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THE DEMAND FOR INTERNATIONAL RESERVES AND MONETARY EQUILIBRIUM: SOME EVIDENCE FROM DEVELOPING COUNTRIES

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ABSTRACT

Traditionally, two alternative explanations have been offered for the behavior of international reserves through time. On the one hand, the literature on the demand for international reserves postulates that reserves movements respond to discrepancies between desired and actual reserves. On the other hand, according to the monetary approach to the balance of payments, changes in international reserves will be related to excess demands or excess supplies for money. The purpose of this paper is to empirically integrate these two basic explanations for international reserves movements. This is done by estimating a dynamic equation that explicitly allows reserves movements to reflect the monetary authority's excess demand for international reserves, and the public's excess demand for money. The results obtained, using a sample of 23 developing countries that maintained a fixed exchange rate during period 1965-1972, confirm the hypothesis that reserves movements respond both to monetary factors and to differences between actual and desired reserves. These results indicate that the exclusion of monetary considerations from the dynamic analysis of international reserves will yield biased coefficients.

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1. Introduction

Traditionally, two alternative explanations have been offered for the behavior of international reserves through time. On one hand, the literature on the demand for international reserves has postulated that reserves movements basically respond to discrepancies between desired reserves and the amount of reserves actually held by a particular country. (See, for example, Clark 1970a,b; Iyoha 1976; Heller and Khan 1978; Bilson and Frenkel 1979a,b; Edwards 1980, 1983).[1] However, an alternative explanation is offered by the simple version of the monetary approach to the balance of payments. According to this view, changes in international reserves will be related to excess demands or excess supplies of money: international reserves will increase if there is an excess demand for money (with domestic credit given), and will decrease if there is an excess supply for money. In that sense, according to the monetary approach, international reserves are a residual (see, for example, the essays collected in Frenkel and Johnson, 1976).[2] This apparent contradiction between the demand for reserves theory and the monetary approach can be solved once it is recognized that, as long as there is a stable demand for international reserves, domestic credit cannot be exogenous. In this case, changes in domestic credit will partially depend on the relationship between actual and desired reserves. In a fixed exchange-rate system, with other things given, if actual reserves are below their desired level, there will be a tendency to reduce domestic credit in order to increase actual holdings of international reserves.

The purpose of this paper is to empirically integrate these two basic explanations for international reserves movements. This is done by estimating a dynamic equation for the demand for reserves that incorporates monetary disequilibrium considerations.[3] The analysis explicitly allows reserves movements to reflect the monetary authorities excess demand for international reserves, and the public's excess demand for money. The study uses annual data from 23 developing countries that maintained a fixed exchange rate between 1965 and 1972.[4] The results obtained confirm the hypothesis that international reserves movements, during this period, responded both to monetary factors and to differences between actual and desired reserves. These results indicate that the exclusion of monetary considerations from the dynamic analysis of international reserves will yield biased coefficients.

2. Dynamic Adjustment and the Demand for Reserves

Most studies that have investigated the dynamic behavior of international reserves have assumed that the following partial adjustment equation can be written (Bilson and Frenkel, 1979a,b; Clark 1970b; Edwards, 1980, 1983):

$$\Delta \log R_t = \theta[\log R_t^* - \log R_{t-1}] \tag{1}$$

where R_t refers to international reserves actually held at period t, and R_t^* are desired reserves. It has also been assumed that the long run demand for reserves function depends positively on a scale variable (i.e., GNP -- y); positively on a variable that measures the degree of openness of the economy (i.e., the average propensity to import -- API); and positively on a variable that measures the variability of international payments (i.e., the coefficient of variation of detrended reserves -- σ).[5] The long run demand for reserves function can be then written as (Bilson and Frenkel 1979b):

$$\log R_t^* = a_o + a_1 \log y_t + a_2 \log API_t + a_3 \log \sigma_t + u_t \tag{2}$$

Clearly, however, this formulation is incomplete to the extent that it ignores the possible effects of monetary disequilibrium on the behavior of international reserves. If, for example, as the monetary approach postulates, an excess supply of money is partially reflected in a reduction of reserves actually held, equation (1) will be unsatisfactory. The effect of monetary disequilibria on reserves movements can be captured by rewriting the partial adjustment equation in the following form:[6]

$$\Delta \log R_t = \alpha[\log R^*_t - \log R_{t-1}] + \beta[\log M^*_t - \log M_{t-1}] \qquad (3)$$

This equation indicates that movements of (the log of) international reserves will respond to two factors: (1) differences between desired and actual reserves, ($\alpha[\log R^*_t - \log R_{t-1}]$); and (2) disequilibria in the money market ($\beta[\log M^*_t - \log M_{t-1}]$). The coefficient α measures the speed at which discrepancies between actual and desired reserves will be corrected. On the other hand, β measures what proportion of an unitary monetary disequilibrium will be translated, in the first period, into an accumulation or disaccumulation of international reserves. The presence of $\beta[\log M^*_t - \log M_{t-1}]$ in equation (3) distinguishes the approach taken in this paper from the dynamic equations used in previous work (Clark 1970b, Iyoha 1976, Hipple 1979, Shinkai 1979, Bilson and Frenkel 1979a,b; Edwards 1980).

The estimation of (3), however, presents some problems. First, it is important to decide if this equation should be estimated in real or nominal terms. In this paper I present results obtained when all relevant variables (i.e., M, R and y) are expressed in real terms. The reason for this is that according to the theory of the demand for reserves, these are held either to finance <u>real</u> transactions or to face <u>real</u> unexpected shocks. In that sense, the demand for reserves is a demand in real terms. On this see Machlup (1966), Saidi (1981), von Furstenberg (1982), Edwards (1983) and Frenkel (1983).[7] The second problem is related to the estimation method. In this paper I have used a two steps procedure. In the first step a demand for money equation is estimated for these countries using a least squares with dummy variables procedure (LSDV) on pooled cross-section and time series data for 1965-1972. In the second step the fitted values from this demand for money equation $[\log \hat{M}_t^*]$ are used as a proxy for $[\log M_t^*]$ in (3). The reason for using an LSDV procedure is that, as has been pointed out by Balestra and Nerlove (1966), Nerlove (1971), Maddala (1971) and Anderson and Hsiao (1981), the use of pooled data on dynamic equations present a number of problems. In particular, to the extent that it is assumed that the error term includes a country specific element, OLS will yield biased results. A straightforward way to avoid this problem is to assume, as we have done in this paper, that these country specific terms can be captured by country specific dummy variables. However, when more complicated methods — like Nerlove's (1971) two steps procedure — are used, the results are not affected in any significant way. For alternative methods of estimating the dynamic behavior of reserves using pooled data see Bilson and Frenkel (1979b), Edwards (1983), and Frenkel (1983). Then, in the second step the equation to estimate is (from (3) and (2)):

$$\log R_{nt} = \alpha a_o + \alpha a_1 \log y_{nt} + \alpha a_2 \log API_{nt} + \alpha a_3 \log \sigma_{nt} + (1-\alpha) \log R_{nt-1} + \beta[\log \hat{M}_{nt}^* - \log M_{nt-1}] + w_{nt} \quad (4)$$

It is assumed that the long run demand for money function has the following form:

$$\log M^{*}_{nt} = b_{on} + b_1 \log y_{nt} - b_2 \Pi_{nt} + \varepsilon_t \quad (5)$$

where M^{*}_{nt} is real money demanded in country n in period t, y_{nt} is real income, and Π_{nt} is the actual inflation in country n during period t, and is used as a proxy for expected inflation.[8]

3. Emirical Results

In order to estimate the first stage, it is assumed that the dynamic behavior of the real quantity of money can be expressed by the following partial adjustment equation:

$$\log M_{nt} = \log M_{nt-1} + \lambda \, [\log M^{*}_{nt} - \log M_{nt-1}] + \delta_t \quad (6)$$

Combining (5) and (6) a standard short run demand for money function is obtained. The estimation of this function using LSDV on pooled data yielded the following result, where the number in parentheses are t-statistics, and the estimated country dummy variables are presented in Table 1. (See the Appendix for an exact definition of the variables.)

$$\log M_{nt} = \lambda b_{on} + \underset{(1.303)}{0.207} \log y_{nt} - \underset{(1.382)}{0.005} \Pi_{nt} + \underset{(4.762)}{0.645} \log M_{tn-1} \quad (7)$$

$$R^2 = 0.994$$

In (7) all the coefficients of the short-run demand for money equation have the expected signs. From these results and the country-specific constants reported in Table 1, the long run coefficients were derived, and the estimated value of $\log \hat{M}^{*}_{t}$ were computed. These values were then used in the estimation of the demand for reserves-cum-monetary disequilibrium equation

(4). Using a LSDV procedure the following results were obtained from the estimation of (4), where the estimated country dummy variables are presented in Table 1.

$$\log R_{nt} = \alpha a_{on} + \underset{(4.675)}{0.795} \log y_{nt} + \underset{(0.345)}{0.061} \log API_{nt} + \underset{(0.333)}{0.026} \log \sigma_{nt}$$
$$+ \underset{(9.873)}{0.736} \log R_{nt-1} + \underset{(1.816)}{0.299} [\log \hat{M}^*_{nt} - \log M_{nt-1}] \quad (8)$$
$$R^2 = 0.984$$

The results reported in equation (8) are interesting in various respects. First, all the coefficients have the expected signs. Second, the coefficients of $\log y_{nt}$ and $\log R_{nt-1}$ are highly significant, while the coefficient of $[\log \hat{M}^*_{nt} - \log M_{nt-1}]$ is significant at the 10% level. The nonsignificance of the coefficients of the variability measure (σ) and openness variable (API) is consistent with previous results presented by Frenkel (1978, 1980) for the demand for reserves for developing countries between 1963 and 1978. The estimated partial adjustment coefficient $(\hat{\alpha})$ is equal to 0.264, indicating that, with other things given, approximately one quarter of a unitary disequilibrium between desired and actual reserves will be solved in one year. This coefficient is lower than those previously obtained in studies that did not include monetary considerations (Bilson and Frenkel 1979, Edwards 1983), and indicates that on average once these countries get off their long-run demand curves for reserves, it will take some time before equilibrium is restored. However, this coefficient is much closer to that recently obtained by Frenkel (1983) in his analysis of the dynamic behavior of reserves in developed countries for 1963-1972, that includes monetary considerations.

Table 1

Estimates of Country-Specific Constants

Country	Equation (7)		Equation (8)	
	Estimated Coefficient	t-statistic	Estimated Coefficient	t-statistic
Greece	-0.069	-0.176	-2.435	-4.208
Portugal	-0.198	-0.577	-2.126	-5.028
Costa-Rica	-0.292	-0.723	-2.320	-4.744
Dominican Republic	0.210	0.407	-3.250	-4.720
El Salvador	-0.329	-0.875	-1.952	-4.399
Guatemala	0.161	0.284	-3.197	-4.425
Haiti	-0.324	-0.743	-2.281	-4.340
Honduras	-0.590	-1.629	-1.841	-3.904
Mexico	-0.410	-1.135	-1.885	-4.614
Nicaragua	0.144	0.250	-3.235	-4.386
Paraguay	-0.016	-0.036	-2.301	-3.905
Venezuela	0.055	0.223	-1.167	-3.322
Jordan	-0.005	-0.010	-2.412	-4.154
Egypt	0.183	0.261	-3.967	-4.272
Thailand	-0.110	-0.243	-2.482	-4.156
Nigeria	-0.389	-1.087	-1.753	-4.466
Sudan	-0.114	-0.207	-3.163	-4.567
Iran	-0.505	-1.375	-1.769	-3.804
Iraq	0.450	0.908	-2.508	-3.801
Syria	-0.161	-0.390	-2.693	-5.078
Burma	0.112	0.302	-2.303	-4.604
Malaysia	0.004	0.008	-2.710	-4.098
Morocco	0.010	0.170	-3.108	-4.098

The estimated coefficient of $[\log \hat{M}^*_{nt} - \log M_{nt-1}]$ is significant at the 10% level, suggesting that in these countries money market disequilibria have had an important role in determining the movement of reserves through time. Specifically, this result indicates that, on average (with other things given), a 1% excess supply of money will result in a 0.3% reduction in the level of reserves held by a particular country. Also, according to this result, the coefficients of the long-run demand for reserves, obtained in dynamic analyses on the demand for reserves that ignore monetary considerations will be biased.

From the results presented in equation (8) it is possible to obtain the estimated long-run coefficients of the demand for reserves. These coefficients are: $\hat{a}_1 = 3.011$, $\hat{a}_2 = 0.231$ and $\hat{a}_3 = 0.098$. According to these estimates, the demand for international reserves by LDC's face strong diseconomies of scale. Even though previous work on the subject had also found diseconomies of scale (Edwards 1983), the estimated coefficient for a_1 obtained in this case [equation (8)] is higher than those previously reported. A possible explanation for this difference in the results is that the present study includes monetary considerations, while these were ignored by previous work.

4. Concluding Remarks

This paper has empirically analyzed the dynamic behavior of international reserves, integrating the demand for reserves theory and the monetary approach to the balance of payments. The results obtained using data for 23 fixed exchange-rate developing countries for period 1965-1972, show that reserves movement respond both to discrepancies between desired and actual reserves and to monetary disequilibrium situations. This indicates that dynamic analyses of the demand for reserves that have excluded monetary considerations have yielded biased coefficients.

The results obtained show that on average, for this sample, an excess demand for money equal to one percent will result in an accumulation of reserves of 0.27 percent. Also, the long-run demand for reserves for LDC's exhibits diseconomies of scale (Edwards 1983). Finally, this analysis suggests that while the country's scale is important for determining the amount of desired reserves, the degree of openness and payments variability play a secondary role.

The results obtained in this paper suggest that, to the extent that there is a well-defined demand for international reserves, domestic credit cannot be considered to be completely exogenous. In fact, these results can be viewed as partial evidence that at least for these countries during this period, changes in domestic credit partially responded to the existence of discrepancies between international reserves actually held and desired reserves (see footnote 2). Since the evidence available shows that during the more recent period (i.e., post-Bretton Woods period), different countries also have a stable demand for international reserves (Frenkel, 1978, 1980), these conclusions can be extended for the present conditions. It should be noted, however, that an empirical analysis of the more recent period should explicitly incorporate the effect of exchange rate movements on the behavior of reserves through time. In that sense, a model similar to that presented by Girton and Roper (1977) for the Canadian case could be integrated with the demand for reserves literature (see Levi, 1983).

Footnotes

[1]There are two traditions in the laterature on the demand for international reserves. One tradition is purely empirical (i.e., Frenkel 1974, 1978; Iyoha 1976; Heller and Khan 1978; Edwards 1980, 1983); while the second uses estimating equations derived from general equilibrium cost-benefit models (i.e., Kelly 1970; Hipple 1974; Frenkel and Jovanovic 1980). The present paper is an extension to the empirical side of this literature.

[2]While most work on the demand for reserves has ignored money market conditions, some of the work on the monetary approach recognizes the possibility of a simultaneous determination of the reserves flow equation and the domestic credit creation equation. See Genberg (1976).

[3]The need of finding a compatibilization between the demand for international reserves theory and the monetary approach to the balance of payments has been put forward by Frenkel (1978). Lau (1980) recently attempted this. Also, von Furstenberg (1982) introduces monetary variables in his new estimates of the demand for reserves. For recent attempts to combine the demand for international reserves with monetary equilibrium considerations see Frenkel (1983) and Levi (1983). On the relationship between "reserves targets" and "domestic credit" targets of monetary policy see Harberger and Edwards (1982).

[4]Both the countries and the time period considered responded to the need of fixed rate economies, for the empirical analysis.

[5]For reviews of the literature on the demand for reserves see Clower and Lipsey (1968), Grubel (1971), Williamson (1973) and Bird (1978). Notice that some authors -- Heller (1968), Kelly (1970), Iyoha (1976) -- have postulated a negative coefficient for the average propensity to import. Also, the proxy used for the variability measure has differed across studies. See, for

example, Kenen and Yudin (1965), Clark (1970b), Frenkel (1974), Heller and Khan (1978), Saidi (1981) and Edwards (1983). Also in some studies the opportunity cost of holding reserves has been included. However, almost always its coefficient has been insignificant (see Williamson (1973) and Frenkel and Jovanovic (1981)).

[6]This equation can be derived from the monetary system's balance sheet identity and the following assumptions: (a) the money market clears slowly; (b) domestic credit (D) behavior can be summarized by the following reaction function $\Delta \log D_t = \gamma[\log R_{t-1} - \log R^*_t] + w_t$; and (c) the multiplier is constant. A detailed presentation of the model underlying equation (3) is available from the author upon request.

[7]It is interesting to note that, despite these considerations, a number of papers have specified the demand for international reserves function in <u>nominal</u> terms. See, for example, Frenkel (1974, 1978). Recently, however, most authors have specified their analysis in real terms.

[8]Theoretically we would want to have the interest rate instead of π in equation (4). However, there is no interest rate data easily available for these countries.

APPENDIX

A. Data Sources

International Reserves: Taken from the International Financial Statistics (IFS) tape.

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

Average Propensity to Import: Defined as the ratio of imports to GNP.

Variability Measure (σ): To calculate σ^2_{Tn} for year T for country n, the following regression was first run for that country:

$$R_t = a_o + a_T t + e_t \quad \text{over} \quad t = T-14,\ldots,T,$$

then using the estimated value of $\hat{a}_T$, $\tilde{\sigma}^2_T$ was defined as:

$$\tilde{\sigma}^2_T = \sum_{t=T-14}^{T} (R_t - R_{t-1} - \hat{a}_T)^2/14$$

The variability measure -- σ -- was then defined as: $\sigma_T = \tilde{\sigma}_T/IM_T$, where IM are imports. For further details, see Bilson and Frenkel (1979).

Money: M1 as reported in IFS, converted into U.S. $ using average exchange rate.

Inflation: Computed as rate of change of CPI. The Price Indexes were taken from the IFS.

References

Anderson, Theodore W. and Cheng Hsiao, "Estimation of Dynamic Models with Error Components," Journal of the American Statistical Association, 76, (1981), 598-606.

Balestra, Pietro and Marc Nerlove, "Pooling Cross Section and Time Series Data in the Estimation of a Dynamic Model," Econometrica, 34, (1966), 585-612.

Bilson, John F.O. and Jacob Frenkel, "Dynamic Adjustment and the Demand for International Reserves," NBER Working Paper 403 (1979).

__________, "International Reserves: Adjustment Dynamics," Economic Letters, 4 (1979): 267-270.

Bird, Graham, The International Monetary System and the Less Developed Countries, London: MacMillan, 1978.

Clark, Peter B., "Optimum International Reserves and the Speed of Adjustment," Journal of Political Economy, 78 (1970a), 356-376.

__________, "Demand for International Reserves: A Cross-Country Analysis," Canadian Journal of Economics, 3, (1970), 577-594.

Clower, Robert W. and Richard Lipsey, "The Present State of International Liquidity Theory," American Economic Review, 58, (1968), 586-595.

Edwards, Sebastian, "A Note on the Dynamic Adjustment of the Demand for International Reserves by LDC's," Economic Letters, 5, (1980), 71-74.

__________, "The Demand for International Reserves and Exchange Rate Adjustments: The Case of LDC's, 1964-1972," Economica, 50 (1983), 269-280.

Frenkel, Jacob A., "The Demand for International Reserves by Developed and Less Developed Countries," Economica, 41 (1974), 14-24.

__________, "International Reserves: Pegged Exchange Rates and Managed Float," in K. Brunner and A.H. Meltzer, (Eds.), Economic Policies in Open Economies (North-Holland, 1978), 111-140.

__________, "International Liquidity and Monetary Control," unpublished paper, University of Chicago (March 1983).

__________, and Harry G. Johnson, The Monetary Approach to the Balance of Payments, Toronto: University of Toronto Press, 1976.

__________, and Boyan Jovanovic, "Optimal International Reserves: A Stochastic Framework," Economic Journal, 91 (1981), 507-14.

Genberg, Hans, "Aspects of the Monetary Approach to the Balance of Payments: An Empirical Study of Sweden," in J. Frenkel and H. Johnson (Eds.), The Monetary Approach to the Balance of Payments, Toronto: University of

Toronto Press, 1976.

Girton, Lance and Don Roper, "A Monetary Model of Exchange Rate Pressure Applied to the Post-War Canadian Experience," American Economic Review, 67 (September 1977), 537-48.

Gruebel, Herbert G., "The Demand for International Reserves: A Critical Review of the Literature," Journal of Economic Literature, 9 (December 1971), 1148-1166.

Harberger, Arnold C. and Sebastian Edwards, "Lessons of Experience Under Fixed Exchange Rates," in Mark Gersowitz, et al. (Eds.), The Theory and Experience of Economic Development (George Allen & Unwin, 1982).

Heller, H. Robert, "Optimal International Reserves," Economic Journal, 76 (June 1966), 296-311.

__________, and Mohsin S. Khan, "The Demand for International Reserves Under Fixed and Floating Exchange Rates," IMF Staff Papers, 25 (December 1978), 623-49.

Hipple, F. Steb, The Disturbances Approach to the Demand for International Reserves, Princeton Studies in International Finance No. 35, (Princeton, NJ, 1974).

__________, "A Note on the Measurement of the Holding Cost of International Reserves," Review of Economics and Statistics, 61 (November 1979): 612-14.

Iyoha, Milton A., "Demand for International Reserves by Less Developed Countries: A Distributed Lag Specification," Review of Economics and Statistics, 58 (August 1976), 351-55.

Kelly, Michael G., "The Demand for International Reserves," American Economic Review, 60 (September 1970), 655-667.

Kenen, Peter B. and Elionor B. Yudin, "The Demand for International Reserves," Review of Economics and Statistics, 47 (August 1965), 242-250.

Lau, Melanie, "The Simultaneous Determination of International Reserves and Domestic Credit When the Monetary Authorities have a Demand for International Reserves," Ph.D. Dissertation, University of Chicago, 1980.

Levy, Victor, "Demand for International Reserves and Exchange Rate Intervention Policy in an Adjustable-Peg Economy," Journal of Monetary Economics, 11, 1 (January 1983), 89-101.

Machlup, Fritz, "Further Reflections on the Demand for International Reserves," in his International Payments, Debts and Gold (2nd ed.), New York: New York University Press, 1976, 260-277.

Nerlove, Marc, "Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross-Sections," Econometrica, 39 (March 1971), 359-82.

Saidi, Nasser, "The Square Root Law, Uncertainty and International Reserves Under Alternative Regimes: Canadian Experience, 1950-1976," Journal of Monetary Economics, 7 (1981), 271-283.

Shinkai, Yoichi, "Demand for International Reserves in Less Developed Countries: Comment," Review of Economics and Statistics, 61 (November 1979): 614-15.

von Furstenberg, George M., "New Evidence of the Demand for Non-Gold Reserves Under Floating Exchange Rates," Journal of International Money and Finance, 1 (1982), 81-93.

Williamson, John, "International Liquidity: A Survey," Economic Journal, 83 (1973), 685-746.