NOTE 2. THE DEMAND FOR INTERNATIONAL RESERVES—A REVIEW OF THE LITERATURE

4. Most studies have concluded that the demand for international reserves can be explained as a relatively stable long-run function of a few variables. This conclusion appears to have held despite estimated structural shifts in the demand for reserves associated with the collapse of the Bretton Woods regime in the early 1970s and the debt crisis in the early 1980s. Much of this work dates back to the 1970s and 1980s, however, and relatively little has been done in recent years. Accordingly, it is unclear to what extent reserve holding behavior may have changed in response to the broad-based shift to more flexible exchange rate regimes, the increasing importance for emerging market economies of borrowing on international capital markets, and the periodic exchange market crises of the 1990s.

Early work

5. Early empirical work focussed on establishing rough proportions between reserves and other broad economic aggregates.[3] For example, Harrod (1953) and IMF (1958) assumed a direct functional relationship between reserves and the level of imports, or more generally between the demand for reserves and the total volume of international transactions. Harrod (1961) concluded that the stock of international reserves was inadequate by pointing to a sharp secular decline in the reserves-import ratio. Triffin (1960) argued, also based on the assumption of proportionality between reserves and the volume of trade, that the demand for reserves would grow faster than the supply unless the United States ran a deficit that would ultimately undermine confidence in the dollar. One critic of this approach was Machlup (1966), who questioned the existence of any relationship between reserve demand and a set of identifiable variables. At a theoretical level, Olivera (1969) argued that the demand for reserves should be a function of the variance of annual changes in the level of imports, implying that the demand for reserves would have an elasticity of 0.5 with respect to the volume of transactions.

Optimizing approach to the demand for reserves

6. Heller (1966) was first to derive the optimal level of reserves from a cost-benefit approach. He stressed the precautionary motive for holding international reserves, rather than the transactions motive that had at least implicitly lain behind much of the earlier work. The benefit from holding reserves stemmed from the ability to avoid a reduction in output in cases of a balance of payments deficit. This benefit needed to be balanced against the cost of holding liquid international reserves. While the empirical specification of Heller's model was relatively crude, his framework of presenting the demand for reserves as a rational optimizing decision process formed the basis for much of the work that was to follow. Heller

---

[3] Among several early literature surveys are Niehans (1970), Grubel (1971), Williamson (1973), and Claasen (1974). See references below.

identified three parameters determining the demand for reserves: (i) the cost of adjusting to an external imbalance; (ii) the opportunity cost of holding reserves; and (iii) the probability that a need for reserves of a given magnitude would arise. He hypothesized that the cost of adjustment was inversely related to the marginal propensity to import, on the grounds that, the higher was the propensity to import, the smaller would be the required compression of aggregate expenditure. The opportunity cost was defined as the difference between the social rate of return on capital and the average yield on liquid reserves. Reflecting measurement difficulties, this cost was assumed to be the same (5 percent) for all countries. The probability of a reserve need was given by the variability of external payments, which Heller estimated using the mean absolute first difference of historical trend-adjusted annual reserves. This probability was viewed as independent of the actual level of reserves.[4]

7. Kelly (1970) modeled optimal reserves for a government seeking to maximize utility subject to the trade-off between the opportunity cost of holding reserves on the one hand, and the output variability associated with exogenous shocks that could be neutralized by reserve changes on the other. Using data for 46 countries over the period 1953–65, he tested a model employing the standard deviation of exports as a proxy for payments variability, and the average propensity to import as an indicator of the degree of output fluctuation needed to restore external balance in response to an export shock (with the adjustment coming through imports). Two proxies were used for the opportunity cost of holding reserves: per capita income, on the grounds that poorer countries had a greater need for capital and therefore a higher opportunity cost; and net foreign indebtedness, as an indicator of past capital scarcity. The results for both pooled and cross-sectional data suggested that reserve holdings could be explained as a relatively stable function of the variables chosen, with export variability appearing as the main determinant. However, for the propensity to import and per capita income variables, different signs were obtained depending on whether the regressions were run for the whole sample or for specific country groupings or annual cross-sectional data, while the sign on the net foreign liability variable did not fit the assumed model.

8. Both Heller and Kelly assumed a negative relationship between reserves and the marginal propensity to import on theoretical grounds. In practice, however, these and subsequent empirical studies have typically used the average propensity to import (M/Y), either as a proxy for the marginal propensity or as an explanatory variable in its own right. The expected sign of the average propensity to import is ambiguous. To the extent that it is viewed as a proxy for the marginal propensity to import, the assumed negative relationship with reserves reflects a presumption that adjustment to external disequilibrium takes place primarily through output compression, rather than expenditure-switching (Williamson, 1973). To the extent that it reflects an economy's openness, and therefore its vulnerability to external shocks, on the other hand, a positive relationship with reserve demand might be

[4] Later work by Clark (1970a), and Frenkel and Jovanovic (1981) linked the probability of reserve depletion explicitly to the level of reserves.

expected (Cooper (1968)). Similarly, Frenkel (1974a) developed a theoretical price-adjustment model under which the effect of openness on reserve holdings was positive for plausible values of the elasticity of money demand.

9. Frenkel (1974b) tested the hypothesis of a positive relationship between reserves and openness for a group of 55 countries covering the period 1963–67. In addition to the propensity to import, Frenkel included as explanatory variables a measure of external variability, and the level of imports as a scale variable. Based on cross-sectional estimates, he found evidence of a stable demand function, where reserve holdings were positively related to the variability of international receipts and payments, the volume of imports, and the relative size of the foreign trade sector. He also found evidence that the behavior of the developed countries differed significantly from that of the developing countries, with external variability appearing more important for the developed countries, and the scale variable more important for the developing countries.

10. Heller and Khan (1978) extended this work to examine the stability of the reserve demand function for six different country groups. Their database covered the period 1964–76, enabling them to assess the impact on reserve demand of the move to more flexible exchange rates following the collapse of the Bretton Woods system in 1973. The specification of the reserve demand function included the same three variables used by Frenkel, though a two-step procedure was used to calculate the measure of external variability. They concluded that, for industrial countries, there was a downward shift in the demand for reserves following the shift to a floating rate system, whereas for the non-oil developing countries the demand for reserves appeared if anything to have increased.[5] They attributed the latter finding to the fact that most developing countries maintained pegged exchange rate regimes following the collapse of Bretton Woods, and that, for these countries, overall uncertainty and payments variability had increased. They also found preliminary evidence that, after the structural change in 1973, the function explaining reserve behavior remained stable for both industrial and developing countries in the subsequent period of managed floating. The parameter estimates varied significantly across country groups but generally pointed to an elasticity of reserves with respect to imports of somewhat less than unity and a significant negative coefficient on the measure of openness (in contrast to Frenkel). The variability measure had a higher weight for the industrial countries than for the developing countries.

Disequilibrium models of the demand for reserves

11. The above-mentioned studies generally assumed that actual reserve holdings adjusted to desired holdings during the observation period, such that reserve demand was constantly in equilibrium. Other studies allowed explicitly for a gradual adjustment of actual to desired

[5] The timing of the structural break for the developing countries preceded the collapse of Bretton Woods, and was attributed to the commodity price boom in 1972–73.

reserve holdings, based on stock adjustment models.[6] While these studies yielded differing results as regards the speed of adjustment to equilibrium, they generally followed a standard specification of the determinants of the demand for reserves and confirmed the results of the equilibrium models regarding the existence of a stable long-run demand function.

12. Early empirical work on this subject (see, for example, Clark (1970b) and Iyoha (1976)) generally found that the speed of adjustment was very slow, raising questions about the usefulness of the optimizing approach to the demand for reserves. However, Bilson and Frenkel (1979a and 1979b) developed a two-stage process under which the long-run demand for reserves was estimated based on an average of cross-sectional data (where the explanatory variables were assumed to be the same as in the earlier studies referred to above), and the resulting desired reserve stocks were used to estimate a stock adjustment equation. The model was estimated for 22 developed countries and 32 developing countries covering the period 1964–72. They found evidence of a quite rapid adjustment of actual to desired holdings (40–50 percent of the divergence being made up within a year), with developed countries generally adjusting more rapidly than developing countries.[7] They also found evidence for developed countries that the speed of adjustment was more rapid for reserve deficiencies than for excess reserves, and for developing countries that the speed of adjustment was positively related to the absolute size of the divergence between actual and desired reserves. There was tentative evidence for developing countries that the speed of adjustment had increased following the shift to a managed floating rate regime.

13. Frenkel (1983) extended this work to allow for the effects of domestic monetary disequilibrium on the stock adjustment process for reserves. Based on estimates for a group of 22 developed countries, he found that actual changes in reserves were influenced by both the central bank's excess demand for reserves and the private sector's excess demand for money.[8] He also found that speeds of adjustment to disequilibrium reserve holdings were relatively high, and appeared to have increased following the change in exchange rate regime. Frenkel also re-estimated a conventional long-run demand for reserves function for a group of 22 developed countries covering the period 1963–79 and 32 developing countries for the period 1963–77, confirming earlier findings of a stable reserve demand function though with some evidence that the demand for reserves had declined following the move to

---

[6] Clark (1970a) developed a theoretical model of the optimal trade-off between the level of reserves and the speed of adjustment, under which the cost of holding reserves increases with the stock of reserves, and the cost of adjustment increases with the speed of adjustment.

[7] Based on data for 32 developing countries, Edwards (1980) found evidence that the speed of adjustment may be even higher, virtually all taking place within one year.

[8] Edwards (1984) also sought to integrate the demand for reserves with the monetary approach to the balance of payments, arguing that actual reserve changes were a function of both discrepancies between actual and desired reserves and domestic monetary disequilibria.

a more flexible rate regime. He also found that developed countries' demand for reserves differed significantly from that of developing countries, and that the behavior of developed countries underwent a more drastic change after 1972 than that of developing countries.

14. In order to assess whether the general finding of a relatively stable demand for reserves had been affected by the debt crisis in the early 1980s, Lizondo and Mathieson (1987) re-estimated a representative sample of models from previous studies[9] and extended the data period covered to 1984. For the period 1963–79, they confirmed the findings of earlier studies using equilibrium models that, apart from some evidence of instability or structural shifts in reserve demand associated with the move to greater exchange rate flexibility in the early 1970s, this demand had been a relatively stable function of a scale variable, the average propensity to import, and the variability of external payments. Their re-estimates of earlier disequilibrium models also generally confirmed the original results that there had been a structural change in the stock adjustment processes for reserve accumulation during the 1972–73 period for developed countries.

15. When they extended the data period, Lizondo and Mathieson found that the financial market disturbances of the early 1980s had resulted in changes in the structure of the demand for reserves of comparable magnitude to those that accompanied the collapse of the Bretton Woods system. Specifically, the average demand for reserves for both developed and developing countries was estimated to have fallen by about 30 percent. Sensitivity of the demand for reserves to payments imbalances appeared to have increased; sensitivity to openness had increased for developing countries but declined for developed countries; and the long run income or scale elasticity remained close to one. Although they did not model the effects of changes in access to international capital markets explicitly, Lizondo and Mathieson hypothesized that, for the developing countries, the decline may have reflected the sharp curtailment (and higher implicit cost) of access to market financing, whereas for the developed countries, the more likely explanation was the growing importance of borrowing from international capital markets, which permitted countries to economize on their gross reserve holdings.

The opportunity cost of reserve holdings

16. The opportunity cost of holding reserves has generally been recognized as a potentially important determinant of the demand for reserves. However, early studies failed to find a significant coefficient for this variable, and subsequent studies (including most of those referred to above) generally excluded it from their estimation. To address this deficiency, Frenkel and Jovanovic (1981) developed a stochastic model of the optimal stock of reserves that included the forgone earnings on reserve holdings (proxied by the

[9] Results were estimated using two examples of equilibrium models (Heller and Khan (1978) and Frenkel (1983)), and two examples of disequilibrium models (Bilson and Frenkel (1979a) and Frenkel (1983)).

government bond yield) as one of the determinants. They tested the model using pooled cross-section and time series data for 22 developed countries covering the period 1971–75, and obtained a negative coefficient for the interest rate variable, in line with the predictions of the model.

17. Edwards (1985) argued that the appropriate measure of the opportunity cost of reserves is the net cost, given by the gross foregone income minus the return obtained from holding reserves. Using the spread of a country's borrowing cost over LIBOR to approximate this net cost of reserves, he obtained a significant negative regression coefficient on the net cost variable for a group of 17 developing countries based on data for 1976–80. Landell-Mills (1989) extended this work using data for 1978–86 for three country groups—non-reserve-center industrial countries, developing countries that did not develop debt-servicing problems after 1982, and developing countries that did encounter subsequent debt-servicing problems. For the full sample, she found that the demand for reserves was positively related to the scale variable, and negatively related to the propensity to import and the opportunity cost of holding reserves (the external variability measure yielded mixed results). However, when the regression was run for the three country groups separately, the opportunity cost measure was significant only for the group of countries with subsequent debt-servicing difficulties.[10]

18. Ben-Bassat and Gottlieb (1992a) argued that the insignificant results obtained by many studies for the opportunity cost variable had stemmed from a failure to measure it in accordance with its theoretical foundations, i.e., as the difference between the yield on reserves and the marginal productivity foregone from an alternative investment in fixed capital. They argued that capital productivity generally exceeds borrowing costs (owing to market imperfections, asset risk and, mainly, because of controls on international capital movements), such that the use of the cost of external borrowing as a proxy would tend to bias the opportunity cost estimate downward. They found significant results in a model estimated for Israel, where the opportunity cost of reserve holding was proxied by the difference between the yield on reserves (a weighted average of returns on dollar and deutsche mark deposits) and the rate of return on capital, calculated as the ratio of business profits to gross capital stock (the criterion rate of return for public works contracts was substituted during periods of economic slowdown). In a second paper (Ben-Bassat and Gottlieb (1992b)), they introduced the notion of sovereign risk into the considerations for precautionary reserve demand, whereby the cost and probability of reserve depletion may be viewed as equivalent to the cost and probability of default on external debt. Specifically, they estimated a model of optimal reserves for Israel as a function of the output loss from external default (based on the experience of 13 countries that defaulted between 1960–82), several variables that affect the

[10] For the latter group, credit was rationed after 1982 and therefore no market rate for new borrowings was available. Accordingly, the results reflected data from 1978–82.

probability of default, and the opportunity cost of holding reserves. They obtained satisfactory results, which, they argued, explained reserve demand better than conventional models.

Reserve demand and the exchange rate

19. As discussed, most empirical studies have found that, contrary to earlier expectations, the move to greater exchange rate flexibility following the collapse of Bretton Woods does not appear to have led to a fundamental change in the pattern of reserve holding behavior. Frenkel (1983) argued that the observed stability in reserve demand across regimes may reflect the fact that the "fixed" exchange rate period was largely characterized by "adjustable peg" regimes while "floating exchange rates" had in fact been "managed rates." Relatively few empirical studies have explicitly sought to examine the effect of different exchange rate behavior on the demand for reserves. Edwards (1983) found using data from the Bretton Woods period that developing countries that had occasionally used devaluation as a means of correcting payments imbalances appeared to have a lower demand of reserves than countries that had maintained a fixed rate for long periods. Bahmani-Oskooee and Malixi (1987) included a measure of exchange rate variability into a conventional reserve demand function and obtained a significant negative coefficient for a sample of 13 developed countries covering the period 1976–85.[11] However, more work would seem to be needed to assess what effect, if any, the shift to more flexible exchange rate arrangements since the early 1980s has had on reserve holding behavior. In a theoretical paper on this subject, Grimes (1993) develops a model of central bank reserve holding behavior under a floating rate regime. He argues that the empirical observation that behavior has not changed significantly with flexible rates may indicate either that the opportunity cost of holding reserves is negligible or, more plausibly, that central banks are extremely risk averse regarding reserve shortfalls.

Concluding remarks

20. The demand for international reserves has been the subject of considerable theoretical and empirical work, though much of it dates back to the 1970s and 1980s and relatively little cross-country work has been done in recent years.[12] In general, this work has concluded that it is possible to identify a relatively stable long-run demand for reserves function, based on a

[11] In a subsequent paper (Bahmani-Oskooee and Malixi (1988)), they found similar results for 28 developing countries, though the negative coefficient on the exchange rate variable was smaller than for the developed countries.

[12] Two more recent studies are Lehto (1994), who tested a model for 56 countries using data for 1974–91, and Islam, Khan and Islam (1994), who estimated the demand for reserves for three Central American countries covering the period 1960–89.

small number of variables. This conclusion has held despite estimated structural shifts in the demand for reserves associated with the collapse of the Bretton Woods regime in the early 1970s and the debt crisis in the early 1980s.

21. Most studies have followed a fairly standard specification of the determinants of the demand for reserves. Reserve holdings appear to be positively related to a scale variable (either aggregate output or imports) and to external payments variability. The ratio of imports to output has also typically been included as an explanatory variable and found to be significant, though the sign of the coefficient is ambiguous both from a theoretical standpoint, and in terms of the empirical results. The opportunity cost of reserves has also been identified as an important theoretical determinant of reserve holding, but difficulties in obtaining a satisfactory measure have restricted its use in past empirical work. However, some studies that have specifically focussed on this variable have obtained significant coefficients with the expected sign. Empirical studies that have differentiated between country groups have generally identified significant differences in reserve-holding behavior, for example between industrial and developing countries, suggesting that it is necessary to go beyond highly aggregated data to obtain meaningful results.

22. In the absence of more recent cross-country studies, it is difficult to know whether the broad findings of this earlier work still hold. A cursory look at trends in the ratio of reserves to imports (see attached figure) suggests that, in the aggregate, the level of global reserves has continued to grow broadly in line with the volume of international trade, with some evidence of an upward trend in the reserve to import ratio among the developing countries over the past decade. However, reserve holding behavior appears to have diverged significantly across countries and country groups. Whether earlier models can do an adequate job of capturing this diversity of behavior is unclear. Attempts to update earlier work also need to take account of the substantial changes in exchange rate regimes that have taken place in recent years, increased capital market integration, and the growing importance of access to private market financing for many developing countries.[13] The impact of recent exchange market crises on reserve-holding behavior is also a topic for further study.

---

[13] For example, Huang (1995) notes that traditional inventory models of reserve holding do not allow for the potential role of international reserves as an indicator of creditworthiness. Eichengreen and Frankel (1996) argue that there can be no presumption that the advent of capital mobility either raises or lowers the demand for reserves.

References

Bahmani-Oskooee, M. and M. Malixi, 1987, "Effects of Exchange Rate Flexibility on the Demand for International Reserves," *Economic Letters,* Vol. 23, pp. 89–93.

Bahmani-Oskooee, M. and M. Malixi, 1988, "Exchange Rate Flexibility and the LDCs Demand for International Reserves," *Journal of Quantitative Economics,* Vol. 4 No. 2 (July), pp. 317–28.

Ben-Bassat, A. and D. Gottlieb, 1992a, "On the Effect of Opportunity Cost on International Reserve Holdings, *The Review of Economics and Statistics,* Vol. 74, No. 2 (May), pp.329–32.

Ben-Bassat, A. and D. Gottlieb, 1992b, "Optimal International Reserves and Sovereign Risk," *Journal of International Economics,* Vol. 33 (November), pp. 345–62.

Bilson, J. F. O., and J. A. Frenkel, 1979a, "International Reserves: Adjustment Dynamics," *Economic Letters,* Vol. 4 (June), pp. 267–70.

Bilson, J. F. O., and J. A. Frenkel, 1979b, "Dynamic Adjustment and the Demand for International Reserves," *National Bureau of Economic Research,* Working Paper No. 407 (November).

Claassen, E. M., 1974, "The Optimizing Approach to the Demand for International Reserves," *Weltwirtschaftliches Archiv,* No. 3, pp. 353–98.

Claassen, E. M., 1975, "Demand for International Reserves and the Optimum Mix and Speed of Adjustment Policies," *American Economic Review,* Vol. 65 (June), pp. 446–53.

Clark, P. B., 1970a, "Optimum International Reserves and the Speed of Adjustment," *Journal of Political Economy,* Vol. 78 (April), pp. 356–76.

Clark, P. B., 1970b, "Demand for International Reserves: A Cross-Country Analysis," *Canadian Journal of Economics,* Vol. 3 (November), pp. 577–94.

Cohen, B. J., 1975, "International Reserves and Liquidity: A Survey," in Peter B. Kenen, ed., *International Trade and Finance* (Cambridge, England: Cambridge University Press).

Cooper, R. N., 1968, "The Relevance of International Liquidity to Developed Countries," *American Economic Review* (May).

Edwards, S., 1980, "A Note on the Dynamic Adjustment of the Demand for International Reserves by LDCs," *Economic Letters,* Vol. 5, No. 1, pp. 71–74.

Edwards, S., 1983, "The Demand for International Reserves and Exchange Rate Adjustments: The Case of LDCs, 1964–72," *Economica,* Vol. 50, No. 199 (August), pp. 269–80.

Edwards, S., 1984, "The Demand for International Reserves and Monetary Equilibrium: Some Evidence from Developing Countries," *The Review of Economics and Statistics,* Vol. 66 (August), pp. 495–500.

Edwards, S., 1985, "On the Interest-Rate Elasticity of the Demand for International Reserves: Some Evidence from Developing Countries," *Journal of International Money and Finance,* Vol. 4 (June), pp. 287–95.

Eichengreen, B. and J. A. Frankel, 1996, "Implications of the Future Evolution of the International Monetary System," in *The Future of the SDR in Light of Changes in the International Financial System,* (International Monetary Fund: Washington, D.C.)

Frenkel, J. A., 1974a, "Openness and the Demand for International Reserves," in National Monetary Policies and the International Financial System, ed., by Robert Z. Aliber (Chicago: University of Chicago Press, 1974) pp. 289–98.

Frenkel, J. A., 1974b, "The Demand for International Reserves by Developed and Less Developed Countries," *Economica,* Vol. 41 (February), pp. 14–24.

Frenkel, J. A., and C. S. Hakkio, 1980, "Country –Specific and Time-Specific Factors in the Demand by International Reserves," *Economic Letters,* Vol. 5, No. 1, pp. 75–80.

Frenkel, J. A., and B. Jovanovic, 1981, "Optimal International Reserves: A Stochastic Framework," *Economic Journal,* Vol. 91, pp. 507–14.

Frenkel, J. A., 1983, "International Liquidity and Monetary Control," in George M. von Fursetenberg, ed., *International Money and Credit* (Washington, D.C.: International Monetary Fund).

Grimes, A., 1993, "International Reserves under Floating Exchange Rates: Two Paradoxes Explained," *The Economic Record,* Vol. 69, No. 207 (December), pp. 411–15.

Grubel, H., 1971, "The Demand for International Reserves: A Critical Review of the Literature," *Journal of Economic Literature,* Vol. 9 (December), pp. 1148–66.

Harrod, R. F., 1953, "Imbalance of International Payments," IMF *Staff Papers,* Vol. 3.

Harrod, R. F., 1961, "Alternative Methods for Increasing International Liquidity," *European League for Economic Co-operation,* Brussels.

Heller, H. R., 1966, "Optimal International Reserves," *Economic Journal,* Vol. 76 (June), pp. 296-311.

Heller, H. R., and M. S. Khan, 1978, "The Demand for International Reserves Under Fixed and Floating Exchange Rates," IMF *Staff Papers,* Vol. 25 (December), pp. 623–49.

Hipple, F. S., 1974, "The Disturbances Approach to the Demand for International Reserves," *Princeton Studies in International Finance,* No. 35 (May).

Huang, G. 1995, "Modelling China's Demand for International Reserves," *Applied Financial Economics,* Vol. 5, No. 5 (October), pp. 357–66.

International Monetary Fund, 1958, "International Reserves and Liquidity ," (Washington, D.C.: International Monetary Fund).

International Monetary Fund, 1970, International Reserves Needs and Availability, (Washington, D.C.: International Monetary Fund).

Islam, A. M., M. Khan, and M. M. Islam, 1994, "An Empirical Test of the Demand for International Reserves," in Dilip K. Ghosh and Edgar Ortiz, eds., *The Changing Environment of International Financial Markets* (St. Martins Press: New York).

Iyoha, M. A., 1976, "Demand for International Reserves in Less Developed Countries: A Distributed Lag Specification," *The Review of Economic and Statistics,* Vol. 60 (August), pp. 351–55.

Kelly, M. G., 1970, "The Demand for International Reserves," *American Economic Review,* Vol. 60 (September), pp. 655–67.

Kenen, P. B. and E. B. Yudkin, 1965, "The Demand for International Reserves," *The Review of Economics and Statistics,* Vol. 47 (August), pp. 242–50.

Landell-Mills, J. M., 1989, "The Demand for International Reserves and Their Opportunity Cost," IMF *Staff Papers,* Vol. 36 (September), No. 3, pp. 708–32.

Letho, T., 1994, "The Level of a Central Bank's International Reserves: Theory and Cross-Country Analysis," *Bank of Finland Discussion Papers 15/94.*

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

Lizondo, J. S. and D. J. Mathieson, 1987, "The Stability of the Demand for International Reserves, *Journal of International Money and Finance,* Vol. 6 (September), pp. 251–282.

Machlup, F., 1966, "The Need for Monetary Reserves," *Banca Nazionale del Lavoro Quarterly Review* (September).

Makin, J. H., 1974, "Exchange Rate Flexibility and the Demand for International Reserves," *Weltwirtschaftliches Archiv,* Vol. 110, No. 2, pp. 229–43.

Olivera, J. H. G., 1969, "A Note on the Optimal Rate of Growth of International Reserves," *Journal of Political Economy* (March).

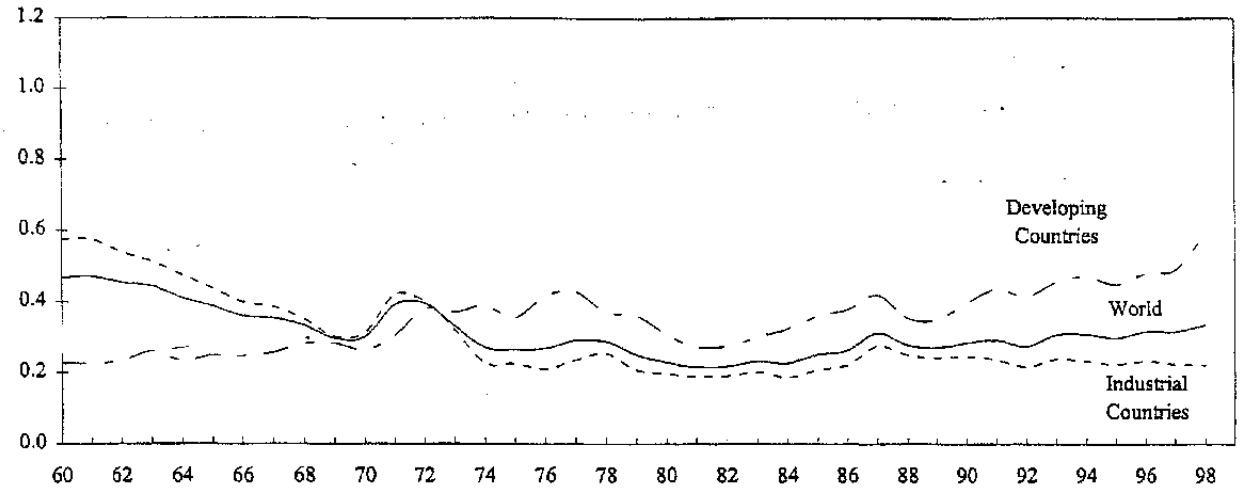
Saidi, N., 1981, "The Square Root Law, Uncertainty and International Reserves Under Alternative Regimes: Canadian Experience," *Journal of Monetary Economics,* Vol. 7 (May), pp. 271–90.

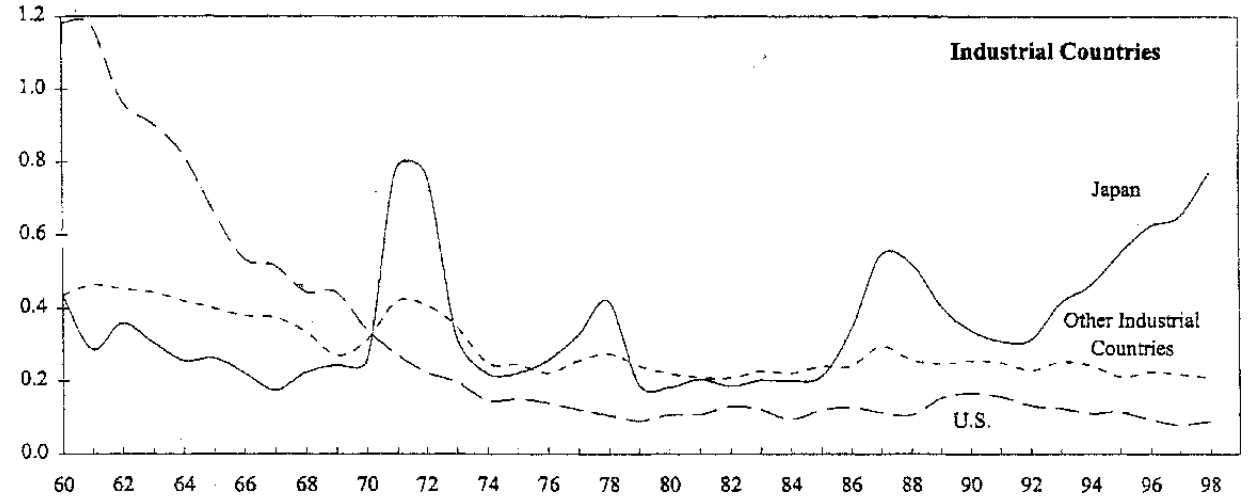
Triffin, R., 1960, "Gold and the Dollar Crisis," (Yale University Press: New Haven).

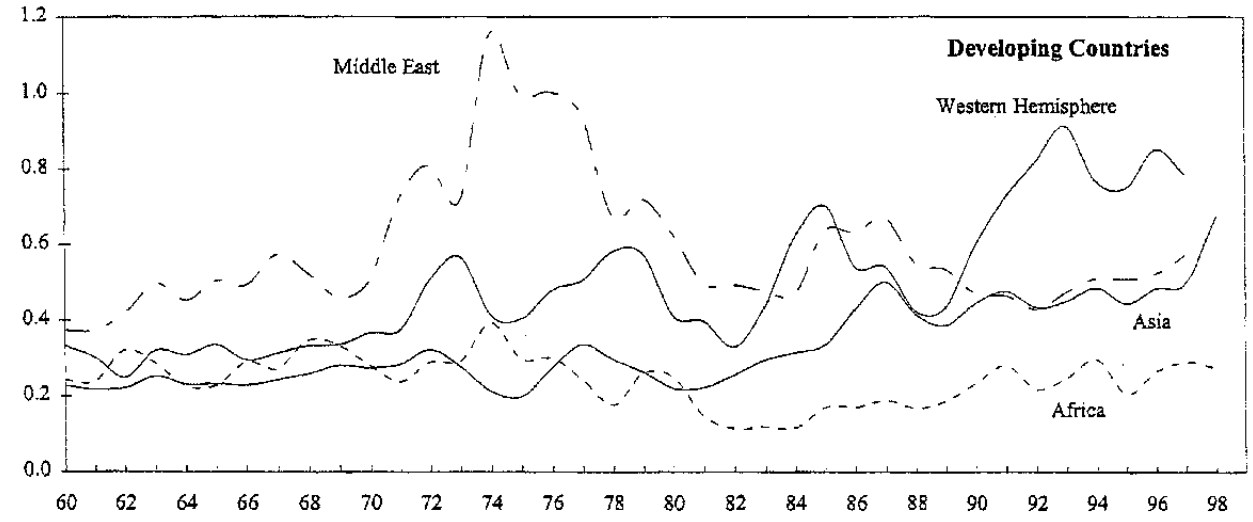
Von Furstenberg, G. M., 1982, "New Estimates of the Demand for Non-Gold Reserves Under Floating Exchange Rates," *Journal of International Money and Finance,* Vol. 1 (April), pp. 81–95.

Williamson, J., 1973, "International Liquidity : A Survey," *Economic Journal,* Vol. 83 (September), pp. 685–746.

Figure 2.1 Total Reserves to Imports Ratios 1/
1960 to 1998







Source: International Financial Statistics.

1/ Both total reserves and imports are in U.S. dollars.