].

More interesting for us is the issue of the stability of alternative currency structures. The simple "optimal structure" shows in Table 11 a relatively high variability of the domestic value of debt services not only when it is compared to the actual structures (as in Table 11), but also (which we did not do explicitly) with the "constant real" alternative, because the former structure is designed to make the debt burden oscillate in order to offset underlying changes in the trade balance of opposite signs. When the effect of the foreign exchange rate shock on the value of trade flows is also taken into account, as in Table 12, the standard error of this alternative (optimal 1, corresponding to alternative 4 in tables 10 and 11) is the lowest in three cases — Brazil, Indonesia and Mexico (see Table 12a/e, last column). (This finding is only made valid on the condition that the debt flows were forecast correctly at the time of setting up the optimal currency composition (Table 12, row 2A). Otherwise the result could no longer hold water). This result does not hold water for Korea and the Philippines because the differences in variabilities of OECD/LDC currency exchange rates are not considered in the first model, represented by equation (9)[34].

4.2 Current account instability with alternative currency compositions of foreign debt, 1985-88

Table 12a/e compares the Current Account (trade balance + debt service) variability of the debt currency structures that a) actually existed in 1984; b) imply only US dollar-denominated debt, c) are "suggested" by the World Bank, d) would keep the value of the debt constant in real effective (trade-weighted) domestic terms, and e),f),g) are designed *ex-ante* to stabilize the Current Acccount (based on the optimization of eq. 9, 17, and 18).

From (1c.) for all five countries there clearly emerges the danger of a wrong currency composition. For example, Brazil would have had its foreign debt stock of 103 billions reach 187 billions in three years simply because of exchange rate movements, had the World Bank currency composition been actually used. The terms of trade shock caused by major currencies' swings was particularly harmful in the case of Indonesia, whose debt currency composition was far from being "optimal" in 1984. The fcreign debt of this country rose from 31.9 billion to 46.3 billion (US dollars) between 1985 and 1987 (row 1) just for valuation effects, while at the same time the same exchange rate swings were causing a cumulative deterioration of the trade balance of about 2 billions (row 4). In fact the trade balance deterioration was much worse because of falling oil prices and other terms of trade shocks that are not considered in this paper but that, all taken together, created serious problems for that Asian country. Indeed, the Indonesian case best illustrates the need of *ex-ante* stabilization policies for the balance of payments.

Row 5 gives the results for the whole current account in domestic (1984) currency. With alternative "OPTIMAL 1", the instability collapses in the case of Brazil, Indonesia and Mexico, when compared to the four previously considered currency structures. It is however not an efficient strategy in the cases of the Philippines s.e. (standard error) of 11.72 — and South Korea (s.e. of 975). *Ex ante* optimizing strategies are "best" only on average, not in any single actual circumstance, unless the two constraints we considered (in Section 2) are lifted; still the cases of Korea and the Philippines highlight the fact that a simple "Exposure Minimizing" strategy is too naïve an approach when the total debt (flows) are given.

In 5.f. (alternative "OPTIMAL 2"), we show what happens if the portfolio is optimized considering the variability of the domestic exchange rate with respect to the OECD currencies, but ignoring the correlations among the major currencies' exchange rates. In the case of Korea (see graph 4), for example, in 1984 there was a negative global net exposure of the current account; $\Sigma d_i > \Sigma X_i$. In "alternative OPTIMAL 2", when compared to OPTIMAL 1, part of the "excess debt" is taken away from the more unstable DM, UK pound, SF and FF currencies and invoiced in the more "stable" (with respect to the domestic exchange rate) US dollar. This improved somewhat with respect to the simple alternative OPTIMAL 1. However the largest unhedged exposure was still in Yen, and if the negative correlation of the deficit currency Yen with the surplus currency US$ was taken into account, a much greater burden of the debt should have been set in dollars than the alternative OPTIMAL 2 considered: an appreciation of the then greater US$ current account deficit would have been compensated by a depreciation of the Yen trade deficit, and vice versa. Therefore, alternatives a., b. and d., which by coincidence had more dollars in their portfolio all proved more stable than both alternatives OPTIMAL 1 and OPTIMAL 2 in the case of Korea.

The "Correlation Model", including the further decisive information on the sign of the correlation among exchange rates, turns out to be the most efficient model. In the case of the Philippines, the high variability of alternatives OPTIMAL 1 and OPTIMAL 2 is reduced from about 11.5 to 0.9. Only in the case of Brazil OPTIMAL 3 (s.e. of 325) is not the best strategy of all: one reason is that the U.K. pound low correlation coefficient with other currencies upsets the general picture, showing how this third model is highly sensitive to *ex-ante* estimated values of the coefficients of exchange rates. Still, even in the case of Brazil, OPTIMAL 3 is far better than any other non-optimizing structure.

5. CONCLUSIONS

This paper has dealt with the problem of the optimal currency composition of LDCs' foreign debt.

In the first part, it was argued that, while the variability in the cost of foreign borrowing has been dramatic in recent years, the LDCs have no serious chance to know *ex-ante* the direction of the changes. Therefore, it was suggested, the currency composition of the external debt should be used to insulate the domestic economy as much as possible from external shocks caused by foreign exchange rate swings rather than to engage in speculative types of behaviour. In the second part, the optimal debt currency structure for any country was worked out. In the third part, the outcome in the years 1985-88 of six alternative debt structures was compared with the actual 1984 foreign debt structure of Brazil, Indonesia, Mexico, the Philippines and South Korea, both in terms of the gains and losses each structure would have caused and in terms of the variability of their cost.

5.1. Suggestions for further work

Future work should be developed along the following lines.

In Section 2: a) The model should be developed to account for more than one period of time, with exogenous constraints for every period on the amount of debt that can be swapped into other currencies or with a cost function of swaps. b) The model could be generalized to include speculative types of behaviours, by considering some possible differences in the expected cost of borrowing in the various currencies along the lines of portfolio models. This however would be useless unless a very considerable amount of work were devoted to the empirical problem: "what are the determinants of the differences in the cost of borrowing in (the yields of) different currencies"? c) The model could include a weighting of the different currencies according to the absolute value of their correlation coefficient (R^2) with the other currencies, although this weighting is partly subjective and depends on the risk-aversion function of each country given the probability distributions of the co-movements of exchange rates.

In Section 3: a) the major drawback of the empirical work is that flows arising from trade in services, capital movements, foreign assets and aid are not considered: the debt flows are optimized considering only the trade flows. For example, in the case of the Philippines, the "net exports" in US dollars are the largest negative number among all currencies. As a consequence, the largest shares of foreign debt are to be set in currencies other than the dollar in the optimal case. If, however, US aid is considered, this conclusion is likely to be reversed. Flows arising from trade in services, capital movements and aid should be equally studied when the optimal debt composition is modeled for policy purposes.

b) The estimation of the currency composition of foreign debt and of the currency invoice of trade flows could be improved, both enlarging the sources and the number of invoicing currencies considered. (In this study it has been assumed that Balance of Payments flows of developing countries are invoiced only in six OECD currencies.) Elasticities of prices of traded goods in the currency of invoicing to exchange rate movements could be studied at a more disaggregated level, by country of origin/destination and by product.

c) The base of the estimation for the currency composition of current account flows has been the year 1984. The data for that year have been assumed to hold in subsequent years. The base of the estimation should be enlarged, and trends should be extrapolated in order to obtain better forecasts on the future BoP flows by currency. The trade figures can be updated using either national sources or the OECD trade figures (which cover about 80% of developing countries' trade) instead of the UN trade figures that are complete but are available at a disaggregated level with a lag of about 3 years. It would be interesting to check the current situation of LDCs *vis-à-vis* possible future random shocks.

In Section 4: a) Different assumptions from the ones in this paper could be made on debt service flows, which in fact depend on the degree of rolling over of old debts. The best assumptions would be those which best describe the actual situation of every single LDC considered. There are also interesting implications for the existence of opportunities to "save money" by changing the currency composition of foreign debt, contrary to what has been suggested in Section 2, if the objective (function) of a LDC (to be optimized) is to increase indirectly the total real amount of foreign debt, by lowering interest payments. For example, Thailand has recently reduced its debt service payments by 60 per cent by simply changing the currency composition of its foreign debt from dollars into low interest, appreciating currencies (yen, Korean won)[35].

b) The models should be applied introducing sensible long run estimates of the "pass-through coefficient" of exchange rates on prices and, eventually, of volume changes (although this is already part of the adjustment process forced upon the country affected and is not, strictly speaking, part of our "insulating" strategy). Furthermore, if the prices of traded goods would show a poor correlation with the exchange rates, a case could be made for hedging by contract the value of the debt-service payments to the price of the main commodities exported by LDCs. Although this would imply shifting the risk from LDCs to the lenders — a risk that financial lending institutions clearly cannot take — some northern investors willing to accept a long run risk for a premium are likely to emerge within a co-ordinated third world debt strategy.

Finally, the objective function of LDCs authorities should be carefully studied. Should they try to minimize the shocks only on foreign public debts (but shocks on private debt feed back onto the service burden of foreign public debt through changes in the domestic exchange rate, tax collection, etc.), or should they consider both private and public debt, but with different weights? What are the implications of optimizing a social welfare function where poor people have a higher weight? None of these questions are answered in these pages.

5.2. Concluding remarks

In the 1980s, the shocks on LDCs economies induced by OECD exchange rate fluctuations have been increasingly powerful. These shocks are due to the great expansion of world financial assets and to increased capital mobility, and are therefore likely to persist unless appropriate offsetting policies are undertaken. Developing countries have a clear interest in OECD exchange rate stability.

The first and most serious effect of misalignments of major currencies from a developing country's perspective, which has not been analysed here, is *the impact on the capital movements account* and on *the interest payments* share of the debt service. Misalignments make possible large Current Account deficits in some OECD countries, and, if national savings are somehow "structural" in surplus OECD countries, the deficits increase the level of *world real interest rates*, channelling surplus countries' savings towards deficit OECD countries instead of letting them finance development in LDCs (SENGUPTA, 1988).

Second, however, it is in the interest of both developing countries and their creditors that the current account and debt ratios of LDCs be stabilized against foreign exchange rates shocks: this should be achieved by pursuing a policy of optimal currency composition of foreign debt.

The World Bank is presently suggesting, and actually lending the same currency pool to every borrower, partly in an attempt to decrease the cost of borrowing. This currency structure has proved to be at the same time the one that would have caused more losses to each of the five countries in 1984-88 — given its heavy reliance on the DM- and yen-appreciating currencies — and the one that showed the highest variability in real and dollar terms from the point of view of the borrowing countries.

The reasons given by the Bank for its lending policy are that "the Bank avoids exchange rate risks by holding or lending the proceeds of its borrowings in the same currencies in which they were borrowed". This policy, amounts to transferring completely the exchange risks to its borrowers[36], and is therefore a "sound" policy only from the Bank's point of view. On the other hand, the reputation of soundness enables the Bank to maintain its credit rating at the highest ranking, and thus to borrow at favourable rates and in this way benefitting the LDC borrowers (LONAEUS, 1988, p.40). At the same time, it is maintained that "the emphasis on currencies with low interest rates has paid off in the past ... Recently ... even after three consecutive years of depreciation of the US dollar, the effective cost of the Bank's portfolio of borrowings in other currencies is still comparable to the cost had the same funds been raised in US dollars" (Lonaeus, 1988, *ibid*).

The latter statement is rather surprising; as can easily be seen from Table 4, the average cost of borrowing in US dollars in 1985-88 (and even more in 1985-1987) was much lower than in DM and in yen (8.5 per cent against 11.7 and 16.4 per cent) Apart from this, the whole argument seems to imply that, according to the Bank, there is a long-term convenience in borrowing in some of the major currencies rather than in others. As we have stressed, there is no theoretical evidence that some currencies have a lower borrowing cost average. The data show conflicting outcomes when the cost of borrowing of the last five years and the cost of borrowing over the last ten years are compared. Furthermore, they are clearly sensitive to the choice of the year-base; as a result, they could support opposite conclusions. However, even if past experience could be projected into the future and some currencies emerged as "cheaper", risk considerations should still indicate the need for a differentiated currency composition, determined within a portfolio model and adapted to the needs of each debtor.

The first argument appears correct only in its premise. The soundness of the Bank effectively enables a lower borrowing cost for its customers; the Bank, however, would maintain exactly the same solidity by matching the currency composition of its total assets with that of its total liabilities, while at the same time enabling individual LDCs to choose, at least to some degree, the currency structure of its borrowings. This is even more important as the Bank has a higher ability to swap original funds into the desired currencies than have market-constrained individual LDCs, and should therefore help to increase the financial markets' flexibility for LDC borrowers rather than increase their implicit rigidity[37].

The Brazilian, Mexican, South Korean, Philippine and Indonesian authorities seem to have followed a borrowing policy aimed at invoicing the foreign debt in the same currency shares as the trade flows. Through this policy, if not by coincidence, they have managed to stabilize, to some degree, the real value of their foreign debt, but the trade balance has had to bear all the terms-of-trade shocks caused by OECD exchange rate movements. Though better than nothing, this policy cannot be considered optimal.

A slight variability in the real value of foreign debt flows seems preferable for risk-averse countries, provided that these variations have an opposite sign from the variations in the trade balance caused by the same major exchange rate movements. This is the optimal "hedging" policy, for which we have determined the optimal rules in the case of a constrained amount of total foreign debt. The simulations effectued for the five developing countries indicate that the major currencies' exchange rate movements caused a marked variability of the current accounts in the years 1984 to 1988, which could have been avoided by setting an appropriate currency structure of the foreign debt.

APPENDIX 1

The optimal debt flow for each currency will be given by formula (9) in the simple *case when exposures are minimized*, (see Section 2.2).

$$d_j = X_j + \overline{D} - X \qquad J = 1, ..., g \qquad (9)$$

The proof is as follows.

The objective function to be minimized is

$$(d_1 - X_1)^2 + (d_2 - X_2)^2 + ... + (d_n - X_n)^2$$

where X1, ..., Xn, are numbers (net exports in every currency), and

d_i, ..., d_n are the unknown variables.

This function describes (the square of) the country exposure disaggregated by currency. We want to minimize the square of the exposures (27) because it is not known in advance what currency flows will be hit by the shock and because the country is assumed to be risk averse.

The constraints are

$$\sum_{i=1}^{n} d_i = D \qquad (5)$$

and, if assets are constrained to equal zero[17].

$$d_i \geq 0 \qquad (6)$$

To set the almost optimal hedge,

$$(d_1 - X_1)^2 = (d_2 - X_2)^2 = ... = (d_n - X_n)^2$$

we have to have a minimum amount of total debt. This minimum is given by

$$D^c = (n-1)\, X_n - \sum_{i=1}^{n} X_i = nX_n - \sum_{i=1}^{n} X_i$$

as can be checked by the reader in Graph 1.

Defining

$D^* = D - D^c$

we can have these cases:

$D^* > O$: there is excess debt, $D > D_c$

$D^* = O$: the optimal amount of debt $D = D^c$

$D^* < O$: $D^c > D$. The actual debt is not enough to hedge all currencies equally.

Case 1: $D^* = 0$, the ideal case. Here, the optimal debt currency composition is given by

$$d_1 = (X_1 - X_2) + (X_2 - X_3) + (X_3 - X_4) + \dots (X_{n-1} - X_n) = X_1 - X_n$$

$$d_2 = (X_2 - X_3) + (X_3 - X_4) + \dots (X_{n-1} - X_n) = X_2 - X_n$$

$$d_i = X_i - X_n \qquad (10)$$

Case 2: $D^* > 0$

Here, the "excess debt" will have to be spread, in principle, among all currencies. Therefore, to equation 10 we have to add the "excess" quota of debt, spread equally across all currencies.

$$d_i = X_i - X_n + 1/n\ D^*. \qquad (11)$$

Therefore case 1 is a subcase of Case 2 when $D^* = 0$, as can be seen by comparing (11) and (10).

Since

$$D^* = D - D^c = D - (\Sigma X_i - nX_n),$$

that gives

$$d_i = X_i - X_n + 1/n\ [D - \Sigma X_i + nX_n] = X_i - X_n + D/n - X + X_n = X_i + \overline{D} - X. \qquad (12)$$

Case 3: $D^* < O$, there is not enough debt to have a complete hedge.

As $D < D^c$, then at least one currency $g < n$ exists so that:

$$\sum_{i=1}^{g} (X_i - X_g) < D < \sum_{i=1}^{g+1} (X_i - X_{g+1}) \qquad (7)$$

Then the optimal hedge can be proven to be

$$d_i = X_i + D - X \qquad i = 1 \dots g \qquad (13)$$

This formula resembles (12) above, but the foreign debt D will have to be distributed only among the first g currencies; there will be three possible degrees of hedging: a complete hedging for the first g - 1 currencies; a partial hedging for the g currency; and no hedging for the last n - g currencies.

The iterative proof is the following:

$$d_1 = (X_1 - X_2) + (X_2 - X_3) + \dots + (X_{g-1} - X_g) + w = X_1 - X_g + w$$

$$d_2 = (X_2 - X_3) + \dots + (X_{g-1} - X_g) + w = X_2 - X_g + w$$

$$d_i = (X_i - X_{i+1}) \dots + (X_{g-1} - X_g) + w = X_i - X_g + w$$

where

$$w = [D - \Sigma(X_i - X_g)] (1/g)$$

therefore

$$d_i = X_i - X_g + [D - \Sigma(X_i - X_g)] (1/g)$$

$$= X_i - X_g + D/g - X + X_g = X_i - X + D/g .$$

In the case where there is also a limited amount of foreign assets (reserves) on top of a rigid total amount of foreign debt, these should be distributed in the following manner: find a number 1 < h < n so that:

$$\sum_{i=1}^{h+1} (X_{h+1} - X_i - d_i) < a_i < \sum_{i=1}^{h} (X_i - X_h)$$

Then:

$$a_i = X_h - X_i + d_i + (r/n) A^*$$

where: $A^* = A - D$

$r = 1$ when $A^* > 0$

$r = 0$ when $A^* < 0$.

APPENDIX II

The objective functions considered in Section 2 have only one minimum. The proof is as follows:

1. Let $P(x_1, x_2, ...x_n)$ be the point in the n-dimensions space (given by n currencies) that indicates the expected trade balance at time t + 1.
2. Let point Q $(d_1, d_2,...d_n)$ be the global minimum of the objective function (equation 5: the same would hold true for eq.17).
3. $\Sigma d_i = D$, the first constraint, is the equation of an iper-plan in the n dimension space 1,...,n to which Q must belong.. The second constraint, $d_i > = 0$, limitates the dominium of the iper-plan

   $\Sigma d_i = D$ on which Q is allowed to lay.
4. For Pythagoras' theorem in n dimensions, then, our objective function $\Sigma(d_i - x_i)^2$ is the square of the distance of P from Q:

$$PQ = \sqrt{(d_1 - x^1)^2 + (d_2 - x_2) + \ldots (d_n - x_n)^2}$$

Our problem in geometrical terms therefore becomes finding point Q on the iper-plan Σd_i such that the distance PQ is minimal.

Solution

If there was not the constraint $d_i > = 0$, the distance between P and the iper-plan Σd_i would be the line PQ perpendicular to Σd_i. In two dimensions this can be visualised as in graph 5.

The optimal point Q is the "foot" of the perpendicular from P to line $\Sigma d_i = D$. If we take another point Q' on the line $\Sigma d_i = D$ different from Q (say: to the left of Q), Q'QP will form a right-angle triangle, with Q'P being the hypotenuse and therefore PQ' > PQ for any Q'≠ Q . In our graph, Q' would however still be the constrained optimum, since the constraint $d_i > = 0$ allows Q' to stay only in the upper right quadrant of the cartesian plan. It is a "corner solution" (all debt should be invoiced in currency 1). The essential point is however that every time we move Q' towards the left (say; to Q"), the dimension of the side Q'Q increases (Q"Q > Q'Q); and the other side PQ being given, the hypotenuse Q'P must increase according to Pythagoras' theorem, q.e.d.. Pythagoras' theorem in n dimensions makes the proof valid for any value of n. The proof can be easily extended to the other objective functions considered in Section 2.

APPENDIX III

The following is a simple programme written to optimize the currency composition of Indonesian 1987 foreign debt eq. 17 (see Section 2). The software is "GAMS3", which was developed by the World Bank to solve in particular non-linear problems, and which is available in the OECD.

```
SET I / USD, DM, FF, SF, UK, YEN /
TABLE CDATA (I, *)
          X     B ALPHA
USD11410    1    0.05
DM 61000    1    0.23
FF      0   1    0.21
SF      0   1    0.18
UK    750   1    0.16
YEN-2430    1    0.18
PARAMETER ALPHA(I), X (I), X (I), B(I);
ALPHA (I) = CDATA (I, 'ALPHA');
X(I)      = CDATA (In 'X');
B(I)      = CDATA (I, 'B')
EQUATIONS   OBJ, CONVEXITY;
VARIABLES Z, D(I);
OBJ .. SUM(I, SQR (ALPHA(I)* (D(I) - X (I) ) ) =E= z;
CONVEXITY .. SUM(I, D(I) ) =E= 3197.2;
D.LO (I) = 0.0;
MODEL TRY / all / ; SOLVE TRY MINIMIZING Z USING NLP;
```

* I thank Mr. Anthony Brooks for introducing me to GAMS.

NOTES AND REFERENCES

(1) The literature has stressed, on the one hand, the risks of raising the share of debt due to international private institutions, whose variable interest rates and short maturities contracts increased the debtors' vulnerability in the seventies; on the other hand, the fact that the extreme monetarist and liberist assumption that private debt would be self-financing and therefore of no concern to the governments failed almost everywhere to survive the severity of the crisis. The conclusion has generally been that debtors should restructure their foreign debt in order to extend the maturities and increase the fixed-interest share (see FFRENCH DAVIS, 1983, and for a more technical analisys: B.I.S., 1983).

(2) The EEC's STABEX and the two IMF Compensatory Financing Schemes (Compensatory and Contingency Financing Facility — CCFF — and the recent External Contingency Mechanism) are the most important schemes presently functioning at an international macroeconomic level. Their scope, however, is still narrow; moreover, a high degree of conditionality is attached to the use of the Fund's facilities (Singh, 1989). The North-South dialogue of the 70's within UNCTAD has also produced a number of producers-consumers agreements on single commodities (Maize, Cocoa, Natural Rubber, Sugar, Jute, Coffee, Tropical Timber, Tin and Olive Oil), supported, from July 1989 on, by a "Common Fund" (UNCTAD, 1989). These agreements have so far been costly and uneffective so far in stabilizing prices, the noticable exception being the Natural Rubber Agreement. As for domestic policy attempts to reduce the instability of export earnings, the problems involved are highlighted in the econometric study by Brundell et al. (1980).

(3) If investors are risk-neutral, $B_t = O$. However, there is no agreement on this point. On the existence and the time-varying nature of the risk premium see the recent attempt by DIEBOLD and PAULY (1988), Domowitz and Hakkio (1985) in the Journal of International Economics, and FAMA (1984) in the Journal of Monetary Economics. For a better specification of the uncovered interest parity condition, see Koromzay et al., 1987.

(4) There is a considerable historical evidence supporting this statement. Furthermore, risk-love and uncertainty seem to entail high costs in LDCs, contrary to belief in some quarters. For example, it has been argued that the variability of commodity prices and output is capable of making a positive contribution to development owing to a resulting increase in the propensity to save for the countries in question. It is also suggested that swings in the relative prices of an economy could favour investment by creating new profit opportunities, thus helping to overcome entry costs,etc. However, the possibility of such positive effects being achieved has to be balanced against "many possible negative consequences such as a more uncertain climate for investment, the encouragement of a speculative mentality which reduces the productivity of investment, the need for holding higher reserves of foreign exchange" and the costs of macroeconomic destabilization (UNCTAD, 1988, p.50).

(5) DORNBUSCH, 1986, Isard, 1987, Boughton, 1986.

(6) Mankiw, 1986, and Gaab, Granziol and Horner, 1986, Shiller et al., 1983, Cumby and Obstfeld, 1981, quoted in BODART, 1989. Of course the world is not as simple as the Mundell-Fleming model assumes. Fiscal and political ("safe haven") considerations, in particular, can modify the interest parity condition; the literature, however, has not provided consistent findings.

(7) For an exposition of recent developments in both DCs and LDCs forward exchange markets, see: Finance and Development, September 1988; Quirk, P.J., et al., "Policies for Developing Forward Foreign Exchange markets", IMF Occasional Papers no. 60, June 1988; Rowley, A., "The Risk Business", Far Eastern Economic Review, 23 June 1989.

(8) Some authors have suggested matching the debt service flows with export flows only (ex.: SWEET, 1987). We cannot see why imports and other items should not also be considered among the cash-flows of a country in need of a hedge.

(9) Since there are no expected positive returns for investing/borrowing in one currency rather than in another, there is no trade-off problem between risk minimization and excess returns: the objective is only risk-minimization; the only point one needs to define, therefore, is the lowest stationary point of the risk function.

(10) Two things are worth noting here. First, with the use of foreign debt for macroeconomic hedging, gains and losses caused by foreign exchange rate movements will most likely be offset only on average and not for each and every operator. Second, the government should have an interest in setting up an optimal currency composition, not so much for its own foreign debt, but rather for the total national foreign debt; this is because, for given monetary and fiscal policies, the shocks affecting the private sector would feed back into the public foreign debt via involuntary movements in the real exchange rate: see Hinds (1988).

(11) Since the trade percentage shares in every currency are fairly stable and since the present average maturity of foreign debt is not more than 4.5-5 years for most LDCs, this assumption does not appear to be necessarily excessive.

(12) In the case of a small open economy facing given world prices of traded goods, changes in the value of the domestic currency do have an impact equivalent to a real terms of trade shock if the trade balance (or the B.o.P.) is not in equilibrium.

(13) The alternative is to estimate the behaviour of the domestic exchange rate econometrically: see section 3.1. We use a trade-weighted REER because trade flows are considered to be somehow given in the short- and medium-term and the exchange rate has to adapt, while the currency composition of the financial flows is more flexible and is treated as the policy variable. Even though this latter assumption may not always be fully realistic, knowing the optimal debt currency composition highlights the direction to follow for the financial part of the BoP.

(14) Volume flows are given in this case, and the "pass-through coefficient" of exchange rate movements onto prices is 0: credible in the short run.

(15) Any exponent greater than one will yield the same stationary point if we minimise the absolute value of the objective function given. ß can therefore have any value above one until we do not need to know the shape of the whole objective function.

(16) In this case, if K < 1, there is a current account deficit, or an excess of negative financial flows: here, a devaluation of the surplus ($X_i > 0$) currency i against the other currencies implies a deterioration of the terms of trade that is more than offset by a decrease in the value of the debt flows; thus, if K > 1, the opposite will hold true. The complete hedging of eq. (4) is not possible in this case.

(17) Or that they are included in the net trade surplus terms Xs.

(18) The variability must be measured in domestic (LDC currency) terms. Some OECD currencies' exchange rates with the domestic currency are more "variable" simply because their weight in the basket of currencies to which the domestic exchange rate is pegged is low. Thus, although in the analysis so far only the net exports in every currency have mattered, the total trade share of an OECD currency plays a major role in the ex-ante optimization through its weight in the domestic constant real effective (trade weighted) exchange rate.

(19) We use the correlation coefficient r_{ki} and not covariances, because the former is "unit-free": $0 < r < 1$.

(20) See Williamson (1982). It is true, however, that some bias could be introduced by this procedure because the "true" real effective exchange rate is difficult to estimate empirically, even for "given" domestic economic policies (PIETROBELLI, 1987).

(21) "Observed movements are not necessarily an adequate proxy for a variable's degree of unpredictability at all times ... Even if variability — which can be measured only in the *ex-post* sense — is low, *ex ante* uncertainty reflecting forecast errors may be very high" (UNCTAD, 1988, p. 33). This is especially true for exchange rates.

(22) Cushman (1988) and IMF (1984) discuss different concepts of exchange rate variability. The lack of studies on the impact of "the risk of long-term swings in exchange-rates" on trade flows is emphasized by the former author. Contrary to these two studies, however, neither the ex-ante risk effects on trade flows nor its effects on total foreign borrowing are the subject of this paper.

(23) The "pass-through coefficient of exchange rate movements on prices" is defined as the percentage change in import prices due to a change in the dollar marginal cost of exporting countries (from a change in the exchange rate and a change in the exporter's cost of production), Varangis and Duncan, 1988.

(24) Varangis and Duncan, 1988; Gilbert, 1986. There are four possible further reasons for price stickiness: 1) The prices are reset roughly every six months when there is no inflation in the manufacturing sector; 2) Exchange rate swings have to be believed to be permanent before prices are changed; 3) If there is a high degree of oligopoly and there are few foreign firms, the prices are sticky and exchange rate movements are lost in the form of extra profits; 4) Strategic behaviour in general may reduce the link between prices in the importing country's currency and exchange rates movements. The degree of capacity utilisation is another fundamental determinant of the pass-through coefficient, but it somehow encompasses some of the phenomena described in the text and domestic demand behaviour.

(25) See Hartman, 1986. This may be true, especially in the years 1984-87, because of the increased number of exchange rates pegged to the dollar.

(26) R. Dornbusch, "Policy and Performance Links between LDC Debtors and Industrial Nations", Brookings Papers on Economic Activity, 1985:2, pp.303-356, and Beenstock, M., "An Econometric Investigation of North-South Interdependence", CEPR/IESG, 1987, both quoted in C.Gilbert (1988).

(27) The fall of some costs due to the national currency's appreciation may be greater in the manufacturing industries than in the primary productions (Bank of Japan, March 1988).

(28) See some different findings in Stern et al., 1976.

(29) "The Summary Report on Trade of Japan", by the Japanese Ministry of Finance, quoted in: Bank of Japan (March 1988).

(30) In the ex-ante optimization of the currency distribution of 1984 debt stocks we will assume, specifically, that long term (or *ex ante*) interest rates were equal to 10% and the expected devaluation (Dev^{exp}) was equal to zero for every currency, and that interest payments represented the whole debt servicing: the latter is the most plausible assumption in four of the five countries considered in 1984-88, while Korea was also repaying a fraction of the principal.

(31) These estimates are based on roughly 90% of the actual 1984 debt using World Bank, OECD and national data; because 10-40 per cent of this debt is recorded in "unspecified" currencies (these include "multicurrency" liabilities and "other" liabilities, mainly in Dutch Guilders and other DM-connected currencies), there may be some bias in the estimated repartition of debt, with a possible exaggeration of the dollar share of the debts.

(32) See H. Lonaeus, "How the Bank Finances Its Operations", *Finance and Development,* September 1988. We have aggregated Guilders and DM in our calculations.

(33) To clarify the calculation procedures of Alternative 4 and some of the issues involved, we show the details of the calculations for the Philippines in Table 8. Using equation (9) of Section 2, we first order the six currencies considered according to the value of net exports, then calculate all the elements of formula (9), and use the formula to calculate the optimal debt levels for every currency, given the total debt. The two estimated data are the expected net exports for every currency and the expected net debt service flows on a given initial stock of debt. It was assumed that the 1984 stock of debt could be invoiced in the six currencies considered, in any proportion that would result in being optimal. Second, it was assumed that debt servicing would be effectued only in the form of interest payments and that these would amount to 10 per cent of the stock of debt for each and every currency. Neither of these two simplifications is too disturbing; the first because if it is not possible to swap all debt into the desired currencies, knowing the optimal currency composition can serve as a guide for the part of debt being restructured, as explained in Section 2.1.: the formulas given can be interpreted as relating only to the part of debt to be restructured. The second assumption depends on the amount of debt rolled over. The ex-ante forecast of interest paymens totalling 10% of the principal is as good as any other: we could have used our ex-post knowledge about the levels of interest rates prevailing in 1985-88 to optimize the debt structure accordingly, but this would not have meant that we are good forecasters of future levels of interest rates.

Third, however, the net exports of 1984 in any currency have been projected to stay constant in subsequent years. This is clearly unrealistic. Trade shares tend to be fairly constant over the years; in 1984, however, the Philippines were running a trade balance deficit of more than one billion dollars on top of negative debt service flows. This is not sustainable in the long run without major aid flows, and although in 1987 the trade deficit was even higher (1.5 billion), the overall deficit trend in the 80s has in fact been declining. If changes in the trade balance are reflected in the same proportions in the single currency balances, they will have a much greater impact on the value of net exports of the currencies that account for a larger part of total trade. For example, in the case of the 1984 Philippine trade balance, a swing to a trade surplus would mean that the dollar would become a surplus currency, with net exports quite higher than SF net exports. Then the optimal amount of debt in dollars, presently equal to zero, would presumably rise above every other currency. The optimal currency composition depends crucially on the expected value of the Xs, for which we have used as a proxy the value at the beginning of the period. In the case of the Philippines, in 1984-88 this would have been a good guess, but the same crude method cannot be applied automatically to any situation.

(34) Table 11 also shows how the exchange rates have in recent years replaced interest rates as the major determinant of changes in the debt burden. For example, in Alternative 2, although the focus is on low interest currencies, in 1987 the interest payments are higher than in the actual structure in four of the five countries considered (as indicated by the positive sign); this is because exchange rate movements increase the value of interest payments so much as to more than offset the difference between interest rates, even without considering the further effects on the value of the stock of debt (which would become an actual cost if debts were paid back).

(35) "L'Express", 22 February 1989.

(36) For a more thorough critical discussion of the Bank's strategy as regards foreign exchange risks, see Hinds (1988).

(37) Indeed, commercial banks face the same exchange-rate risk on their assets as the one faced by LDC liabilities. Therefore they have an incentive to denominate their loans in the same currencies of their own liabilities. Since the banks' market power is currently greater than that of the developing countries, the risk tends to be shifted permanently to borrower countries, who often are "market-constrained not only on the total amounts they can borrow, but also on the currencies they can borrow. For example "...despite initial resistance from the indebted nations, even currency conversion options for the banks were incorporated into refinancements agreements with Mexico and Venezuela in 1984 and 1985" (SWEET, 1987, p.24).

Table 1

EXCHANGE RATES AT DECEMBER 31, CURRENCY UNITS PER US $

	1984	1985	1986	1987	1988
$	1.00	1.00	1.00	1.00	1.00
DM	3.15	2.46	1.94	1.58	1.89
FF	9.59	7.56	6.46	5.34	6.36
SF	2.59	2.08	1.62	1.28	1.57
£	0.87	0.69	0.68	0.53	0.59
Y	251.10	200.50	159.10	123.50	133.29

(a) Data of mid-August 1988.

Source: IMF.

Table 2

EACH YEAR'S DOLLAR PERCENTAGE DEVALUATION AGAINST FIVE CURRENCIES

	1978	1979	1980	1981	1982	1983
$	0.0	0.0	0.0	0.0	0.0	0.0
DM	13.1	5.3	-13.1	-15.1	-5.4	-14.6
FF	11.2	3.8	-12.3	-27.3	-17.0	-24.1
SF	1.9	2.5	-11.6	-0.2	-10.9	9.3
£	6.7	9.3	7.2	-0.2	-15.4	-10.2
Y	18.9	-23.2	15.3	-8.3	-6.9	1.2

	1984	1985	1986	1987	1988
$	0.0	0.0	0.0	0.0	0.0
DM	-15.6	17.4	23.1	17.5	-14.4
FF	-14.9	21.2	14.6	17.3	19.1
SF	-18.6	19.7	21.8	21.3	-23.2
£	-20.3	24.9	2.1	29.6	-9.9
Y	-8.1	21.2	20.6	22.4	-7.9

Source: Calculations based on IMF International Financial Statistics.

Table 3

ACTUAL INTEREST RATES 3 MONTH LIBOR RATES
ON DEPOSITS, VARIOUS CURRENCIES

	1978	1979	1980	1981	1982	1983
	10.26	14.28	16.56	18.87	12.61	9.32
DM	3.48	6.28	8.73	11.89	8.62	5.60
FF	10.26	10.74	12.21	18.16	19.45	16.53
SF	0.08	2.25	5.64	9.29	5.19	4.19
£	10.80	13.88	16.35	14.32	12.58	10.18
Y	-	6.08	11.30	7.73	6.99	6.57
	1984	**1985**	**1986**	**1987**	**1988**	
$	10.4	8.0	9.7	7.5	8.3	
DM	05.8	5.4	4.6	4.1	5.2	
FF	12.8	10.8	9.5	8.6	8.5	
SF	04.5	5.0	4.3	3.9	3.8	
£	10.0	12.3	11.0	9.9	11.0	
Y	06.4	06.7	5.1	4.3	4.7	

Source: IMF - IFS

Table 3a

INFLATION DIFFERENTIALS BETWEEN
SELECTED OECD COUNTRIES AND THE UNITED STATES

	1985	1986	1987	1988a
Germany	-1.7	-2.3	-2.6	-1.7
France	1.9	0.5	0.4	1.4
Switzerland	-0.5	-1.3	-1.5	-2.9
UK	2.2	1.4	1.3	2.3
Japan	-1.9	-1.4	-2.9	-3.7

a. estimated

Sources: IMF and, for 1988, various sources.

Table 4

COST OF BORROWING IN DIFFERENT CURRENCIES
(3 month deposits LIBOR interest rates plus
each year's % appreciation against the dollar)

	1978	1979	1980	1981	1982	1983
$	10.26	14.28	16.56	18.86	12.61	9.32
DM	16.58	11.58	-4.37	-3.21	3.22	-9.00
FF	21.46	14.54	-0.09	-9.14	2.45	-7.57
SF	19.88	4.75	-5.96	7.29	-5.71	-5.11
£	17.5	23.18	23.55	-5.68	-2.82	-0.02
Y	-	-17.12	-4.00	-0.57	0.09	7.77

	1984	1985	1986	1987	1988
$	10.38	8.0	9.7	7.5	8.3
DM	-9.77	22.8	22.7	21.6	-9.2
FF	-2.13	31.9	24.1	25.9	-10.6
SF	-14.15	24.7	26.2	25.2	-19.3
£	-1.28	37.2	13.0	36.8	1.1
Y	-1.67	26.8	25.8	26.6	-3.2

	Average 1978-87	Average 1978-88	Average 1984-88	Average 1985-88
$	11.7	11.4	9	8.4
DM	7.2	5.7	11	14.5
FF	10.2	8.3	14	17.8
SF	7.6	5.2	9	14.2
£	13.2	12.1	15	19.4
Y	7.7a	6.6b	15	19.0

a. 1979-87
b. 1979-88

Source: Elaboration of IMF-IFS data.

Table 5

SIX OECD CURRENCIES' EXCHANGE RATES
WITH A BASKET OF CURRENCIES REPRESENTING A CONSTANT REER
OF FIVE DEVELOPING COUNTRIES: CORRELATION COEFFICIENTS

	United States	Germany	France	Switzerland	United Kingdom	Japan
			A: BRAZIL			
1974-1988						
United States	1.000					
Germany	-0.938	1.000				
France	-0.951	0.964	1.000			
Switzerland	-0.947	0.857	0.872	1.000		
United Kingdom	-0.713	0.546	0.657	0.643	1.000	
Japan	-0.589	0.350	0.377	0.679	0.355	1.000
1980-1988						
United States	1.000					
Germany	-0.986	1.000				
France	-0.981	0.980	1.000			
Switzerland	-0.958	0.960	0.921	1.000		
United Kingdom	-0.842	0.846	0.882	0.726	1.000	
Japan	-0.708	0.631	0.611	0.763	0.308	1.000
			B: INDONESIA			
1974-1988						
United States	1.000					
Germany	-0.651	1.000				
France	-0.678	0.964	1.000			
Switzerland	-0.871	0.964	1.000			
United Kingdom	-0.547	0.535	0.646	0.600	1.000	
Japan	-0.893	0.286	0.306	0.619	0.229	1.000
1980-1988						
United States	1.000					
Germany	-0.844	1.000				
France	-0.830	0.978	1.000			
Switzerland	-0.912	0.955	0.911	1.000		
United Kingdom	-0.569	0.828	0.867	0.690	1.000	
Japan	-0.910	0.566	0.545	0.720	0.201	1.000

Table 5 (continued)

C: PHILIPPINES

	United States	Germany	France	Switzerland	United Kingdom	Japan
1974-1988						
United States	1.000					
Germany	-0.817	1.000				
France	-0.831	0.962				
Switzerland	-0.942	0.848	0.863	1.000		
United Kingdom	-0.584	0.515	0.632	0.602	1.000	
Japan	-0.770	0.285	0.310	0.633	0.269	1.000
1980-1988						
United States	1.000					
Germany	0.913	1.000				
France	-0.899	0.978	1.000			
Switzerland	-0.950	0.955	0.912	1.000		
United Kingdom	-0.655	0.830	0.868	0.694	1.000	
Japan	-0.852	0.578	0.557	0.233	1.000	

D: MEXICO

	United States	Germany	France	Switzerland	United Kingdom	Japan
1974-1988						
United States	1.000					
Germany	-0.931	1.000				
France	-0.936	0.971	1.000			
Switzerland	-0.967	0.885	0.899	1.000		
United Kingdom	-0.718	0.638	0.728	0.719	1.000	
Japan	-0.729	0.453	0.479	0.729	0.455	1.000
1980-1988						
United States	1.000					
Germany	-0.972	1.000				
France	-0.962	0.984	1.000			
Switzerland	-0.976	0.970	0.939	1.000		
United Kingdom	-0.810	0.880	0.907	0.787	1.000	
Japan	-0.838	0.701	0.685	0.808	0.434	1.000

Note: The exchange rate between the OECD currency and the basket of currencies representing the LDC exchange rate was calculated on a quarterly basis according to the following formula:

$$\prod_{i=1}^{6} [\,(\overline{e / e_i})\ (\overline{p_i / p})\,]^{w_i}$$

where: $\overline{}$ indicates an index

e = exchange rate of the currency concerned (ex:DM/$)

e_i = exchange rate of currency i/$

i = $, DM, FF, SF, £, Yen

p_i = CPI of country i

p = CPI of the country whose exchange rate is being estimated

w_i = the trade weight of the ith currency in the LDC concerned

Table 6

VARIABILITY OF SIX OECD CURRENCIES' REAL EXCHANGE RATE IN TERMS OF A BASKET OF CURRENCIES REPRESENTING THE CONSTANT REAL EFFECTIVE EXCHANGE RATE OF FIVE LDCs

Period	1974-1982	1980-1988	1974-1988
A: BRAZIL			
United States	0.02	0.03	0.03
Germany	0.11	0.16	0.18
France	0.10	0.16	0.17
Switzerrland	0.11	0.15	0.14
United Kingdom	0.12	0.15	0.13
Japan	0.11	0.16	0.15
B: INDONESIA			
United States	0.03	0.04	0.04
Germany	0.11	0.15	0.17
France	0.09	0.15	0.16
Switzerland	0.10	0.14	0.14
United Kingdom	0.12	0.14	0.12
Japan	0.10	0.15	0.14
C: KOREA			
United States	0.03	0.05	0.05
Germany	0.11	0.14	0.17
France	0.09	0.15	0.16
Switzerland	0.10	0.13	0.13
United Kingdom	0.12	0.14	0.12
Japan	0.10	0.14	0.13
D: MEXICO			
United States	0.01	0.01	0.01
Germany	0.12	0.17	0.20
France	0.11	0.18	0.18
Switzerland	0.12	0.17	0.16
United Kingdom	0.13	0.16	0.14
Japan	0.12	0.18	0.16
E: PHILIPPINES			
United States	0.03	0.04	0.04
Germany	0.11	0.15	0.17
France	0.09	0.15	0.16
Switzerland	0.10	0.14	0.14
United Kingdom	0.12	0.14	0.12
Japan	0.11	0.15	0.14

Note: The coefficient of variability was calculated according to the following formula: standard error of the series/mean of the series (for the generation of the series refer to the note of Table 5).

Table 7

REGRESSION COEFFICIENTS OF SIX OECD CURRENCIES/
LDC CURRENCY EXCHANGE RATES

	$	DM	FF	SF	UK	Yen
			BRAZIL			
$	1.00	-3.85	-3.76	-4.11	-3.03	-3.99
DM	-0.26	1.00	0.98	1.07	0.79	1.04
FF	-0.27	1.02	1.00	1.09	0.81	1.06
SF	-0.24	0.94	0.91	1.00	0.74	0.97
UK	-0.33	1.27	1.24	1.36	1.00	1.31
Yen	-0.25	0.97	0.94	1.03	0.76	1.00
			INDONESIA			
$	1.00	-2.31	-2.25	-2.50	-1.76	-2.40
DM	-0.43	1.00	0.97	1.08	0.76	1.04
FF	-0.44	1.03	1.00	1.11	0.78	1.06
SF	-0.40	0.93	0.90	1.00	0.70	0.96
UK	-0.57	1.32	1.28	1.42	1.00	1.36
Yen	-0.42	0.97	0.94	1.04	0.73	1.00
			S KOREA			
$	1.00	-1.90	-1.85	-2.06	-1.42	-1.97
DM	-0.53	1.00	0.97	1.08	0.74	1.04
FF	-0.54	1.03	1.00	1.12	0.77	1.07
SF	-0.49	0.92	0.90	1.00	0.69	0.96
UK	-0.71	1.34	1.31	1.46	1.00	1.39
Yen	-0.51	0.96	0.94	1.04	0.72	1.00
			MEXICO			
$	1.00	-11.18	-10.95	-11.85	-9.14	-11.48
DM	-0.09	1.00	0.98	1.06	0.82	1.03
FF	-0.09	1.02	1.00	1.08	0.83	1.05
SF	-0.08	0.94	0.92	1.00	0.77	0.97
UK	-0.11	1.22	1.20	1.30	1.00	1.26
Yen	-0.09	0.97	0.95	1.03	0.80	1.00
			PHILIPPINES			
$	1.00	-2.56	-2.49	-2.75	-1.96	-2.64
DM	-0.39	1.00	0.97	1.08	0.77	1.03
FF	-0.40	1.03	1.00	1.10	0.79	1.06
SF	-0.36	0.93	0.91	1.00	0.71	0.96
UK	-0.51	1.30	1.27	1.40	1.00	1.35
Yen	-0.38	0.97	0.94	1.04	0.74	1.00

Table 8

PHILIPPINES: ESTIMATED NET EXPORTS, DEBT SERVICE AND OPTIMAL CURRENCY COMPOSITION OF FOREIGN DEBT
(millions of dollars)

Net Exports

X_1	=	DM = 75.184	X_i = net exports in currency i
X_2	=	£ = 48.366	
X_3	=	SF = -26.038	
X_4	=	FF = -103.797	
X_5	=	Y = -419.351	
X_6	=	\$ = -736.387	

D	=	3 197.2	= Estimated Debt Service (per year)	
g	=	5	= Number of currencies in which the debt should be invoiced.	
D	=	D/g	=	639.440
X	=	1/5 ΣX_j	=	-85.127
D-X	=			724.567

Optimal debt currency composition

d_1	=	DM	=	799.751	=	25%
d_2	=	£	=	772.529	=	24%
d_3	=	SF	=	698.529	=	22%
d_4	=	FF	=	620.770	=	19%
d_5	=	Y	=	305.216	=	10%
d_6	=	\$	=	0.0	=	0%

Table 9

ESTIMATED CURRENCY COMPOSITION OF FOREIGN TRADE AND FOREIGN DEBT – (6 CURRENCIES)

	Percentages			Millions of $	
	Imports	Exports	Total trade	Net exports	Foreign Debt
			A: BRAZIL (1984)		
$	86.6	82.8	82.5	9438	89 653
DM	7.5	7.4	7.7	734	5 402
FF	1.8	1.8	2.0	133	1 351
SF	0.3	0.3	1.0	-149	831
£	1.4	5.5	3.6	1146	416
Y	2.4	2.2	3.2	-41	6 233
TOTAL	100.0	100.0	100.0	11261	103 855
			B: INDONESIA (1984)		
$	63.3	84.8	74.3	11 410	17 265
DM	8.6	1.8	5.1	-1 000	2 238
FF	1.4	0.3	0.8	0	959
SF	0.4	0.1	0.3	0	320
£	2.0	7.3	4.7	750	959
Y	24.3	5.7	14.8	-2 430	10 231
TOTAL	100.0	100.0	100.0	8 730	31 972
			C: SOUTH KOREA		
$	66.7	75.5	71.0	1 656	37 862
DM	6.2	7.2	6.6	207	624
FF	1.1	1.0	1.0	-501	104
SF	0.4	0.3	0.4	-48	528
£	1.9	3.2	2.6	362	863
Y	23.7	12.8	18.4	-3 513	7 006
TOTAL	100.0	100.0	100.0	-1 386	47 987

Table 9 (continued)

	Percentages			Millions of $	
	Imports	Exports	Total trade	Net exports	Foreign Debt
			D: MEXICO		
$	84.7	98.1	93.4	13 822	100 083
DM	6.6	0.8	2.8	-749	1 700
FF	2.1	0.2	0.9	-247	637
SF	0.8	0.1	0.4	81	637
£	1.4	0.2	0.6	158	1 169
Y	4.4	0.6	1.9	481	2 019
TOTAL	100.0	100.0	100.0	12 166	106 245
			E: PHILIPPINES (1984)		
$	75.2	77.8	10.3	-736	15 586
DM	6.4	9.2	7.7	75	219
FF	3.2	2.0	2.7	-104	715
SF	0.6	0.2	0.4	48	917
£	1.9	3.3	2.5	48	88
Y	12.7	7.5	76.4	-419	5 626
TOTAL	100.0	100.0	100.0	-1 162	21 891

Table 10

ALTERNATIVE DEBT STRUCTURES
(percentages)

	REFERENCE	ALTERNATIVES			
	1984 (ACTUAL)[a]	ALL US $	WORLD BANK	1984 CONSTANT REAL	OPTIMAL1
	(0)	(1)	(2)	(3)	(4)
BRAZIL					
$	86.3	100	17	82.5	88
DM[b]	5.2	0	29	7.8	4
FF	1.3	0	1	2.0	0
SF	0.8	0	23	1.0	0
£	0.4	0	2	3.6	8
Y	6.0	0	28	3.2	0
INDONESIA					
$	54	100	17	74.3	100
DM_b	7	0	29	5.1	0
FF	3	0	1	0.8	0
SF	1	0	23	0.3	0
£	3	0	2	4.7	0
Y	32	0	28	14.8	0
MEXICO					
$	94.2	100	17	93.4	100
DM[b]	1.6	0	29	2.8	0
FF	0.6	0	1	0.9	0
SF	0.6	0	23	0.4	0
£	1.1	0	2	0.6	0
Y	1.9	0	28	1.9	0
PHILIPPINES					
$	71.2	100	17	76.4	0
DM[b]	1.0	0	29	7.7	25
FF	0.8	0	1	2.7	19
SF	0.9	0	23	0.4	22
£	0.4	0	2	2.5	24
Y	25.7	0	28	10.3	10

Table 10 (continued)

SOUTH KOREA					
$	78.9	100	17	71.0	45
DM[b]	1.3	0	29	6.6	16
FF	2.3	0	1	1.0	10
SF	1.1	0	23	0.4	10
£	1.8	0	2	2.6	19
Y	14.6	0	28	18.4	0

a. **Estimated**
b. DM area, including Benelux and EFTA

Source: Author's estimates

Table 11

VALUATION EFFECTS: ADDITIONAL COST OF FOREIGN DEBT IN 1985-88
WITH ALTERNATIVE PORTFOLIOS
[Currency Savings(+) and Losses(-) of the **actual** currency structure]
(Billions of dollars)

	1985	1986	1987	1988
		BRAZIL		
ALTERNATIVE 1				
Total	-3.41	-4.41	-5.79	2.85
Principal	-3.38	-4.59	-5.56	2.99
Service	-0.03	0.18	-0.23	-0.13
ALTERNATIVE 2				
Total	16.36	22.87	29.59	-18.41
Principal	16.97	24.42	29.04	-18.26
Service	-0.61	-1.55	0.55	-0.15
ALTERNATIVE 3				
Total	1.15	0.50	1.36	-0.70
Principal	0.92	0.35	1.04	-0.99
Service	0.23	0.15	0.32	0.29
ALTERNATIVE 4				
Total	0.11	-2.42	-0.82	1.32
Principal	-0.40	-2.86	-1.30	0.78
Service	0.51	0.44	0.48	0.55
		INDONESIA		
ALTERNATIVE 1				
Total	-3.75	-4.35	-6.45	2.43
Principal	-3.63	-4.49	-6.17	2.60
Service	6.12	0.14	-0.28	-0.17
ALTERNATIVE 2				
Total	2.33	4.04	4.44	-4.12
Principal	2.63	4.43	4.48	-3.94
Service	-0.30	-0.39	-0.04	-0.18
ALTERNATIVE 3				
Total	-1.63	-2.13	-2.91	1.16
Principal	-1.62	-2.23	-2.83	1.17
Service	-0.01	0.10	-0.08	-0.01
ALTERNATIVE 4				
Total	-3.75	-4.35	-6.45	2.43
Principal	-3.63	-4.49	-6.17	2.60
Service	6.12	0.14	-0.28	-0.17

Table 11 (continued)

	1985	1986	1987	1988
		MEXICO		
ALTERNATIVE 1				
Total	-1.59	-1.71	-2.58	1.18
Principal	-1.5	-1.7	-2.4	1.3
Service	-0.04	0.01	-0.18	-0.12
ALTERNATIVE 2				
Total	18.74	26.25	33.62	-20.55
Principal	19.30	28.0	33.0	-20.4
Service	-0.69	-1.75	0.62	-0.15
ALTERNATIVE 3				
Total	0.13	0.41	0.23	-0.26
Principal	0.17	0.44	0.25	-0.24
Service	-0.04	-0.03	-0.02	-0.02
ALTERNATIVE 4				
Total	-1.59	-1.71	-2.58	1.18
Principal	-1.5	-1.7	-2.4	1.3
Service	-0.04	0.01	-0.18	-0.12
		PHILIPPINES		
ALTERNATIVE 1				
Total	-1.63	-2.09	-2.89	0.96
Principal	-1.6	-2.0	-2.8	1.0
Service	-0.03	0.09	-0.09	-0.04
ALTERNATIVE 2				
Total	2.85	4.37	4.58	-3.45
Principal	2.7	4.1	4.5	-3.4
Service	-0.15	-0.27	0.08	-0.05
ALTERNATIVE 3				
Total	-0.31	-0.44	-0.77	0.05
Principal	-0.34	-0.50	0.80	0.01
Service	0.03	0.06	0.03	0.04
ALTERNATIVE 4				
Total	4.2	3.6	5.9	-3.9
Principal	3.8	3.4	5.2	-4.4
Service	0.42	0.2	0.7	0.5

.../...

Table 11 (continued)

	1985	1986	1987	1988
		SOUTH KOREA		
ALTERNATIVE 1				
Total	-2.67	-2.90	-4.51	1.70
Principal	-2.54	-2.95	-4.26	1.84
Service	-0.13	0.06	-0.25	-0.15
ALTERNATIVE 2				
Total	6.46	9.70	11.84	-8.13
Principal	6.89	10.44	11.72	-7.98
Service	-0.40	-0.74	0.12	-0.16
ALTERNATIVE 3				
Total	0.81	1.18	1.48	-0.60
Principal	0.84	1.27	1.47	-0.63
Service	-0.03	-0.09	0.01	-0.03
ALTERNATIVE 4				
Total	4.48	3.17	6.00	-3.90
Principal	3.88	2.82	5.04	-4.62
Service	0.60	0.34	0.96	1.28

TABLE 12a: BRAZIL

Valuation effects of 6 major currencies' exchange rate swings on B.o.P. flows with alternative debt currency structures

Millions of dollars

	1984	1985	1986	1987	1988	S.E.
(1) Total Debt						
a. Actual c.c.	103885	107269	111855	117414	114423	5434
b. All dollars	103885	103885	103885	103885	103885	0
c. World Bank	103885	124240	153245	187850	166596	33423
d. Const.Real Va.	103885	108193	113129	119728	115747	6231
e. Optimal 1.	103885	106898	108657	112959	110715	3486
f. Optimal 2.	103885	107036	108964	113474	111097	3687
g. Optimal 3.	103885	107232	111975	117844	112652	5361
(2) Interest Payments		millions of dollars				
a. Actual c.c.	10273	8381	9900	8056	8763	966
b. All dollars	10783	8352	10077	7822	8635	1244
c. World Bank	6864	7770	8349	8610	8611	742
d. Const. Real Va	10258	8610	10052	8372	9050	848
e. Optimal 1.	10564	8896	10337	8540	9310	888
f. Optimal 2.	10539	8904	10334	8560	9329	872
g. Optimal 3.	9974	8110	9694	7883	8356	961
(3) (Ex-ante) estimated Debt Service: (1)/10				(mill. of $)		
a. Actual c.c.	10388.5	10726.9	11185.5	11741.4	11442.3	543
b. All dollars	10388.5	10388.5	10388.5	10388.5	10388.5	0
c. World Bank	10388.5	12424.0	15324.5	18785.0	16659.6	3342
d. Const. Real Va	10388.5	10819.3	11312.9	11972.8	11574.7	623
e. Optimal 1.	10388.5	10689.8	10865.7	11295.9	11071.5	349
f. Optimal 2.	10388.5	10703.6	10896.4	11347.4	11109.7	369
g. Optimal 3.	10388.5	10723.2	11197.5	11784.4	11265.2	536

(4) Balance of trade in 1984 and valuation effects in domestic currency

	millions of $	--------- bn cruzados of end 1984 ---------					
$	9438	30051.4	29185.0	28232.6	27513.1	27868.5	
DM	735	2340.2	2669.5	3178.4	3639.4	3150.2	
FF	134	425.5	500.6	554.8	634.4	519.8	
SF	-149	-475.0	-552.1	-652.2	-769.0	-602.5	
UK	1146	3647.4	4275.1	4195.5	4990.5	4482.7	
Yen	-41	-131.1	-153.0	-178.5	-212.9	-198.6	
Total bot	11262	35858.3	35925.2	35330.5	35795.5	35220.2	326

(5) CURRENT ACCOUNT IN CRUZADOS: (constant 1984 bn. of cruzados)						
a. Actual c.c.	2781.4	2755.6	1871.4	1568.5	1434.5	646
b. All dollars	2781.4	3801.8	4255.4	5512.3	4545.9	1002
c. World Bank	2781.4	-2492.3	-10509.6	-18964.0	-13970.9	8757
d. Const. Real Va	2781.4	2469.8	1490.4	894.0	1043.4	849
e. Optimal 1.	2781.4	2870.1	2828.0	2867.3	2529.1	142
f. Optimal 2.	2781.4	2827.5	2736.3	2717.2	2416.3	162
g. Corr.model	2781.4	3138.8	2750.5	3546.4	2969.4	325

TABLE 12b: INDONESIA

Valuation effects of 6 major currencies' exchange rate swings on B.o.P. flows with alternative debt currency structures

Millions of dollars

	1984	1985	1986	1987	1988	S.E.
(1) Total Debt						
a. Actual c.c.	31792	35605	40096	46264	43662	5874
b. All dollars	31792	31792	31792	31792	31792	0
c. World Bank	31792	38236	47163	57813	51272	10345
d. Const.Real Va.	31792	33983	36245	39581	38154	3134
e. Optimal 1;2;3.	31792	31792	31792	31792	31792	0
(2) Interest Payments			millions of dollars			
a. Actual c.c.	2813	2688	2956	2691	2831	112
b. All dollars	3319	2571	3101	2407	2658	383
c. World Bank	2112	2391	2570	2650	2650	229
d. Const. Real Va	3053	2683	3059	2615	2817	206
e. Optimal 1;2;3.	3319	2571	3101	2407	2658	383
(3) (Ex-ante) estimated Debt Service: (1)/10						
a. Actual c.c.	3179.20	3560.50	4009.60	4626.40	4366.20	587
b. All dollars	3179.20	3179.20	3179.20	3179.20	3179.20	0
c. World Bank	3179.20	3823.64	4716.34	5781.33	5127.22	1034
d. Const. Real Va	3179.20	3398.30	3624.50	3958.10	3815.40	313
e. Optimal 1;2;3.	3179.20	3179.20	3179.20	3179.20	3179.20	0

(4) Balance of Trade in 1984 and valuation effects in domestic currency

	mill. of $	------- bn. rupiah of end 1984				----------
$	11410	12254.34	11741.01	11133.47	10719.89	10823.74
DM	-1000	-1074.00	-1208.68	-1410.63	-1595.92	-1377.00
FF	0	0.00	0.00	0.00	0.00	0.00
SF	0	0.00	0.00	0.00	0.00	0.00
£	750	805.50	931.43	896.04	1053.06	942.89
Yen	-2430	-2609.82	-3004.38	-3437.17	-4050.02	-3765.09
Total bot	8730	9376.02	8459.38	7181.71	6127.02	6624.55

	1984	1985	1986	1987	1988	S.E.
(5) CURRENT ACCOUNT IN RUPIAH						
a. Actual c.c.	5961.56	4795.59	3269.28	1780.44	2482.69	1707
b. All dollars	5961.56	5187.95	4079.56	3140.11	3608.70	1159
c. World Bank	5961.56	4524.82	2579.67	695.36	1760.77	2125
d. Const. Real Va	5961.56	4962.50	3645.05	2408.32	3005.19	1451
e. Optimal 1;2;3.	5961.56	5187.95	4079.56	3140.11	3608.70	1159

(6) Estimated appreciation of the local currency towards 6 currencies*

Yearly	$	0.00	4.19	5.17	3.71	-0.97	3
%	DM	0.00	-10.29	-16.34	-8.86	10.56	10
changes	FF	0.00	-13.34	-13.08	-8.05	9.70	10
of the	SF	0.00	-11.26	-16.99	-10.49	12.67	12
shadow	£	0.00	-13.50	3.45	-15.06	1.21	9
rate	Yen	0.00	-10.63	-17.41	-8.84	0.30	8

* Estimated nominal changes with a constant Real Effective Exchange Rate

TABLE 12c: KOREA
Valuation effects of 6 major currencies' exchange rate swings on B.o.P. flows with alternative debt currency structures

Millions of dollars

	1984	1985	1986	1987	1988	S.E.
(1) Total Debt						
a. Actual c.c.	47987	50531	53487	57750	55909	3950
b. All dollars	47987	47987	47987	47987	47987	0
c. World Bank	47987	57389	70788	86772	76955	15439
d. Const.Real Va.	47987	51375	55606	61342	58871	5429
e. Optimal 1.	47987	54412	60189	69491	63034	8217
f. Optimal 2.	47987	51025	53282	57696	54959	3708
g. Optimal 3.	47987	47987	47987	47987	47987	0
(2) Interest Payments			millions of dollars			
a. Actual c.c.	4668	3987	4597	3859	4135	364
b. All dollars	4981	3858	4655	3613	3989	575
c. World Bank	3171	3589	3857	3977	3978	343
d. Const. Real Va	4484	3953	4506	3869	4162	294
e. Optimal 1.	4429	4592	4943	4816	4851	210
f. Optimal 2.	4460	4573	4939	4768	4827	194
g. Optimal 3.	4981	3858	4655	3613	3989	575
(3) (Ex-ante) estimated Debt Service: (1)/10						
a. Actual c.c.	4798.70	5053.15	5348.69	5775.00	5590.88	395
b. All dollars	4798.70	4798.70	4798.70	4798.70	4798.70	0
c. World Bank	4798.70	5738.93	7078.78	8677.24	7695.47	1544
d. Const. Real Va	4798.70	5137.51	5560.62	6134.25	5887.12	543
e. Optimal 1.	4798.70	5441.20	6018.91	6949.12	6303.40	822
f. Optimal 2.	4798.70	5102.47	5328.22	5769.65	5495.94	371
g. Optimal 3.	4798.70	4798.70	4798.70	4798.70	4798.70	0

(4) Balance of Trade in 1984 and valuation effects in domestic currency

$	1656	1370.01	1306.34	1221.60	1172.70	1186.37
DM	207	171.24	191.79	220.73	248.98	215.24
FF	-50	-41.08	-47.47	-50.85	-57.27	-46.87
SF	-48	-40.00	-45.65	-52.13	-60.55	-47.38
£	363	299.98	345.22	327.51	383.75	344.27
Yen	-3513	-2906.92	-3330.39	-3757.41	-4414.10	-4111.55
Total bot	-1386	-1146.78	-1580.16	-2090.55	-2726.49	-2459.92

	1984	1985	1986	1987	1988	S.E.
(5) CURRENT ACCOUNT IN WON						
a. Actual c.c.	5117.22	5566.84	6036.66	6816.57	6465.74	680
b. All dollars	5117.22	5366.09	5630.89	6125.11	5898.15	403
c. World Bank	5117.22	6107.89	7313.07	8872.04	7973.66	1488
d. Const. Real Va	5117.22	5633.39	6193.01	7071.00	6677.99	784
e. Optimal	5117.22	5872.99	6531.13	7648.12	6976.25	978
f. Optimal 2.	5117.22	5605.75	6021.56	6812.78	6397.71	662
g. Corr.model	5117.22	5366.09	5630.89	6125.11	5898.15	403

TABLE 12d: MEXICO

Valuation effects of 6 major currencies' exchange rate swings on B.o.P. flows with alternative debt currency structures

Millions of dollars

	1984	1985	1986	1987	1988	S.E.
(1) Total Debt						
a. Actual c.c.	106245	107736	109402	111763	110457	2181
b. All dollars	106245	106245	106245	106245	106245	0
c. World Bank	106245	127062	156727	192117	170381	34183
d. Const.Real Va.	106245	107904	110015	112625	111080	2532
e. Optimal 1;2;3.	106245	106245	106245	106245	106245	0
(2) Interest Payments			millions of dollars			
a. Actual c.c.	10884	8632	10293	8181	8956	1148
b. All dollars	11028	8542	10306	8000	8832	1272
c. World Bank	7019	7946	8539	8805	8807	759
d. Const. Real Va	10808	8596	10259	8164	8937	1129
e. Optimal 1;2;3.	11028	8542	10306	8000	8832	1272
(3) (Ex-ante) estimated Debt Service: (1)/10						
a. Actual c.c.	10625	10774	10940	11176	11046	218
b. All dollars	10625	10625	10625	10625	10625	0
c. World Bank	10625	12706	15673	19212	17038	3418
d. Const. Real Va	10625	10790	11002	11263	11108	253
e. Optimal 1;2;3.	10625	10625	10625	10625	10625	0

(4) Balance of Trade in 1984 and valuation effects in local currency

	mill. of $	pesos of 1984				
$	13882	2673.67	2645.39	2608.74	2585.32	2597.94
DM	-749	-144.28	-167.68	-203.52	-236.99	-203.51
FF	-247	-47.50	-56.95	-64.33	-74.80	-60.81
SF	-81	-15.60	-18.48	-22.25	-26.68	-20.73
£	-159	-30.55	-36.48	-36.49	-44.14	-39.34
Yen	-482	-92.75	-110.26	-131.18	-159.09	-147.19
Total bot	12165	2343.00	2255.56	2150.97	2043.61	2126.36

(5) CURRENT ACCOUNT IN PESOS

	1984	1985	1986	1987	1988	S.E.
a. Actual c.c.	296.72	202.51	95.06	-37.80	59.22	130
b. All dollars	296.72	230.92	154.39	64.96	138.04	89
c. World Bank	296.72	-165.77	-794.28	-1534.28	-1062.23	725
d. Const. Real Va	296.72	199.31	83.54	-53.86	47.56	136
e. Optimal 1;2;3.	296.72	230.92	154.39	64.96	138.04	89

TABLE 12e: PHILIPPINES

Valuation effects of 6 major currencies' exchange rate swings on B.o.P. flows with alternative debt currency structures

Millions of dollars

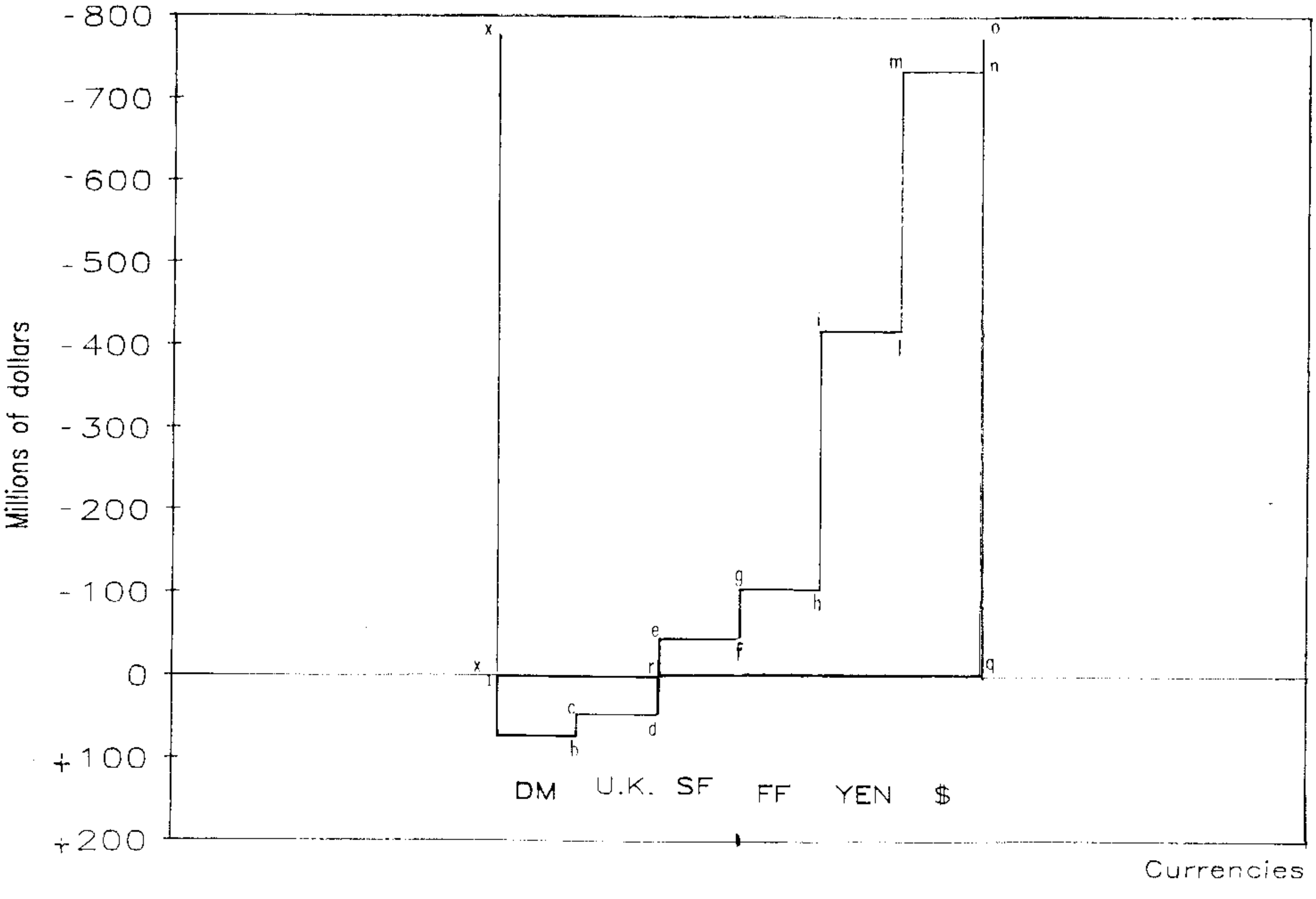
	1984	1985	1986	1987	1988	S.E.
(1) Total Debt						
a. Actual c.c.	21891	23475	25496	28298	27268	2639
b. All dollars	21891	21891	21891	21891	21891	0
c. World Bank	21891	26180	32292	39584	35106	7043
d. Const.Real Va.	21891	23134	24654	26653	25628	1907
e. Optimal 1.	21891	27227	32642	40639	35198	7230
f. Optimal 2.	21891	27213	32440	40342	34846	7086
g. Optimal 3.	21891	23052	24698	26733	24932	1860
(2) Interest Payments			millions of dollars			
a. Actual c.c.	2032	1788	2033	1736	1860	138
b. All dollars	2272	1760	2123	1648	1820	262
c. World Bank	1446	1637	1759	1814	1815	157
d. Const. Real Va	2113	1813	2094	1773	1906	157
e. Optimal 1.	1732	2215	2231	2487	2356	286
f. Optimal 2.	1743	2249	2261	2527	2398	298
g. Optimal 3.	1992	1676	1991	1669	1723	167
(3) (Ex-ante) estimated Debt Service: (1)/10						
a. Actual c.c.	2189.10	2347.50	2549.60	2829.80	2726.80	264
b. All dollars	2189.10	2189.10	2189.10	2189.10	2189.10	0
c. World Bank	2189.10	2618.00	3229.20	3958.40	3510.60	704
d. Const. Real Va	2189.10	2313.40	2465.40	2665.30	2562.80	191
e. Optimal 1.	2189.10	2722.70	3264.20	4063.90	3519.80	723
f. Optimal 2.	2189.10	2721.30	3244.00	4034.17	3484.57	709
g. Optimal 3.	2189.10	2305.19	2469.76	2673.34	2493.23	186

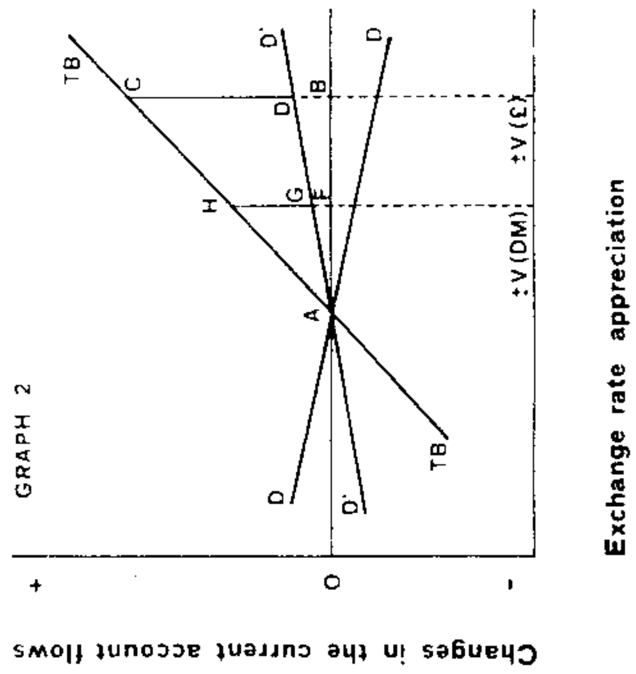
(4) Balance of Trade in 1984 and valuation effects in domestic currency

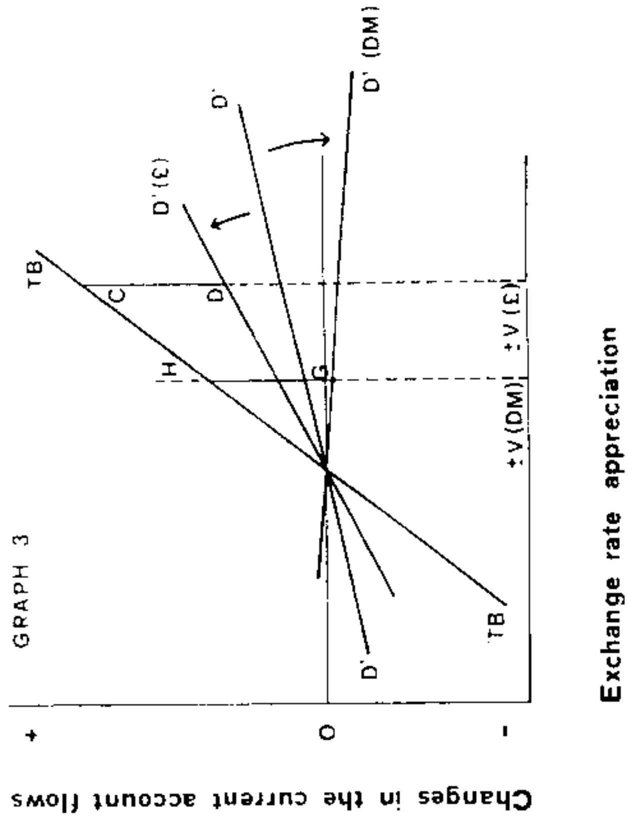
	millions of $	---------- bn pesos of end 1984				------------
$	-736	-14.55	-13.99	-13.29	-12.86	-13.03
DM	75	1.49	1.68	1.96	2.23	1.93
FF	-104	-2.05	-2.39	-2.60	-2.95	-2.42
SF	-26	-0.51	-0.59	-0.69	-0.80	-0.63
£	48	0.96	1.11	1.07	1.26	1.13
Yen	-419	-8.29	-9.57	-10.97	-12.99	-12.12
Total bot	-1162	-22.96	-23.76	-24.52	-26.11	-25.14

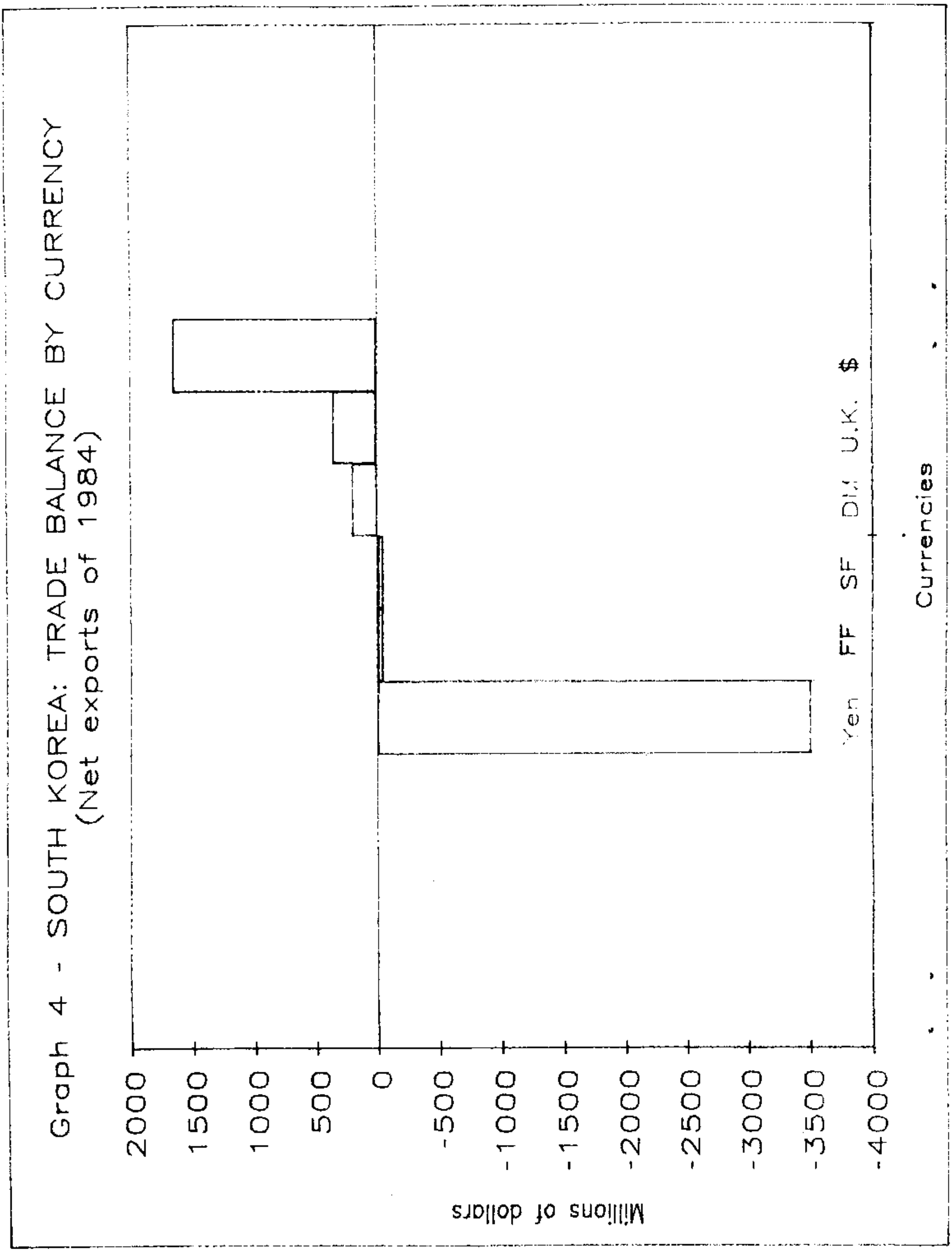
(5) CURRENT ACCOUNT IN PESOS.		(bn of 1984 constant pesos)				
a. Actual c.c.	-66.22	-68.37	-70.53	-75.52	-73.39	3.740
b. All dollars	-66.22	-65.36	-64.03	-64.33	-63.88	0.999
c. World Bank	-66.22	-73.51	-82.80	-95.22	-87.26	11.394
d. Const. Real Va	-66.22	-67.73	-69.02	-72.65	-70.49	2.482
e. Optimal 1.	-66.22	-75.50	-83.43	-97.07	-87.42	11.723
f. Optimal 2.	-66.22	-75.48	-83.07	-96.55	-86.80	11.475
g. Optimal 3.	-66.22	-66.85	-67.39	-68.72	-67.40	0.924

Graph 1 - Philippines, NET EXPORTS of 1984
(six currencies)

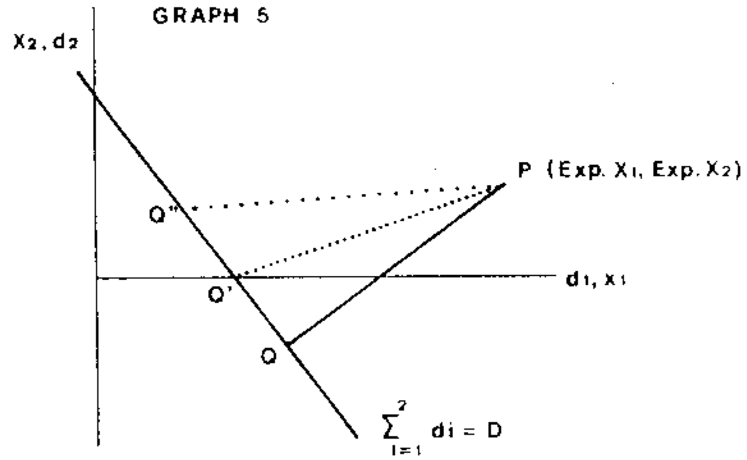



GRAPH 2
TB
C
H
D
D'
A
G
E
B
±V(DM)
±V(£)
+
O
-
Changes in the current account flows
Exchange rate appreciation


GRAPH 3
TB
C
H
D
G
D'
D'(£)
D' (DM)
±V(DM)
±V(£)
+
O
-
Changes in the current account flows
Exchange rate appreciation


Graph 4 - SOUTH KOREA: TRADE BALANCE BY CURRENCY
(Net exports of 1984)
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
Millions of dollars
Yen
FF
SF
DM
U.K.
$
Currencies

GRAPH 5



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