ON THE INTEREST RATE ELASTICITY OF
THE DEMAND FOR INTERNATIONAL RESERVES:
SOME EVIDENCE FROM DEVELOPING COUNTRIES


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## ABSTRACT

Contrary to what is suggested by the theory, most empirical studies
on the demand for international reserves have failed to find a significant
(negative) coefficient for the opportunity cost of holding reserves. In
this paper it is argued that the reason for this is that the opportunity
cost of holding international reserves has been measured incorrectly. In
the empirical analysis presented in this paper the spread between the
interest rate at which countries can borrow from abroad and LIBOR is used as
a proxy for the net opportunity cost for holding reserves. The results
obtained using data for a group of developing countries for 1976-1980 show
that when this net opportunity cost is used, the regression coefficient is
significantly negative.

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Theoretical studies on the demand for international reserves have generally postulated that the quantity of reserves demanded by a particular country will depend, in a negative way, on the opportunity cost of holding them.[1] Most empirical studies on the subject, however, have repeatedly failed to find a significant relation between international reserves and their opportunity cost. These results have puzzled for a long time economists that have analyzed international reserves behavior, and a number of possible explanations have been offered. For example , in his well-known survey John Williamson writes:

> "Various proxies for [the opportunity cost of reserves holdings] ... have been tried, with uniform lack of success. Possible explanations are that the proxies chosen are not good ones, that there is not in fact sufficient variation in the opportunity cost of reserve holding to permit statistical estimation, and that the interest elasticity of demand for reserves is low." (1973, page 696).

Other authors -- Bird (1978, pp. 88-89), Frenkel (1984, p. 58) and Edwards (1983, p. 279), for example -- have discussed this apparent insensitivity of the demand for international reserves with respect to their opportunity cost. As a result of these findings in most recent empirical studies the opportunity ·cost variable has been dropped from the regression analysis of the demand for international reserves.[2]

In this paper the empirical relationship between the demand for international reserves and the opportunity cost of holding them is re-examined. It is argued that since international reserves are usually held in the form of short-term interest bearing assets, the appropriate opportunity cost of holding them is a net cost, which should be computed as the gross income forgone by holding reserves minus the return obtained from holding them.[3] The analysis is performed using data from 17 developing countries for 1976-1980, and the results obtained indicate that when a net cost is used as

the appropriate opportunity cost, the corresponding demand elasticity is in most cases significantly negative as predicted by the theory.

## I. The Opportunity Cost of Holding International Reserves

One of the most difficult problems in the empirical analysis of international reserves behavior has been to find an adequate measure for the opportunity cost of holding them. Some authors [Kenen and Yudin (1965), Kelly (1970)] have used income per capita as a proxy, and have found that its regression coefficient has the "wrong" sign. Hipple (1974), on the other hand, used the inverse of the gross marginal capital-output ratio as a proxy for the opportunity cost of holding reserves, and found that the regression coefficients either had the "wrong" sign or were insignificant. Courchene and Youssef (1967) and Frenkel and Jovanovic (1981) have used the domestic rate of interest as a proxy. While Courchene and Youssef (1967) found that in most cases the regression coefficients were insignificant, Frenkel and Jovanovic found a marginally significant negative elasticity of the demand for reserves with respect to its opportunity cost. Other authors [i.e, Clark (1970b); Frenkel (1978, 1980); Bilson and Frenkel (1979); Heller and Kahn (1978); Edwards (1980, 1983)] have simply decided to drop the opportunity cost variable from their empirical analyses.

An important aspect of the opportunity cost of holding reserves, that has been generally ignored in empirical studies, is that international reserves are usually held in the form of short-term interest bearing assets.[4] This means that the actual opportunity cost of holding reserves is not, as most authors have assumed, the (social) marginal product of capital in the country under consideration. The correct measure of this opportunity cost will be a net cost, given by the difference between the domestic marginal product of

capital — which will capture the <u>gross</u> forgone income from holding resources in the form of international reserves —, and the return obtained from holding the reserves.

From the perspective of empirical analysis, however, there are non-trivial difficulties in computing adequate series for the <u>net</u> opportunity cost of holding reserves. These difficulties are particularly serious for the case of developing countries. First, in most LDC's there are no reliable data on the marginal product of capital, or on other alternative measures for the gross forgone income of holding reserves.[5] Second, there are no data available on the composition of reserves, or on the return obtained from these holdings. For this reason, any attempt to empirically analyze the relation between the demand for reserves and its net opportunity cost requires finding a proxy for this net opportunity cost.

In this paper this problem is handled in the following form: First it is assumed that, in equilibrium, the <u>gross</u> forgone income from holding one unit of international reserves can be approximated by the cost at which that country borrows from the international financial market. This assumption follows from the well-known principle that countries will borrow from abroad as long as the cost of borrowing is lower or equal to the (social) marginal productivity of those funds.[6] This is a convenient assumption, since it is possible to obtain historical data on the cost of borrowing from Euromarkets for a number of developing countries [see for example, <u>World Bank</u>]. Second, with respect to the return obtained on reserves holdings, it is assumed that non-gold reserves earn a rate equal to LIBOR. This seems to be an appropriate assumption since reserves are usually held in the form of highly liquid assets, which earn a fairly low return. Cline (1983), for example, has recently assumed that non-gold reserves holdings by developing countries earn

1.5 percentage points below LIBOR. In the present study, then, it is assumed that the net cost of holding reserves can be proxied by the differential between the cost of foreign borrowing and the LIBOR rate.[7] In section II the results obtained from estimating demand for reserves functions for a group of 17 LDC's during 1976-1980 using this measure of the net opportunity cost are presented.

II. Empirical Results

Most studies on the subject have assumed that the demand for reserves is a stable function of a small number of variables. In particular, it has generally been assumed that the demand for reserves will depend positively on the scale of the country (usually measured by GNP, y); positively on the degree of openness (usually proxied by the average propensity to import, m); positively on the degree of variability of international payments (usually measured as the coefficient of variation of export earnings, $\sigma$); and negatively on the opportunity cost of holding reserves.[8] It should be noted that some authors (Heller 1966, Heller and Kahn 1978) have postulated that the coefficient of the propensity to import m should be negative. Initially this view was the dominant one. More recently however, this view has been superseded on the basis of empirical evidence and the realization that the sign of the openness variable will depend on whether expenditure-switching or expenditure-reducing policies are being pursued.

Generally speaking, the results obtained from the estimation of demand for reserves functions have been quite satisfactory, with most of the regression coefficients -- with the exception of the opportunity cost variable -- being significant and of the expected sign. These empirical studies, however, have generally been more successful for the case of industrialized

countries. In the case of developing countries it has been found that for the more recent period the coefficients of the openness variables and of $\sigma$ have not been significant [Frenkel 1980, Edwards 1984b].

In this section results from the estimation of a demand function for international reserves for a group of 17 developing countries for 1976-1980 are presented. Following the literature on the subject it is assumed that the demand for reserves (R) can be written in the following form:

$$\log R_n = \beta_0 + \beta_1 \log y_n + \beta_2 \log m_n + \beta_3 \log \sigma_n + \beta_4 \log r_n + \omega_n \qquad (1)$$

where, as before, y is GNP expressed in U.S. dollars; m is the average propensity to import; $\sigma$ is the standard error of the log of detrended export earnings; r is the _net_ opportunity cost of holding reserves, and for each country it is measured as the difference between the cost of foreign borrowing and LIBOR; and w is an error term with the usual properties. It is expected that $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$ and $\beta_4 < 0$.

The following countries were included in the estimation: Greece, Portugal, Spain, Argentina, Brazil, Colombia, Ecuador, Mexico, Panama, Uruguay, Venezuela, Indonesia, Korea, Malaysia, Philippines, Thailand and Morocco. The countries' selection was based on data availability; these are the only developing countries for which data on the spread over LIBOR and GNP were available for all the years considered in this study. See the Appendix for the data sources.

Equations of the type of (1) have usually been estimated using OLS on cross-sections for each year (Frenkel 1974). In the present case, however, the use of OLS is inappropriate since there is evidence that suggests that the spread between the cost of borrowing and LIBOR (r) will be affected by the international reserves to GNP ratio (Edwards 1984a). For this reason a

simultaneous procedure should be used in the estimation of (1). Table 1 presents the results obtained from the estimation of equation (1) using two-stages least squares, for each year. Since the errors for each cross-section equation are likely to be correlated across years (Frenkel, 1978), a joint-generalized-least-squares procedure, that takes into account the error covariance across equations, was also used.[10] The results obtained in this case are reported in Table 2.

As may be seen the results obtained are quite interesting. First, contrary to previous results it is shown that for most of the years considered the coefficient of the net cost of holding reserves is significantly negative at the conventional levels. Furthermore, the estimated elasticities of the demand for reserves with respect to the net opportunity cost are quite large in absolute terms, indicating that monetary authorities will generally under-take substantial adjustments in their reserves holdings when the (net) opportunity cost changes. Also these results indicate that the elasticity of the demand for reserves with respect to income is not significantly different from one. This contrasts with previous results that suggested that during the Bretton Woods system there were diseconomies of scales in the holding of international reserves by developing countries (Edwards 1983, 1984c). The coefficient of the variability term σ is never significantly different from zero. This coincides with previous findings reported by Frenkel (1978) for an earlier period, and indicates that during the recent period these LDC's have not taken into account the variability of their export earnings when determining the amount of reserves they want to hold. Regarding the openness variable m, its estimated coefficient is not significant at the conventional levels.[11]

## Table 1

### The Demand for International Reserves by Developing Countries

### 1976-1980:

### (Two-Stages-Least-Squares)

|            | 1976              | 1977              | 1978              | 1979              | 1980              |
|------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| constant   | 0.641<br>(0.316)  | 0.079<br>(0.046)  | -1.503<br>(-0.957)| -0.089<br>(-0.042)| -0.788<br>(-0.367)|
| $\log y_n$ | 0.871<br>(3.771)  | 0.789<br>(3.791)  | 0.897<br>(4.417)  | 0.601<br>(2.052)  | 0.666<br>(2.550)  |
| $\log m_n$ | 0.218<br>(0.436)  | -0.477<br>(-0.905)| 0.168<br>(0.329)  | -0.541<br>(-0.823)| -0.281<br>(-0.478)|
| $\log \sigma_n$ | 0.187<br>(0.326) | 0.158<br>(0.292) | -0.067<br>(-0.140)| 0.111<br>(0.231)  | -0.220<br>(-0.530)|
| $\log r_n$ | -3.066<br>(-2.086)| -3.105<br>(-2.443)| -1.201<br>(-1.618)| -2.471<br>(-1.865)| -1.726<br>(-1.853)|
| F          | 8.94              | 14.00             | 14.09             | 12.25             | 9.67              |
| $R^2$      | 0.765             | 0.836             | 0.837             | 0.817             | 0.779             |
| SEE        | 0.745             | 0.600             | 0.566             | 0.632             | 0.686             |

Notes: t-statistics in parentheses.

## Table 2

### The Demand for International Reserves by Developing Countries

### 1976-1980:

### (Jointly-Generalized-Least-Squares)

|            | 1976     | 1977     | 1978     | 1979     | 1980     |
|------------|----------|----------|----------|----------|----------|
| constant   | 0.299    | -0.323   | -1.442   | -0.879   | -0.412   |
|            | (0.172)  | (0.221)  | (-1.041) | (-0.529) | (-0.216) |
| $\log y_n$ | 0.875    | 0.842    | 0.925    | 0.813    | 0.733    |
|            | (4.397)  | (5.139)  | (6.028)  | (4.203)  | (3.442)  |
| $\log m_n$ | 0.225    | -0.174   | 0.310    | -0.050   | -0.139   |
|            | (0.555)  | (-0.487) | (0.918)  | (-0.210) | (-0.308) |
| $\log \sigma_n$ | 0.279 | 0.292   | 0.009    | 0.200    | 0.122    |
|            | (0.653)  | (0.741)  | (0.242)  | (1.304)  | (0.354)  |
| $\log r_n$ | -2.121   | -1.564   | -0.122   | -0.934   | -0.946   |
|            | (-2.951) | (-3.020) | (-0.272) | (-2.479) | (-1.966) |

Weighted SEE for system = 1.006

Weighted $R^2$ for system = 0.669

It should be noted that the period considered in this study (1976-1980) was characterized by rapid changes in the world economy — the dollar sharply depreciated in real terms, the second oil-shock took place, and there were dramatic changes in the terms of trade between developing and industrial countries. Possibly, those rapidly changing conditions in the world economy explain why the hypothesis of a stable demand for reserves across time was rejected (i.e., these equations cannot be pooled). This contrast with my previous findings (Edwards 1983) using data for 1964-1972, where I showed that the demand for reserves had been stable across time for a larger group of developing countries.

There is, however, an alternative explanation to the results reported in Tables 1 and 2. If when a country runs short of reserves it decides to rebuild them using foreign borrowing instead of reducing absorption or devaluing its currency, one would observe, as in these tables, a negative relation between the cost of foreign borrowing (i.e., the spread over LIBOR) and reserve holdings. This interpretation, however, assumes that reserves and debt are "complements" in the adjustment process. There is, however, some evidence suggesting that, in the case of developing countries, international reserves and foreign borrowing have been used as "substitutes" during the adjustment process. [See Eaton and Gersovitz (1980) and Edwards (1984b)].

III. Concluding Remarks

Contrary to what is suggested by the theory, most empirical studies on the demand for international reserves have failed to find a significant (negative) coefficient for the opportunity cost of holding reserves. In this paper I have argued that the most likely reason for this is that the opportunity cost of holding international reserves has been measured incorrectly as

the gross forgone income from holding international liquidity. I have argued that since reserves are usually held in the form of short-term interest bearing assets, the appropriate cost of holding reserves is a net cost given by gross forgone income minus the return obtained from the holding of reserves. In the empirical analysis presented in this paper I have suggested that the gross forgone income can be approximated by the interest rate at which a particular country can borrow in the international capital market. The reason for this is that in equilibrium a country will borrow abroad until the domestic (social) marginal productivity of capital is equal to the rate at which it can borrow. On the other hand I have assumed that the return obtained on reserve holdings can be approximated by LIBOR. Consequently, in the estimations of the demand function for reserves the spread charged over LIBOR has been used as a proxy for the net opportunity cost of holding reserves. The empirical results obtained using data for 17 developing countries for 1976-1980 indicate that when this net opportunity cost is used in the analysis, a significantly negative coefficient, as suggested by the theory, is found. Regarding the other determinants of the demand for international reserves the results obtained tend to confirm previous findings.

## Appendix

### Data Sources

All raw data, except spreads over LIBOR, have been taken from the IFS tape.

International Reserves: Total reserves minus gold as given by line 11.d of IFS.

Income: Measured as GNP in domestic currency units, converted into U.S. dollars using the average exchange rate. The raw data was taken from the IFS tape.

Average Propensity to Import: Defined as the ratio of imports (line 71.d of the IFS) to GNP.

Variability Measure $(\sigma)$ : $\sigma^2$ is measured as the mean square error of the regression of the log of exports on time over the previous ten years.

Spread $(r)$: Measured as a weighted average of spreads paid on publicized public and publicly guaranteed Eurodollar loans. The raw data was obtained from various issues of the World Bank's Borrowing in International Capital Markets. See Edwards (1984a) for details.

## Footnotes

[1] Most studies on the demand for international reserves have assumed that reserves are held both to finance international transactions and as a buffer stock to face unexpected payments difficulties. These studies have assumed that the demand for international reserves is a stable function of a small number of variables. For reviews of the literature on the demand for reserves see, for example, Clower and Lipsey (1968), Gruebel (1971), Williamson (1973), Hipple (1974), Edwards (1984b) and Frenkel (1984).

[2] See, for example, Frenkel (1974, 1978, 1980, 1984), Bilson and Frenkel (1979), Edwards (1983), and Heller and Kahn (1978). It should be noted, however, that in a recent study Frenkel and Jovanovic (1981) found that the opportunity cost of holding reserves was marginally significant in their regression analysis. Iyoha (1976) also claimed to have found a significant coefficient for the opportunity cost variable. His results, however, have been critized by Hipple (1979) and Shinkai (1979).

[3] On this point see, for example, the discussions in Darby (1983), Edwards (1983, 1984b), and Frenkel (1984).

[4] It is important to point out that while empirical studies have tended to ignore the net cost of holding reserves, analytical discussions on the subject have sometimes recognized this fact. See, for example, Heller (1966), Hipple (1974), Darby (1983), Frenkel (1984) and Edwards (1983). See also Cline (1983).

[5] The problem, of course, is that in most developing countries the domestic capital market is usually "repressed" and there are no reliable data on domestic interest rates.

[6]On the relation between the cost of foreign borrowing and the domestic marginal product of capital see, for example, Thirwall, (1978, p. 298-300) and Williamson (1983, pp. 108-119).

[7]Since the countries considered in this study are small open economies, the opportunity cost measure — the difference between the borrowing rate and LIBOR — can be interpreted as a risk factor. In this case, the spread over LIBOR will be an adquate measure of the opportunity cost only if, as has been suggested by Harberger (1976, 1980) among others, lenders and borrowers have different perceptions regarding the probability of default. In particular, if as Harberger (1980, p. 336) suggests borrowers perceive a lower probability of default than lenders, these small countries will face an upward sloping supply curve for foreign funds, and the spread over LIBOR will be an appropriate proxy for the net opportunity cost of holding reserves.

[8]See, for example, the discussions in Gruebel (1971), Williamson (1973), Hipple (1974), Frenkel (1984) and Edwards (1984b). As mentioned, however, most of the recent empirical studies have dropped the opportunity cost variables. Also, empirical studies have shown that there was a structural shift in the demand for reserve functions around 1973, when the international monetary system abandoned fixed parities and moved towards greater exchange rate flexibility.

[9]In the estimations reported in Table 1 the following instruments were used: debt-output ratio; average duration of foreign loans obtained by each country; average value of foreign loans; investment-GDP ratio; current account to GNP ratio, $y$, $m$ and $\sigma$. The estimation reported in Table 2 amounts to re-estimating simultaneously the equations reported in Table 1 for all years, taking into account the errors' covariance across years. These results include the most recent data available. The reason for this is that in 1981

the World Bank suspended the publication of Borrowing in International Capital Markets. For some of the years data were available for a larger number of countries. The results obtained in this case — not reported here due to space considerations, but available from the author on request — basically confirmed the conclusions discussed in this paper.

[10]It should be noted that the results obtained were somewhat sensitive to the instruments used. In particular, when some of the instruments listed in footnote 9 were dropped, the signs and t-statistics of some of the variables changed. Surprisingly, (sadly?), the problem of choosing instruments, performing and reporting sensitivity analyses under different sets of instruments has been largely neglected by econometricians.

[11]See von Furstenberg's (1982) recent study on the demand for reserves during the recent period, for time series regressions that include the terms of trade and other cyclical variables.

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