Foreign Reserve Holding Behavior of Korea

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I. Introduction

In the last decade, many theoretical and empirical studies have been made on foreign or international reserves under a pegging foreign exchange rate system: Kenen and Yudin (1965), Heller (1966), Courchene and Youssef (1967), Clark (1970), Flanders (1971), Frenkel (1974) and Iyoha (1976), to name a few. One of the common characteristics of these empirical studies is that all of them have attempted to explain the variability of foreign reserve holdings of a country or of a group of countries with the *demand* relationship of foreign reserves, without any exception. The quarterly or annual data used for empirical estimations are the results of interactions between the demand for and the supply of foreign reserves; nevertheless, all of the estimated equations of foreign reserves are interpreted as the demand function of foreign reserves.

Another common characteristic is an implicit or explicit application of the monetary theory, especially the theory of the demand for money. Most of them have based their theoretical underpinnings on the quantity theory of money or the theory of the transaction demand for money such as Baumol (1952) and Tobin (1956), where imports are mostly taken as a proxy variable for the volume of transaction.

It does not look like pure coincidence that the theory of foreign reserves stress only the demand side, excluding the supply side almost completely, just like a theory of money emphasizes only the demand for money. In the theory of money, the reason the demand side is stressed ignoring the supply side is due to the assumption of the exogeneity of the money supply, but in the theory of foreign reserves, no explicit reason has been given for emphasizing only the demand side and ignoring the supply side.

To interpret the estimated equation as the demand function for

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foreign reserves, we need to isolate a demand curve. Courchene and Youssef (1967) point out that the interpretation of the estimated equation as the demand function requires "the more stringent assumption that the demand for reserves is *stable* and that countries are always on their demand functions."[1] It implies that countries fully satisfy their desires for foreign reserves. On *a priori* grounds, it cannot be said whether or not the variability of the demand for foreign reserves is less than that of the supply.

Besides the stability of function, whether the estimated equation can be interpreted as the demand function or the supply function depends on whether or not a country can satisfy its desired demand or desired supply of foreign reserves. Let us then take a look at the ability of a country to satisfy its desired demand or supply of foreign reserves.

To judge that ability, let place the countries in two groups: the more developed countries and the less developed countries. We believe that there may be a difference in the behavior of the two groups of countries as related to their ability to meet their desired levels of foreign reserves.

The more developed countries have better access to the international short-term capital market and their exportables are generally price- and income-elastic. This implies that the governments of more developed countries can easily satisfy the gap between the excess desired demand over the supply of foreign reserves either by borrowing from the international short-term capital market or through monetary and fiscal policies which reduce the prices of the exportables. The assumption, which most of the empirical studies have made implicitly or explicitly that the countries satisfy their desired demand level, seems therefore, to be appropriate and realistic in the more developed countries.

The less developed countries, however, may not be able to satisfy their desired demand for foreign reserves due to their limited access to the international short-term capital market and the generally low price- and income-elasticity of their exportables. Moreover, in the case of Korea, the central bank plays the market clearing role in the foreign exchange market by law and government regulations, which ban holdings of foreign reserves by the non-bank public sector and the non-licensed banking sector. This indicates that the non-bank public must sell (supply) its foreign reserves to the market whenever they are earned either through export or borrowing from abroad, and the central bank must purchase (demand for) them at the pegged exchange rate.

1 Courchene and Youssef (1967), p. 409.

In these circumstances, the suppliers can satisfy their desired supply level of foreign reserves, i.e. they can sell foreign exchange as much as they desire. The actual level of foreign reservs will be equal to the desired supply level. We believe, therefore, that the foreign reserve holding behavior in the less developed country such as Korea should be better explained by the *supply* relationship of foreign reserves, rather than the demand relationship. Thus in this study we have attempted to explain foreign reserve holdings of Korea by its supply relationship. In other words, we wish to explain the variability of foreign reserves held by the Korean Government with the explanatory variables related to the supply of foreign reserves such as exports, imports and foreign capital borrowing.

II. The Model and its Estimation

In the market for foreign exchange, suppliers or net suppliers to be exact are exporters, importers and borrowers of foreign capital. We assume that the supply of foreign reserves is stable and suppliers satisfy their desired level of the supply, indicating that they can sell all the foreign exchange they want to provide. We believe that this assumption is realistic in the less developed countries such as Korea, although we cannot tell for certain whether the assumption is perfectly satisfied or not. Therefore, to the extent that this assumption is not satisfied, our empirically estimated equations cannot be interpreted as the "pure" supply function of foreign reserves, and the conclusion based on the equation should be qualified accordingly.

In some empirical studies. the actual and the desired levels of of foreign reserves are not differentiated [for example, see Kenen and Yudin (1965), Courchene and Youssef (1967)], while others explicitly distinguish these two, indicating an adjustment with a lag [for example, see Clark (1970) and Iyoha (1976)].

Generally, it cannot be told *a priori* whether the actual levels of foreign reserves may adjust to the desired levels with or without a lag; however, in Korea the exporters and foreign capital borrowers are required by law to supply (sell) promptly all the foreign reserves they have earned. It means that there is no room for adjustment between the actual levels and the desired levels of the supply. The actual levels of the supply must be equal to its desired — even though "forced" by law in a real sense — levels. Due to this special institutional characteristic, we are going to assume away the possibility of a partial adjustment.

Now let us assume that the *flow* supply of foreign reserves are functions of exports (X), imports (M) and foreign capital borrowing (F).

(1) $\triangle R_s = R_s(X, M, F)$,

where $(\partial \triangle R_s / \partial X) > 0$; $(\partial \triangle R_s / \partial M) < 0$;

and $(\partial \triangle R_s / \partial F) > 0$, and $\triangle R_s$ = Flow supply of foreign reserves.

The signs of the partial derivatives indicate the theoretical direction of the influence of the explanatory variables. Since exports and foreign borrowing, *ceteris paribus,* increase the supply of foreign reserves, they are assumed to be positively related to the supply of foreign reserves. Since imports reduce the supply of foreign reserves, it is assumed to be negatively related to the supply. This assumed negative relationship between foreign reserve holdings and imports is noteworthy because of the hypothesized and extensively tested positive relationship between the two variables in other empirical studies. We will cover this point further subsequently.

Assuming a stochastic linear relationship between $\triangle R_s$ and its arguments, we may rewrite (1) as follows:

(2) $$\triangle R_s = a_o + a_1 X - a_2 M + a_3 F + e,$$

where "e" denotes a random term. Relation (2) gives a stochastic flow supply equation of foreign reserves to be estimated.

All the data for the estimation are taken from *Economic Statistics Yearbook* of the Bank of Korea. Exports are compiled on f.o.b. and imports, c.i.f. basis. Foreign capital borrowing is expressed in net terms. Fitting equation (2) to the annual data from 1960 to 1975 by utilizing the ordinary least squares estimating method, the estimated flow supply function of foreign reserves has come out as:

(3)
$$\triangle R_s = \underset{(3.25)}{\$7.04} + \underset{(5.81)}{.439X} - \underset{(-5.76)}{.386M} + \underset{(5.49)}{.649F},$$

$R^2 = .8602$

$DW = .9764$

In equation (3), the t-values are given in parenthesis under each coefficient. First, a brief examination of the estimated equation shows a relatively good fit, considering that we are dealing with the flow, not the stock, of foreign reserves. The adjusted coefficient of determination exceeds .86 indicating that the estimated equation explains over 86% of the variations in the reserve supply behavior of the Korean economy. The coefficient of the three explanatory variables shows the theoretically expected sign specified in equation (1). All of the

explanatory variables pass the t-test at the 1% level.

The Durbin-Watson statistic in equation (3) is .9764 which remains within the indeterminate range to tell a possible existence of autocorrelation. We have estimated the same equation again by using the Cochrane-Orcutt's Iterative estimating technique. The result is shown as follows:

(4)

$$\triangle R_s = \underset{(.805)}{61.56} + \underset{(.946)}{.521X} - \underset{(-10.89)}{.444M} + \underset{(7.78)}{.737F}.$$

$$R^2 = .9139$$
$$DW = 1.207$$

All the coefficients bear the expected signs and the t-values show that they are significant at the 1% level. There is a substantial increase in the goodness of fit from .8602 to .9139. The absolute magnitude of the coefficients of the explanatory variables is slightly increased.

The influence of the explanatory variables to the dependent variable can be measured by computing their elasticity. We have calculated them based in the mean values of R_s, X, M and F. The outcomes are as follows: exports, 5.85; imports, -8.25 and foreign borrowing, 2.28. However, the magnitudes can be misleading due to wide fluctuations of the dependent variable.

In equation (3) and (4), we have regressed the *flow* supply of foreign reserves. Now we have regressed the *stock* supply equation of foreign reserve holdings specified as follows.

(5)

$$R_s = b_0 + b_1X - b_2M + b_3F + b_4R_{-1} + e,$$

where R_s denotes the stock of foreign reserves held at the end of the current year and R_{-1}, the stock of foreign reserves held at the end of the previous period. The estsimated results are shown as follows.

(6)

$$R_s = \underset{(5.35)}{160.7} + \underset{(7.12)}{.410X} - \underset{(-4.83)}{.286M} + \underset{(7.93)}{.740F} + \underset{(2.27)}{.415R_{-1}}$$

$$R^2 = .9907$$
$$DW = 1.38$$

The t-values in the above estimated equation indicate that all the coefficients are significant at the 1% level. Also the coefficient of the explanatory variables show the theoretically expected sign. The Durbin-Watson statistic remains within the indeterminate range. The adjusted coefficient of determination exceeds, .99, indicating that the explanatory variables explain about 99% of the variations in the foreign reserve

stock of the Korean economy.

We have also calculated the elasticities of the explanatory variables. The elasticity of exports with respect to the stock supply of foreign reserve holdings is .945 and that of imports, -1.05, while that of foreign borrowing is .45. Thus the exports and imports are more or less close to unitary-elastic, while that of foreign borrowing is inelastic. It implies that a 10% increase in exports will result in a 9.45% increase in the stock of foreign reserves, while the same percentage increase in imports will reduce the stock by 10.5% and the same percentage increase in foreign borrowing will increase the stock by 4.5%.

The following table shows the actual and simulated values based on equation (6).

Table 1

Actual and Simulated Stock of Foreign Reserves

Unit: Million U.S. Dollars

Year	Actual Reserve	Simulated Reserve	Residual
1960	157.0	149.6	7.3
1961	207.0	162.4	44.6
1962	166.8	160.5	6.3
1963	131.5	168.1	−36.6
1964	136.4	175.9	−39.5
1965	146.3	200.6	−54.5
1966	245.2	264.9	−19.7
1967	356.6	289.9	66.7
1968	391.0	341.0	50.0
1969	552.9	530.4	22.5
1970	609.7	584.5	25.2
1971	568.1	636.5	−68.4
1972	739.7	773.3	−33.6
1973	1094.0	1048.0	46.4
1974	1056.0	1064.0	−8.44
1975	1550.0	1559.0	−8.57

In order to look at the explanatory power of the flow terms in the stock equation, we have regressed equation (5) after having deleted the lag term, R_{-1}. The results are shown as follows:

(7)

$$R_s = \underset{(7.91)}{205.95} + \underset{(5.90)}{.39X} - \underset{(-3.68)}{.215M} + \underset{(7.80)}{.805F},$$

$$R^2 = .9864$$
$$DW = 1.42$$

All the explanatory variables bear the theoretically expected signs and the t-values indicate that the coefficients are significant at the 1% level. The Durbin-Watson statistic remains within an indeterminate range to tell an existence of autocorrelation. There is a slight deterioration in goodness of fit from .9907 to .9864. It is noteworthy that the flow terms such as exports, imports and foreign borrowing account for more than 98% of the variations of the stock of foreign reserve holdings. It seems to imply that the variations of foreign reserve holdings in the Korean economy is mainly influenced by the flow terms. This indicates that the foreign reserve stock in the Korean economy is vulnerable to the variations of the trade surplus or deficit and the foreign capital borrowing. Any fluctuations in the trade balance and/or foreign capital borrowing are likely to result in the similar fluctuations in the foreign reserve holdings of the Korean economy.

Our estimated equations show that we have not accounted the change of the foreign exchange rate system into our specification. The Korean Government changed its foreign excrange rate system from the pegged exchange rate system to the floating exchange rate system in May, 1964. However, the system has been operated more or less similar to the pegged exchange rate system. In order to account the different foreign exchange rate system during our sample period, we have tried to estimate equations with a dummy variable which differentiates the two periods of the different foreign exchange rate system. However, we have found that the dummy variable is statistically insignificant and its explanatory power is minimal. So we have dropped the term entirely from our estimated equations.

Now we want to note the consistent negative sign of the import (M) coefficient in our estimated equations (3), (4), (6) and (7). The negative relationship between imports and foreign reserve holdings contrasts sharply with the positive relationship found in all other empirical studies which have interpreted the estimated equation as the demand function. The theoretical basis for the positive relationship in those studies stems from "an application of the strict quantity theory to the international payments sphere, with the level of imports taking the place of transactions."[2] From this theoretical point of view, our negative relationship seems absurd; however, it does seem to

2 Courchene and Youssef (1967), p. 405.

make sense if we interpret the estimated equation as the supply relationship. This would seem to support our proposition that foreign reserve holdings in the more developed countries are better explained via the demand relationship, while those in the less developed countries such as Korea are better explained via the supply relationship.

III. Concluding Remarks

We have encountered with many empirical studies which show that the foreign reserve holdings of the more developed countries can be well explained by the *demand* relationship. However. the differences in the structure of the less developed economy from those in the more developed economy, may, we believe, give a different behavioral relationship in explaining the variations of foreign reserve holdings. So we have hypothesized in this paper that foreign reserve holdings of the less developed countries can be better explained by the *supply* relationship. We have applied this hypothesis in the case of Korea, and found that the supply relationship can explain the variability of foreign reserve holdings up to 99%. The three main explanatory variables – exports, imports and foreign capital borrowing – have shown the theoretically expected sign, respectively, and all of them are significant at the 1% level. We have found a consistent negative relationship between foreign reserve holdings and imports, while other empirical studies of the more developed economy show a consistent positive relationship between the two variables. We have also found that the stock of foreign reserve holdings is very vulnerable to fluctuations of the trade balance.

Our empirical estimation is based on the two crucial assumptions: stability of the supply relationship and the desired supply of foreign reserves is satisfied each year. To the extent these two assumptions are not met, our results should be qualified accordingly. This identification problem arises due to our use of the ordinary least squares estimating method, while the data used for the estimation are the results of complicated interactions between the demand for and the supply of foreign reserves. Thus it may be better to utilize the simultaneous equation system approach rather than the single equation approach.

Appendix

Data for Estimation

Unit: Million U.S. Dollars

Year	R	X	M	F
1960	157.0	32.8	305.4	2.2
1961	207.0	40.9	283.1	0.9

1962	116.8	54.8	390.1	3.9
1963	131.5	86.8	497.0	60.3
1964	136.4	119.1	364.9	21.6
1965	146.3	175.1	415.9	40.9
1966	245.2	250.3	679.9	182.5
1967	356.6	334.7	908.9	202.4
1968	391.0	468.2	1322.0	294.5
1969	552.9	658.3	1650.0	552.3
1970	609.7	882.2	1804.2	469.8
1971	568.1	1132.2	2178.2	514.0
1972	739.7	1675.9	2250.4	448.5
1973	1094.4	3270.8	3837.3	451.5
1974	1055.7	4515.1	6451.9	594.3
1975	1550.2	5003.0	6674.4	1099.4

Source: The Bank of Korea, *The Economic and Statistical Yearbook* (1976).

References

Baumol, W. J., "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly Journal of Economics* (November, 1952), pp. 545-556.

Clark, Peter B., "Demand for International Reserves: A Cross-Country Analysis," *Canadian Journal of Economics* (November, 1970), pp. 577-585.

Courchene, T. J. and Youssef, G. M., "The Demand for International Reserves," *Journal of Political Economy*, 75 (August, 1967), pp. 404-413.

Flanders, M. J., "International Liquidity is always Inadequate," *Kyklos* 22 (1969), pp. 519-529.

Frankel, Jacob A., "The Demand for International Reserves by Developed and Less Developed Countries," *Econometrica*, 41 (February, 1974), pp. 14-24.

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

Iyoha, Milton A., "Demand for International Reserves in Less Developed Countries: A Distributed Lag Specification," *Review of Economics and Statistics* (August, 1976), pp. 351-355.

Kelly, Michael, "The Demand for International Reserves," *American Economic Review*, 60 (September, 1970).

Kenen, Peter B. and Pudin, Elinor B., "The Demand for International Reserves," *Review of Economics and Statistics* (August, 1965), pp. 242-250.

Kmenta, Jan, *Elements of Econometrics* (New York: Macmillan, 1971).

Tobin, James, "The Interest Elasticity of the Transaction Demand for Cash," *Review of Economics and Statistics* (1956), pp. 241-247.