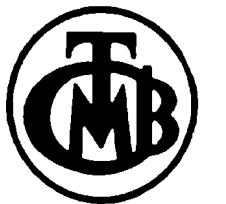


Optimal International Reserves Behavior for Turkey

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ABSTRACT: Models for determining optimal level of international reserves are based on the interaction between two types of costs. On the one hand a high level of reserves reduces the probability of any costly adjustment, which is incurred in the case of reserve depletion. On the other hand the positive reserve holding increases the foregone cost due to a shift in the resources from more productive forms to less favorable forms. In this study we derive the optimal reserve behavior of a country by minimizing the sum of the expected costs. The subjective probabilities of the reserve depletion used in this minimization problem is derived by assuming a condition which imposes an identity between the lender's optimal spread, which reflects the willingness to extend credit, and the spread of the country observed in the market. The conclusions of the model are used to analyze the international reserves of Turkey to assess whether the Turkish reserve behavior has been optimal during the period 1993-2002.

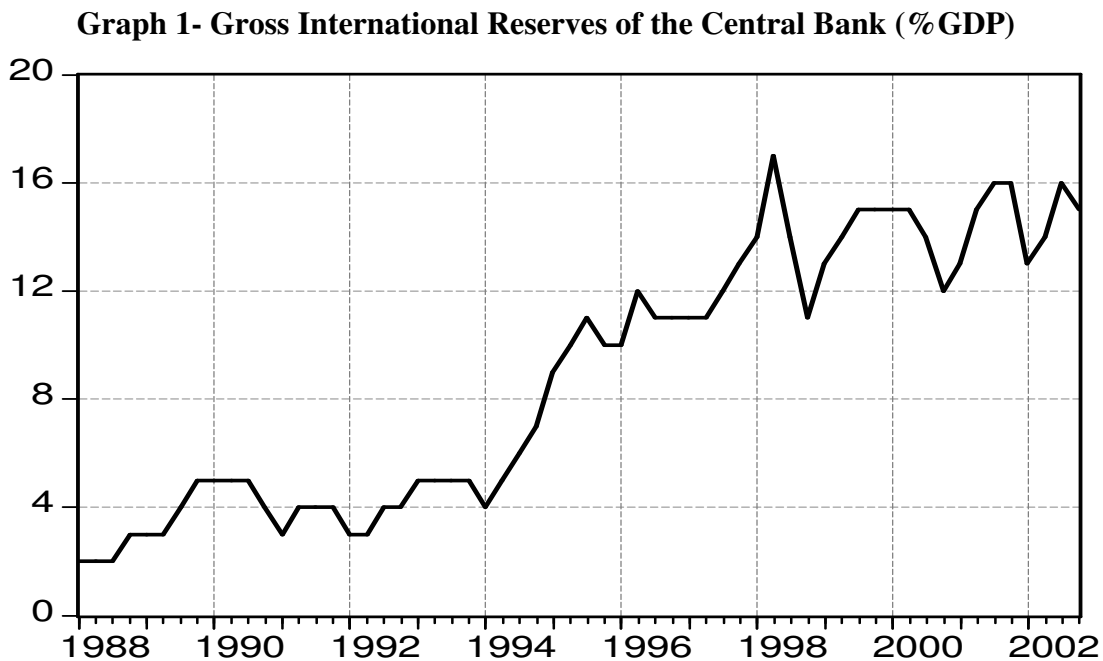
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1- Introduction

The cost of reserve depletion and the negative relationship between the level of international reserves and this cost, which is reflected in the country risk, influences optimal reserve behaviour for central banks. As can be seen from graph-1, the ratio of the gross international reserves to GDP started to increase after the currency crisis in 1994 and this trend continued until the Russian crisis in the third quarter of 1998 in Turkey. Although the trend growth stopped with this event this ratio remained high up to the current period. The purpose of this research is to find the optimal international reserve behaviour, which is consistent with the objective of the Central Bank of Turkey to ensure stability in the financial markets and to compare the movements in the international reserves with the optimal international reserve behaviour to see whether they had been optimal during the period 1993-2002.



We can approach this analysis by describing under what conditions it is sensible to establish a link between the level of international reserves and the existence of an optimal level for this variable. The first condition is that there should be some benefits for holding international reserves. The most common argument for the rationalization of those benefits is that there may be fluctuations in the external receipts and payments of a country. Therefore by holding international reserves the country can reduce the cost of any mismatch, which otherwise mean some kind of costly adjustment, either in the form of income losses or the deterioration in the terms of trade. Other rationalizations of the benefits are directly related to the objective of central banks to ensure stability in the financial markets. These are implementing the exchange regime and enhancing the international confidence in the country. For example, in a pegged exchange rate regime, which might be preferred as a part of a stabilization program, the country must be ready to buy and sell the foreign currency at the pegged rate. Even in a floating exchange rate regime central banks may require international reserves to reduce the variability of exchange rates. Also by holding international reserves countries may improve the terms and conditions of loans offered in the international markets. As a result they may benefit from increasing capital mobility. The second condition is that at the same time it should be costly to hold international reserves. This cost can be generated because there may be more productive forms of investing funds rather than holding in the form of short-term risk free assets¹.

Heller's study (1966) has been distinguished as the first attempt to formalize the above description by introducing a cost-benefit analysis to the determination of the optimal reserves. Studies following Heller basically differ by the probabilistic assumptions of the cost and benefit associated with the reserve holdings. By assuming fixed relative prices, Heller shows that international reserves enable to a country to avoid expenditure changing policies, which would otherwise imply a decrease in income to restore the balance of payments equilibrium. Under such an environment the optimal level of reserves is derived from the welfare maximizing behaviour of the monetary authority that has the precautionary motive for holding reserves due to uncertainty in the external transactions. He derives a specific formula, which is produced by the equality condition between the marginal benefit and the marginal cost of reserve holdings. Hamada and Ueda (1977) extend this formula by elaborating the random walk behaviour for the exhaustion of reserves that eventually leads to the adjustment costs and by taking into account the states of affairs after the exhaustion of reserves. Frenkel and Jovanovic (1981) replace the discrete random walk assumption of the reserve behaviour with the continuous counterpart, i.e. a Wiener process, and introduce uncertainty to the cost of reserve holding. The solution for the optimal reserves is obtained by minimizing a total expected cost function with respect to reserve holdings over an infinite time horizon. Gotlieb and Bassat (1992) also recognize the uncertainty both in the cost of reserve depletion and the positive level of reserve holdings. However, their expected cost function differs from Frenkel and Jakobovanic (1980 and 1981) by restricting the cost to a finite period rather than using an infinite time horizon. They also assume that the cost of reserve depletion is the cost of default on loans by the country rather than the

¹ The recent economic environment and the need for international reserve is discussed in Fischer (1999)

adjustment cost. This enables them to link the probabilistic assumptions of the model to the lender's optimal spread. With this assumption their emphasis is on the benefit of international reserves that stems from reducing the risk of default which may be costly for a country by disturbing the orderly flow of imported good for the production process.

The studies mentioned above, except Gotlieb and Bassat (1992), assume an initial optimal level of reserves and the absence of any structural problems in the balance of payments. Therefore any simulated time path of the international reserves starting from this initial point of the optimal level does not incorporate any deterministic behaviour into the reserve movements and is characterized by a random walk behaviour with an upper and lower bounds. Any observed deterministic behaviour in the actual reserves should be interpreted as the adjustment toward attaining this initial optimal level. In Gotlieb and Bassat (1992), however, the optimal level of reserves depends on the state of the economy which is captured by the subjective probabilities associated with the reserve depletion. Therefore it allows deterministic behaviour both before and after attaining the optimal reserve level since this optimal level is also depends on the state of the economy. This assumption may be important in the Turkish case, because most of the period between 1993-2002 can be described by a conscious effort to increase the reserve level. As it can be seen from graph 1- gross international reserves have increased from 4 percent of GDP in 1993 to 16 percent of GDP in the early 2000s². The model introduced in the next section also follows Gotlieb and Bassat in this respect and allows the possibility of a deterministic behaviour before and after reaching at the optimal level.

2- The Model

The early models for determining the optimal level of international reserves were based on a cost benefit analysis. A high level of reserves reduces the probability of any costly adjustment of the balance of payments that is incurred in the case of reserve depletion. On the other hand the positive holding of international reserves increases the opportunity cost due to a shift in the resources from more productive forms to less favourable forms. In this section we also introduce a model that is based on a cost benefit analysis. However our model assumes a different rationale for the benefits of holding international reserves as in Gotlieb and Bassat (1992). A high level of international reserves reduces the probability of incurring the cost of both the default on government loans and the financial instability in the country. One of the contribution of this study to the model developed by Gotlieb and Bassat is that the stochastic properties of the costs are derived by assuming an equilibrium condition between the optimal spread that would be charged by a lender in addition to the risk free rate and the observed spread in the international bond markets. The other contribution is about the determination of market spread. It is assumed that the macroeconomic variables that are related to the debt servicing capacity

² Such conscious efforts may also have implications on the balance of payment equilibrium. Any deterministic behaviour should be considered under the autonomous items rather than compensating or accommodating items of balance of payments. For a discussion of equilibrium in balance of payment it can be referred to Machlup(1958), Cooper(1966) and Kindleberger(1969).

of the country directly determine the market spread rather than indirectly through the optimal spread for the country.

The first step is to find the optimal spread. Feder and Just (1977) show that the optimal spread that would be charged by lenders is the solution to the objective function, which maximizes the expected utility of the lender by optimally choosing the spread,

$$\underset{s}{Max} \bar{U} = (1-p)U\{s\theta L\} + p \int_{\underline{h}}^1 U\{-hL\}\psi(h)dh \quad (1)$$

In this formulation U represents the utility function, which depends on the discounted net revenue. However the discounted net revenues involves uncertainty as a result of the possibility of default. Therefore, by defining p as the probability of default he relates the discounted net revenue to the spread, s , to the discount factor θ and to the size of the loan, L , if the borrower does not default on the loan and to the loss rate, h , and to the size of the loan if the borrower default. Furthermore he assumes a subjective probability function for the loss rate in the case of default as represented by $\psi(h)$ which ranges from a minimal rate of loss, \underline{h} , to the complete loss, 1.

The first order condition for this maximization problem produces the following solution for the optimal spread,

$$s = \left(\frac{\eta}{\eta-1} \right) \frac{\bar{h}}{\theta} \left(\frac{p}{1-p} \right) \frac{U'(-\bar{h}L)}{U'(s\theta L)} \quad (2)$$

where η is the elasticity of demand for loans defined as $\eta = |sL_s/L|$ and $\eta > 1$ at the level of optimality, \bar{h} is the expected loss rate and $\frac{U'(-\bar{h}L)}{U'(s\theta L)}$ is the extra risk premium due to risk averse behaviour of the lender. This last term takes 1 for the risk neutral lender and is larger than 1 for the risk averse lender. By assuming risk neutrality and perfect competition Edwards (1984) collects the factors η, \bar{h}, θ under a term, α , which he further formulates by a constant and error term with mean zero and a country specific variance. On the other hand Gotlieb and Bassat (1992) simplify this relationship by assuming $\frac{\eta\bar{h}}{\eta-1} = 1$ that gives the following form for the optimal spread,

$$s = \left(\frac{p}{1-p} \right) (1+i) \quad (3)$$

where i represents the risk free rate.

The spread observed in a bond market, however, should not be necessarily equal to the optimal spread of a lender. If we assume that the economic indicators, which are related to the debt-servicing capacity of the country, determine the spread prevailing at the market we can write the following general form for the observed spread in the market,

$$\bar{s} = S(X) \quad (4)$$

where \bar{s} is the market spread and X is a vector which includes the factors that determine the debt-servicing capacity of the country. In the next section we will analyze the variables that should be included this vector. In this section, however, for the sake of simplicity we collect all the determinants of the market spread other than international reserves under a constant term and assume a linear relationship between the market spread and international reserves, which may take the following form,

$$S(X) = a + bR \quad (5)$$

where a is the constant term, b is the response of the spread to the change in international reserves which is expected to be negative and R is the international reserves of the country.

For a lender who is willing to extend loans to a country the market spread should be equal to his optimal spread. As long as the country is able to borrow from international markets or the bonds issued by that country are traded in the market it is also reasonable to assume that this condition will hold in practice. Therefore, by using (3) and (4) we can obtain the following relation,

$$S(X) \equiv \left(\frac{p}{1-p} \right) (1+i) \quad (6)$$

This definitional equilibrium and the functional relationship in (5) allow us to write the subjective probabilities as follows,

$$p = \frac{a + bR}{1 + i + a + bR} = \frac{\bar{s}}{1 + i + \bar{s}} \quad (7)$$

This expression for the subjective probability is an acceptable probability model, which is bounded between zero and one for all values of the market spread and the risk free interest rates. Moreover it captures the increasing risk aspects of the country as the market spread increases for that country³.

³ In the literature (Feder and Just (1977), Edwards (1984) and Gotlieb and Bassat (1992)) the subjective probabilities is derived from the logistic function which is in the form $p = \frac{\exp(s(X))}{1 + \exp(s(X))}$ and

For the lender the risk associated with loans is the difficulty faced by the borrower country to comply with the terms of loans. This risk can range from rescheduling to partial and complete losses of credit in the case of default. Since this range of difficulties in meeting the terms of credit should be also associated with the depletion of international reserves, it is also reasonable to interpret the above subjective probabilities as the probabilities of reserve depletion at each reserve level.

Following this conclusion the probabilities provided by equation (7) allow us to analyze the Central Banks' problem to minimize the sum of the expected cost of reserve depletion and the expected cost of holding reserves by optimally choosing the reserve level. If the probability of reserve depletion is p , then the probability of reserve level being positive will be $(1-p)$. Hence with a similar function used by Gottlieb and Bassat (1992) the expected cost of the international reserves (EC) can be written as follows,

$$EC = pC + (1-p)rR \quad (8)$$

where C is the ratio of the economic cost of reserves being depleted, r is the opportunity cost of reserve holding and R is the ratio of reserve level to output. Since by holding short-term risk free assets the central bank sacrifices some extra returns by not lending to its governments at the rate of spread, we can assume that the opportunity cost of reserve holding can be taken as the market spread as in Edwards (1985). If we substitute for r with the spread and rearrange equation (8), we can write the following relationship,

$$EC = p(C - sR) + sR \quad (9)$$

If we substitute (6) and (7) into (9) and minimize it with respect to R , where R is constrained to $R \geq 0$, the necessary condition for optimal reserve gives two stationary points,

$$R_{1,2} = \frac{1}{2} \left[-\frac{\alpha_1}{\alpha_2} \pm \left(\left(\frac{\alpha_1}{\alpha_2} \right)^2 - 4 \left(\frac{\alpha_0}{\alpha_2} \right) \right)^{0.5} \right] \quad (10)$$

and,

$$\alpha_0 = bC + a(1+i+a)$$

$$\alpha_1 = 2b(1+i+a)$$

$$\alpha_2 = b^2$$

$s = \exp(S(X))$. This gives $p = \frac{s}{1+s}$. Therefore, if we exclude the risk free interest rate i equation (6) will be similar to the logistic form, assuming the equilibrium condition holds.

The negative sign of b guarantees the existence of the solution. An increase in the international reserves decreases the sum of the expected costs both through a decline in the probabilities of reserves depletion and a decline in the spread. However it also increases the cost, as the associated cost with the reserves gets higher with the increase in international reserves. A further check for the second order conditions reveals that R^+ is a minimum and R^- is a maximum stationary point.

3- Market Spread and Estimation Results

The previous section showed us the crucial importance of the negative relationship between spread and international reserves and the resulting subjective probabilities of the reserve depletion in the solution of the optimal reserve behaviour for a country. In this section we present a detailed analysis for the determinants of the market spread in order to test this crucial hypothesis and to derive the coefficients of the market spread equation, which are required for the simulation of the optimal reserves for Turkey in the next section.

To specify the determinants of the market spread we follow the literature that links the determinants of the debt-servicing capacity to the optimal spread via a logistic probability function (see footnote 3) and assume that the same variables also determine the market spread proposed in equation (3). After analysing the literature Min (1998) has categorised those variables under four topics. The first group of variables reflects the liquidity position of the country. These are the ratio of international reserves to GDP, the ratio of exports to GDP and the ratio of the current account to GDP. McDonald (1982) and Edwards (1984) expect that the ratio of reserves and exports to GDP should have a negative effect on the optimal spread. Their reason is that an increase in exports earnings decreases the possibility of liquidity problems in financing the balance of payments transactions while an increase in international reserves decreases the risk imposed by a sudden capital outflow. On the other hand the relationship between the ratio of current account balance to GDP is discussed in Sachs(1981). In his paper, he presents a negative relationship between investment rates and the market spread. The rationale of this finding is that the current account deficits are reflected in high investment rates, which contribute to the future production capacity. Therefore it reduces country risk and thus higher deficits should be associated with a reduction in the spread, which implies a positive coefficient for this variable. Finally we also included the ratio of short-term foreign debt to total foreign debt to reflect the debt servicing difficulties on the market spread which is expected to have a positive impact.

The second group of variables that are analysed by Min (1998) reflects the macro economic environment in the country and he labels those variables as the macroeconomic fundamentals. The variables which are categorized under this heading and can be extended by the list given by Edwards (1984) are the inflation rate, the ratio of imports to GDP, the GDP growth rate and the ratio of government expenditures to GDP. Edwards

argues that the ratio of government expenditures to GDP reflects the size of government, which may lead to balance of payments problems. Instead of government expenditures to GDP we use the ratio of domestic debt to GDP to capture the growing distortion of the government sector on the macroeconomic variables in Turkey. The coefficient of this variable is expected to have a positive sign. On the other hand it is argued that higher inflation rates increase the probability of a balance of payment crisis. Therefore we can expect that this variable will also have a positive impact on the market spread. The same expectation can be also formed for the ratio of imports to GDP. Frenkel (1983) argues this ratio reflects the openness of the economy. Therefore the more open the economy, which is the indication of a high ratio, the more vulnerable should be to the external shocks. Finally, following Feder and Just (1977), it can be argued that a higher growth rate of an economy should be associated with a lower probability of default, which leads to the expectation of the negative sign for this variable in the equation for the market spread. However, if high growth rates are expected to cause balance of payments problems due to a high propensity to import, then this variable may also have a positive effect on the market spread. Other two category, external shocks and dummy variables, which are analysed by Min (1998) as separate topics, are excluded in this section.

The spread variables are taken from Datastream. The calculation of the spread by Datastream is based on the difference between the yields on Turkish bonds and a theoretical US bond with a similar maturity. There are about 30 type of bonds issued by Turkish governments between 1993-2002 and traded in the international markets. The most common type is the euro market bond which is followed by the dollar market bond. There are also some bonds traded in the sterling market and the yen market in this period. For our purposes we preferred a single euro market bond and a single sterling market bond, both issued in 1993 with a maturity of 10 years. The reason to choose these two bonds is that they have the longest time series available for the spread variable. However we also constructed two kinds of weighted euro bond spread series by including 12 Turkish euro market bonds. The weights are chosen as the share of the market values and the turnovers in the total volume.

Table 1- presents the estimation results of these four types of spread series by using the OLS method for the period 1993:q3-2002:q1. There are several common patterns to be observed in this table. The first pattern is that inflation and the foreign debt ratio have the wrong signs and they are not significantly different from zero in all four equations. Another common pattern in those equations is with the liquidity variables, export/GDP, import/GDP and current account/GDP. They have all their expected signs and are significantly different from zero at the 1 percent significance level. The third common pattern is related to the ratio of domestic debt to GDP, which reflects the government sector's distortion on the Turkish economy. An increase in this ratio is associated with an increase in spread in all equations as it is expected. The coefficients of this variable are significant at 5 percent level and have very small standard errors in the euro equations.

The negative relationship between the spread and the ratio of international reserves to GDP, which is of crucial importance in the model, is generally supported by the estimation results. However there seems to be some uncertainty in the size and it is not

significant in the turnover-weighted euro equation (fourth column of table-1). The size of this coefficient is smaller in the euro market equations compared to the pound market equation and it ranges between -0.29 to -0.08 . The last variable is the lagged GDP growth which has a positive effect on the spread. The positive coefficient of this variable can be interpreted as high growth rates increase the balance of payment risk which may indicate the perception of a constrained growth due to the dependence of the growth performance on imports. However this coefficient is not significant in the sterling market equation and it is only significant at 10 percent in the weighted turnover equation.

Diagnostic test statistics in table-1 show no major problem for the euro equations while the sterling equation suffers from the failure of normality. The reported F-statistics for the fourth order serial correlation indicates no auto-correlation in all equations. Moreover there is no indication of serial correlation up to the fourth order. A similar result can be also reported for the ARCH effect. To test for stability we carried out the Chow's forecast test by choosing 2001:q1 as the break point. The null hypothesis of no structural change at this date is accepted at 10 percent for all equations. As it is mentioned the only major diagnostic problem appears to be in the sterling market equation. The Jarque-Bera test for normality of the residuals rejects the null hypothesis of normally distributed errors from this equation.

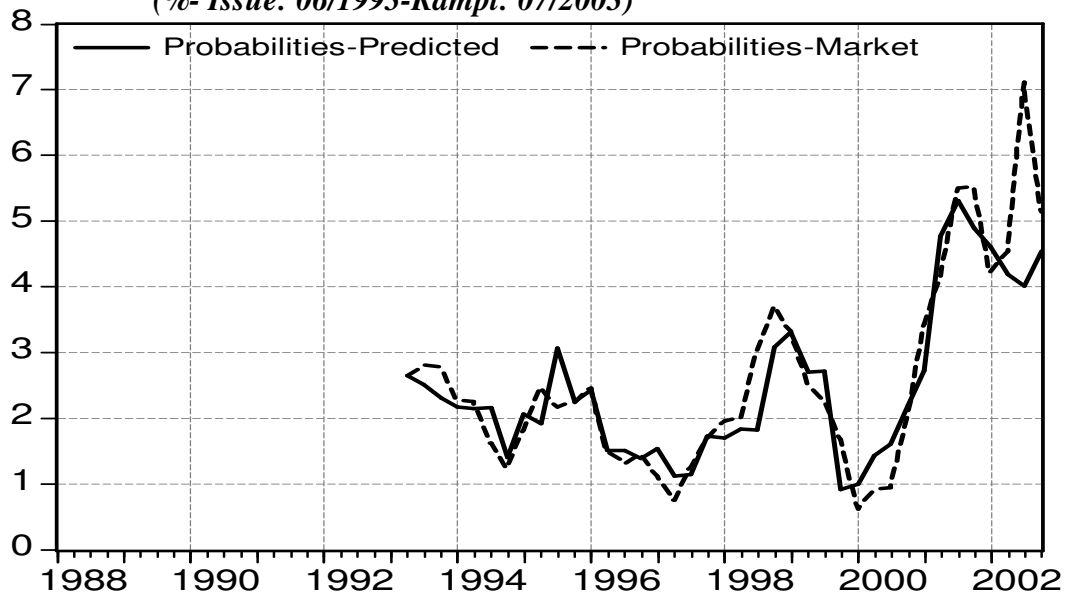
Table 1- Spread Equations (Estimation period; 1993q2-2002q1)

Independent Variables	Spreads			
	Euro Issue -06/1993 Rdmpt-07/2003	Euro Weighted by Market Value	Euro Weighted by Turnover	Pound Issue -10/1993 Rdmpt-10/2003
Constant	-0.0040 (-0.24)	0.0041 (0.24)	0.0102 (0.60)	0.0307 (1.13)
Inflation	-0.0218 (-1.28)	-0.0256 (-1.44)	-0.0213 (-1.21)	-0.0235 (-0.84)
Reserves/GDP	-0.1921 (-3.63)*	-0.1004 (-1.82)**	-0.0831 (-1.51)	-0.2900 (-3.15)*
Import/GDP	0.4202 (5.25)*	0.4118 (4.93)*	0.3622 (4.36)*	0.5050 (3.87)*
Export/GDP	-0.4638 (-5.10)*	-0.5096 (-5.37)*	-0.4687 (-4.97)*	-0.4191 (-2.80)*
Current Account/GDP	0.6051 (6.09)*	0.5252 (5.07)*	0.4349 (4.22)*	0.8203 (4.96)*
Short Term/Total FX Debt	-0.0002 (-0.01)	-0.0229 (-0.36)	-0.0374 (-0.59)	-0.0355 (-0.32)
GDP growth	0.3259 (3.46)*	0.2286 (2.33)*	0.1905 (1.95)**	0.1104 (0.71)
Domestic Debt/GDP	0.1235 (8.17)*	0.1232 (7.81)*	0.1195 (7.63)*	0.0682 (2.28)*
R²	0.8503	0.8484	0.8419	0.7580
LM(4)	0.0092 [0.99]	0.5280 [0.71]	0.1131 [0.98]	1.8100 [0.16]
ARCH(1)	0.0573 [0.81]	0.2654 [0.60]	1.6014 [0.21]	1.0394 [0.31]
Chow	2.0243 [0.12]	1.4712 [0.24]	1.1366 [0.37]	0.7835 [0.57]
Jarque Bera	1.1061 [0.57]	0.6615 [0.71]	1.8320 [0.40]	5.9193 [0.05]

*Significant at %5,**Significant at %10. Values in parentheses are the t-ratios and in brackets the probabilities. Estimation period is 1993:q3-2002:q1.GDP growth is the one period lagged values. Inflation is the quarterly rates. R^2 is for the goodness of fit. LM(2) is the test for second order serial correlation. ARCH(1) is the test for the first order ARCH effect. Chow is the Chow's forecast test by choosing 2001:q1 as the observation for the break. Jarque-Berra test is the test for normality of the residuals.

Graph-2 can be interpreted as a further check for the specification of the estimated equations. It shows the subjective probability (p) of reserve depletion derived from the predicted spread of the euro market bond and reported in the second column of table-1 together with the probability from the actual euro market spread. Both of the spread series move together until the second half of 2002. After this period the estimated spread equation cannot capture the increasing risk aspect of the bond, which may be caused by the political turmoil in the second half of 2002. However this should be considered as a shock to the market that is not explained by the fundamentals or the liquidity variables of the model. In the following section by using the estimated coefficients and the predicted values from this euro market bond spread we will show several simulation results for the optimal reserve ratio for Turkey.

Graph 2- Risk Evaluation of the Euro Market Bond
 (%- Issue: 06/1993-Rdmpt: 07/2003)



4- Simulation of Optimal Reserves for Turkey

In order to calculate the optimal level of reserves we should first estimate cost of reserve depletion. Our model allows this cost to vary from the burden of a financial instability to the insolvency of a country. These costs may arise because these events affect countries' economic relations with the rest of the world, which damages the flow of productive transactions in goods and financial markets as argued by Gotlieb and Bassat.

The external debt of Turkey was not at an alarming level in our sample period. Therefore the insolvency cost, which may be associated with the reserve depletion, can be ignored in this part. However Turkey experienced two episodes of currency collapse, which resulted a sudden change in the relative prices to ease the pressure on the loss of international reserves and to cure the growing balance of payment deficits in 1993 and 2000. Therefore it may be appropriate to use these currency crises to calculate the cost of the reserve depletion on the economy.

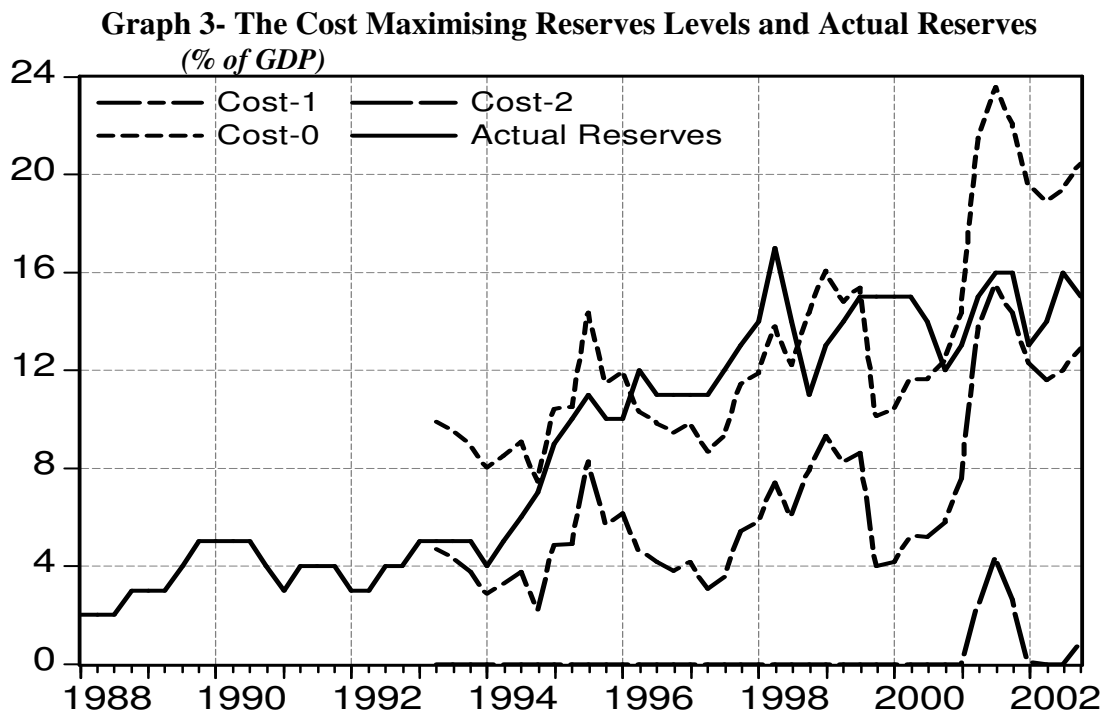
Table 2- shows the calculated costs for Turkey. The calculation is based on the deviation of the actual output from the potential output in the aftermath of the currency collapses in 1994 and 2001. The Turkish economy grew on average 4.5 % between 1988-1993 and 4.6 % between 1995-2000. Therefore, in our calculations we took these average growth rates as the potential growth rate of the economy in the years of crises. After finding the potential growth rates there may be two approaches to assess the deviation of the actual output from these potential rates. The first approach is to concentrate on the short-run losses. If we consider the short run cost of the reserve depletion as the output losses which occurred in the subsequent four quarters after each currency collapses, it is about 10 percent of the pre-crisis GDP in 1994 and about 12 percent of the pre-crisis GDP in 2001. However it can be argued that this short-run output loss does not reflect the full extent of the costs. If the economy continued to grow at the pre-crisis potential growth rate, it would have a higher output level not just in the year of adjustment but in the following years as well. Therefore a more realistic cost assessment can be made by taking into account the present values of the deviation of actual output from the potential output if the economy were on the potential growth path at the rate prevailing just before the crisis. In this case our calculation indicates that the cost of crises in 1994 over the following 7 years is about 42 percent of the pre-crisis GDP as presented by the third line in the table below.

Table 2- Cost of Crisis (*% of GDP_{t-1}*)

	Type of the Cost	Potential Growth	Actual Growth	The Cost of Crisis
1994	Short Run	4.4	-5.6	10
2001	Short Run	4.6	-7.4	12
1994-2000	Long Run			42*

* Deviation of the actual output from the potential over the period 1994:q1- 2000:q4. Discount rate is taken as 0.0264 which is the average real interest rate between 1988-2000 for a quarter.

We solved equation (10) under three cost scenarios to find the optimal reserve levels for Turkey. In addition to the short-term and the long-term cost scenarios of the previous discussion we also included the zero cost scenario of the reserve depletion which may be more realistic for the freely floating exchange rate regime period in Turkey after 2001. The zero cost scenario can be also consistent with the anticipation of the policy makers if they believe that the depletion of international reserves does not impose any cost on the economy. The required parameters are derived from the euro market bond spread estimated in the previous section. Graph-3 below shows the simulation results. Cost-0 is for the case of zero adjustment cost, Cost-1 is for the short-term adjustment cost and Cost-2 is for the long term adjustment cost.



The first thing to mention is that the level of international reserves which minimizes the sum of the expected costs is not in the attainable range and it is around 11 times of GDP in each scenario. At first this seems to be a bit surprising, but the reserve levels which maximize the expected costs and shown in graph-3 can still help us analyze the optimal reserve behaviour for Turkey by comparing these maximum levels with the actual reserves levels. If we consider those maximum levels as the worst cases, the optimal international reserve behaviours can be defined as the movements in the international reserves which are further away from these maximizing levels since those movements will reflect cost saving behaviour by the central bank.

The cost maximizing reserves obtained from the zero cost scenario are very close to the actual reserve levels until 2001. After 2001, however, the gap between actual levels and the zero cost scenario increases as a result of the jump in the cost maximizing levels of the international reserves. On the other hand the cost maximizing reserves obtained from the short-term case scenario behaves in the opposite direction. The gap before 2001 is larger than the gap after 2001. If we use our definition of the optimal reserves behaviour it can be argued that the central bank's behaviour before 2001 is more consistent with the cost saving behaviour under the short-term cost scenario than the zero cost scenario. After 2001, however, there seems to be a change in these roles. The zero cost scenario produces more consistent movements with optimal reserve behaviour than the short-term cost scenario. Despite these differences, the conclusion of these two cost scenarios is the same. The central bank still can achieve some more cost savings by not holding international reserves at all. Therefore the international reserves behaviour is not consistent with the optimal behaviour under these scenarios.

On the other hand, the long-term case scenario produces the border solution (zero level) for the cost maximizing levels of international reserves in most of the years between 1993 and 2002. The importance of this finding is that while there is the possibility of cost saving behaviours in other scenarios by holding zero level of reserves (*given everything else constant*) this is not an option in the long-term cost scenario. Since the maximum cost is attained at the zero level, to reduce the international reserves toward zero will be cost maximizing behaviour. Therefore this scenario can explain the existence of the increasing trend in actual reserves. Any movements in the international reserves, which shifts it further away from the zero level, reduce the expected cost of the reserve depletion for the central bank. As a conclusion it can be argued that the behaviour of international reserves was optimal during the sample period under this scenario as the central bank tried to reduce the probability of the reserve depletion by increasing the level of international reserves. Moreover the central bank perceived the cost of reserve depletion at least as high as the long term cost scenario, which was above 40 percent of GDP.

5- Conclusions

This study extends the model introduced by Gotlieb and Bassat (1992) by distinguishing the market spread from the optimal spread. The stochastic properties of the model are derived by assuming an equilibrium condition between the optimal spread that would be charged by a lender in addition to the risk free rate and the observed spread in the international bond markets. We also considered the cost of reserve depletion which might arise from two sources, the costs of financial instability and the default on international loans. These events may be costly for a country, because they affect the flow of productive transactions in the goods and financial markets, either affecting the use of imported goods in the production process or the ability to finance the investment projects through international markets. As a result it can be argued that the precautionary motive of holding international reserves may not be only related to the adjustment cost as assumed by earlier studies, but the anticipated costs of financial instability and the default on international loans. With this extension this topic becomes directly related to the objective of central banks to ensure stability in the financial markets.

In the empirical part we first derived the parameters of the model by estimating a spread function for Turkey. It is concluded that the variables in the specification give a good explanation of the movement in the spread observed in the international markets for our sample period. Then the parameters of the spread function are used to calculate the numerical solutions of the model under three different cost scenarios. Our conclusions from the simulations of the optimal international reserves are as follows: (1) The observed movements in the actual reserves are consistent with the optimal reserve behaviors if we consider the cost of the reserve depletion for Turkey is as high as the long-term cost scenario, (2) The movements in the international reserves are not consistent with the optimal reserve behaviors produced by the zero cost and the short-term cost scenarios, especially after 2001. The reason for the second conclusion is that the central bank can achieve more cost saving by not holding international reserves at all.

References :

Bassat, B.A. and D. Gotlieb (1992) “Optimal International Reserves and Sovereign Risk” The Journal of International Economics, Volume 33, pp: 345-362

Cooper, R.N. (1966) “The Balance of Payments in Review” The Journal of Political Economy, Volume 74, Issue 4 (Aug.), pp: 379-395

Edwards, S. (1984) “LDC Foreign Borrowing and Default Risk: An Empirical Investigation” The American Economic Review, Volume 74, Issue 4 (Sep.), pp: 726-734

Edwards, S. (1985) “On the Interest-Rate Elasticity of the Demand for International Reserves: Some Evidence from Developing Countries” The Journal of International Money and Finance, Vol.4, No.3, pp:287-295

Feder, G. and R.E. Just (1977) “ An Analysis of Credit Terms in the Eurodollar Market” European Economic Review, Volume 9, pp: 221-243

Fischer, S. (1999) “On the Need for an International Lender of Last Resort” The Journal of Economic Perspectives, Volume 13, Issue 4 (Autumn), pp:85-104

Frenkel, J.A. (1983) “International Liquidity and Monetary Control” Working Paper No:1118, National Bureau of Economic Research.

Frenkel, J.A. and B. Jovanovic (1981) “Optimal International Reserves: A Stochastic Framework” The Economic Journal, Volume 91, Issue 362 (Jun.), pp: 507-514

Hamada, K. and K. Ueda (1977) “Random Walks and the Theory of the Optimal International Reserves” The Economic Journal, Volume 87, Issue 348 (Dec.), pp: 722-742

Heller, H.R. (1966) “Optimal International Reserves” The Economic Journal, Volume 76, Issue 302 (Jun), pp:296-311

Kindleberger, C.P. (1969) “Measuring Equilibrium in the Balance of Payments” The Journal of Political Economy, Volume 77, Issue 6 (Nov.-Dec.), pp: 873-891

Machlup, F. (1958) “Equilibrium and Disequilibrium: Misplaced Concreteness and Disguised Politics” The Economic Journal, Volume 60, pp:1-24

McDonald, D.C. (1982) “Debt Capacity and Developing Country Borrowing: A Survey of the Literature” IMF Staff Papers, Volume 29, pp: 603-646

Min, H.G. (1998) “Determinants of Emerging Market Bond Spread: Do Economic Fundamentals Matter?” Working Paper 1998-3, International Economics Trade and Capital Flows, World Bank

Sachs, J.D., R.N. Cooper and S. Fischer (1981) “The Current Account and Macroeconomic Adjustment in 1970s” Brookings Papers on Economic Activity, Volume 1981, Issue 1, pp: 201-282