

## Demand for International Reserves in Islamic Countries and Determining the Optimal Composition

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### **Abstract**

In this paper, based on error correction model by using panel data, an empirical analysis of demand for international reserves for 16 Islamic countries is investigated.

Besides addressing conventional issues, the model explicitly incorporates the impact of expected export revenues and the impact of the exchange rate system on reserve demand.

The results reveal that, short run money market disequilibrium has not any significant effect on demand for international reserves in Islamic countries. In addition, in these countries expected export revenues have positive long run effect while exchange rate flexibility has negative effect on demand for reserve

Furthermore, by using the mean-variance approach this paper presents a model for selecting an optimal reserves portfolio for the Islamic countries. The model focuses on the relationship between the composition of reserves and the impact of return and risk of holding each foreign currency.

Results reveal that the currency composition of reserves have been influenced by risk and return associated with holding reserves assets denominated in different currencies such that, the share of each currency in composition of foreign reserves have a negative relationship with the risk of each currency in reserves asset.

**Key words:** International Reserves, Islamic Countries, Optional Composition, Error Correction Model, Money Market, Export Revenues, Exchange Rate Flexibility, Return and Risk.

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## **1- Introduction**

Studies of the demand for reserves are typically based on one of two theories. The theory of demand for reserves asserts that reserves are held to finance international transactions and to serve as a buffer stock to meet unexpected payments difficulties. This theory asserts that reserve holding changes in response to discrepancy between desired reserves and actual reserves. The desired demand function for reserves depends on three key variables: a measure of variability in balance of payments, the scale of country, and the average propensity to import. The models employed in the empirical literature of demand for reserves are generally based on partial- adjustment mechanism (PAM) type of loss functions involving desired and actual levels of reserves. This framework foresees reserves movements basically responding to discrepancies between desired reserves and the level of reserves actually held by countries. Examples in literature include Heller and Khan (1978), Frenkel (1974, 1978) Bilson and Frenkel (1979), Edwards (1980, 1983) Elbadawi (1990), and Haung and Shen (1999). The adjustment speed and the dynamic process can be inferred from the coefficient on the lagged dependent variable.

Another explanation of the behavior of holding reserves is provided by a simple version of the “monetary approach to the balance of payments”. This approach focuses on the asset side of the balance sheets of financial institution, where the money supply is equivalent to the sum of foreign assets and domestic credit. Hence, for a given domestic credit, changes in international reserves will be related to changes in the demand for money. The level of international reserves is expected to rise (fall) if there is an excess demand (supply) for money. International reserves are therefore viewed as a residual according to the monetary approach.

A synthesis of the demand for reserves theory and the monetary approach, as claimed by Edwards (1984), can be obtained if there is a stable demand for international reserves. As long as a stable demand for reserve exists, domestic credit cannot be exogenous.

Money market disequilibria will also affect reserve holdings. In order to integrate these two different explanations explicitly, Edwards (1984) incorporates an additional variable, excess money demand, representing an extra adjustment cost between the actual and the desired reserves in the PAM. His underlying assumption is that reserve holdings can be affected by money-market

disequilibria only in the short-run, arising possibly from a domestic economic disequilibrium. The resulting reduced form of the demand for reserves equation includes not only the three key determinates, but also the money market disequilibrium.

The monetary approach stresses that money-market disequilibria have a significant short run positive effect on the demand for reserve; Elbadawi (1990) pursued this idea further by examining whether or not money-market disequilibria influence reserves in the long run specification. He applied error correction model (ECM) to investigate demand function for international reserve. Ford and Huang (1994) also employed the ECM to specify the relationship between reserves and their determinants. In contrast to Elbadawi (1990), their money- market disequilibrium appeared only in the short run dynamic process. The theoretical models underlying Elbadawi (1990) and Ford and Huang(1994) works, are derived from optimizing conventional partial-adjustment types loss function involving two source of adjustment costs: the gap between desired and actual levels of reserves and the difference between current and lagged reserves.

Huang and the Shen derived a dynamic demand function for international reserves based on the seasonal difference. Their model, by using seasonal difference is distinguished from previous studies in three aspects: First, the dependent variable is seasonally differenced instead of being first order differenced. Next, local money market disequilibrium included is also in fourth differences form. Finally, given the existence of stochastic seasonality, using a seasonal error correction, a new model, was specified and estimated.

This paper generalizes the Huang and Shen (1999), Elbadawi (1990) and Ford and Huang (1994) demand function for Islamic countries. Although Elbadawi (1990) Ford and Huag (1994) and Huang and Shen (1999) successfully improved the demand function for reserves for one country, our model is investigated sixteen Islamic countries, based on error correction model (ECM), and panel data is used for estimation.

In addition, this paper presents a model for selecting an optimal foreign exchange reserve portfolio for those countries using the mean variance approach. The model described here focuses on the relationship between the composition of reserves and impact of return and risk of the investment in each currency. A few economists, such as Kenen (1967), Officer and Willett (1969), Hageman

(1969), Steckler and Pickarz (1970) and Makin, have studied the composition of national foreign currency reserve, but they deal only with the optimum ratio of gold to foreign currencies. These studies relate to a period in which the international monetary system was based on gold and typical pattern was one of fixed exchange rate adjusted at relatively long intervals. This helps to explain why studies of foreign-reserves composition deal only with the share of gold in total reserves, other currencies being represented by the dollar. After shifting from fix to floating exchange rates, gold and the dollar lost their special place as the chief reserve assets, and today they are only two out of a whole array of assets in a central bank's portfolio. This study is an attempt to investigate the courses of the selection of such a portfolio.

This paper includes two parts: in part one, we analysis the demand function for international reserves in Islamic countries. In this section, the version of the model employed here draw heavily on Elbadawi (1987). This model introduced in section I and estimates the reduced form model are presented in section II. Structural parameters estimates are computed and discussed and theoretical issues, such as elasticity for any of the factors affecting the demand in the short run and the long run, are examined. The most notable among these, is the test of our Hypothesis. In this frame / work we can also test for the implications of the monetary approach theory.

In the second part of this paper the objective function for foreign exchange reserves is formulated and considerations bearing on the choice of a foreign reserve portfolio are discussed. After it, the application of the model is demonstrated by estimating optimum portfolio for sixteen Islamic countries and mean of them for group is computed. Finally critical issues of reserve relationship and reserve portfolio for these countries are discussed.

## **1- Demand Function for International Reserves of Islamic Countries**

### ***1-1- The Theoretical Model***

The received posits a long run relationship in linear logarithmic form involving the following variable:  $R^*$ , the desired level of reserves;  $Z$ , the ratio of imports to domestic income  $y$ ; and  $\sigma$ , a measure of variability of reserves.  $R$  is generally defined as gross reserves, which includes monetary authorities holding

of gold and convertible foreign exchange, the country's reserve position in the fund, and the holdings of special drawing rights (SDR<sub>s</sub>). The scale measure  $y$  is usually taken to be the GNP, but owing to data limitation, we will use the GDP instead. The measure of variability,  $\sigma$ , is defined as the ratio of standard error of the trend-adjusted change in the stock of reserve to the level of balance of payments. This variable is viewed as a proxy for the theoretical concept of risk and uncertainty; and is computed by the variance of balance of payments. Therefore, it is expected to have a positive impact on the reserve holding. Finally, the average propensity to import,  $Z$  is theoretically justified as an argument in the model because it is considered an approximation to the marginal propensity to import. According to the theory, the direction of its impact is positive.

As mentioned earlier, the monetary approach to the balance of payments calls for a short run impact for the money market disequilibrium ( $m_t^* - m_{t-1}$ ) on reserves demand' specification. Where  $M^*$  and  $m$  refer respectively to the desired level of money and actual stock held. According to the theory, ( $m_t^* - m_{t-1}$ ) is expected to have a significant short run positive effect on reserves demand. We will include ( $m_t^* - m_{t-1}$ ) in the long run specification, however, with the testable implication that its long run effect is zero. Recognising the special characteristic of Islamic countries as a resource based countries, we include the expected exporting revenues variable. In the long run relationship. Expected exporting revenues are computed on the base of Friedman's theory of the permanent income. Therefore, expected exporting revenues are determined by past actual income receipts and it is a weighted average of past actual income with weights declining geometrically. According to the theory, direction of its impact on demand for reserve is positive.

Theory says, those countries willing to use exchange rate adjustment have a different demand function than fixed exchange rate countries. So that, countries with Flexibility exchange rate system hold less reserves than countries with fixed-rate system. This hypothesis is tested using dummy variables procedure,  $D=0$  for fixed exchange rate system, and  $D=1$  for managed flexible exchange rate system and,  $D=2$  for free flexible exchange rate system.

We posit a nominal long run reserve relationship in log linear form as follows:

$$R^* = a_0 + a_1 Y_t + a_2 Z_t + a_3 \sigma_t + a_4 Rem_t + a_5 (m_t^* - m_{t-1}) \quad (1)$$

The above equation is nominal, however in the estimation that follows the entire variable were expressed in real terms.

The long run nominal money demand relationship, in linear logarithmic form is:

$$m_t^* = \delta_0 + \delta_1 p_t + \delta_2 y_t + \delta_3 e_t + \delta_4 \Delta p_t \quad (2)$$

Where  $e_t$  is the average exchange rate and  $p_t$  is the consumer price index for each country. Ordinarily, the interest rate would be included. However, the interest rate in these countries appear to have little empirical relevance because this parameter as a component of money demand specification usually stems from accounting for opportunity cost of holding money. Financial assets do not constitute good substitutes for cash balance in these countries.

Using error correction mechanism and after some manipulations, we obtain the following reduced-term equation for demand function for money and demand function of international reserve: therefore, the equations to be estimated are (see Albadawi, 1988);

$$\begin{aligned} \Delta m_t = & \gamma_0 + \gamma_1 \Delta p_t + \gamma_2 \Delta y_t + \gamma_3 \Delta e_t + \gamma_4 (m_{t-1} - p_{t-1} - y_{t-1}) + \gamma_5 e_{t-1} \quad (3) \\ & + \gamma_6 R_{t-1} + \gamma_7 \Delta p_{t-1} + \gamma_8 p_{t-1} + \gamma_9 y_{t-1} + \varepsilon_{1t} \end{aligned}$$

$$\begin{aligned} \Delta R_t = & \theta_0 + \theta_1 y_t + \theta_2 \Delta z_t + \theta_3 \Delta \sigma_t + \theta_4 \Delta Rem_t + \theta_5 \hat{\Delta} m_t + \theta_6 \hat{\Delta}^2 m_t \\ & + \theta_7 (R_{t-1} - y_{t-1} - z_{t-1} - \sigma_{t-1} - Rem_{t-1}) + \theta_8 y_{t-1} + \theta_9 z_{t-1} \quad (4) \\ & + \theta_{10} \sigma_{t-1} + \theta_{11} Rem_{t-1} + \varepsilon_{2t} \end{aligned}$$

### ***1-2- The Empirical Results***

The model is estimated over the period 1975-2000 using annual data. The three variables (balance of payments, export and import for each country) are available in million U.S. dollars. Other variables are available in domestic currency denomination for each country. Using the average exchange rare, we transform the variable in equation to U.S. dollars denomination for the purpose of estimation, we use the U.S. whole sale price index to deflate our variable.

At first, we test the stationary of the all of variables. For this purpose, we use the Dickey-Fuller methodology. Our result reveals that, all of the data used in our models are integrated at order 1.

The estimation technique for expected export revenue function and money market disequilibrium function are ordinary least square (OLS). With replacing the quantity of parameters in this function, we computed their quantity value and used them for estimating demand function for international reserves. In addition, we use dummy variable for showing exchange rate system, D=0 for fixed exchange rate system, D=1 for managed flexible exchange rate system. For determining the method of estimation, we must do three tests:

### 1- Testing for the Significance of the Group Effects<sup>1</sup>

The F ratio used for test is:

$$F_{(n-1, n_t - n - k)} = \frac{(R_U^2 - R_p^2) / n - 1}{(1 - R_U^2) / (nt - n - k)} \quad F(15, 311) = 3.87$$

The critical value from table is 2.07, so the evidence is strongly in a favor of firm effect in data.

### 2- Testing for Homoscedasticity

Breush and Pagan (1980) have devised a Lagrange multiplier test for the random effects model based on the OLS residuals.

$$LM = \frac{T}{2} \sum \left[ \frac{S_i^2}{S^2} - 1 \right]^2 \sim X_{n-1}^2$$

LM is distributed as chi-squared with n-1 degree of freedom:

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1 - Greene, 2000, pp. 562 and pp 572.

Based on the result, the LM statistics equals 118.23. The critical value from the Chi-squared distribution with 15 degree of freedom is 32.80, so on the basis of the LM tests; we may reject the null hypothesis of homoscedasticity. Therefore, we must use generalized least square variable (GLSV) for estimation.

### 3- Hausman's Test for Fixed or Random Effect<sup>1</sup>

The Hausman test used for this test is:

$$W = X'_{[k]}(b - \hat{\beta})' \hat{\Sigma}^{-1} [b - \hat{\beta}]$$

The result shows that, the W statistics equals 41.36. The critical value from the Chi-square distribution with 9 degree of freedom is 23.56; therefore we must use fixed effect for estimation.

Therefore, the estimation technique for demand function for international reserve is generalized least square variable with fixed effect method (GLSV). Using this procedure, the following result is obtained for 16 Islamic countries:

$$\begin{aligned} Dlusres? = & 0.3 Dlmmy - 0.2 LusGDP? + 0.08 DlusGDP - 0.18 LBBP_1? \\ & (1.09) \quad (-2.39) \quad (0.87) \quad (-1.67) \\ + & 0.19 LSEXP_1? + 0.34 DLSEXP? - 3.24 LMMY_1? - 0.003 DLUSM? \\ & (1.47) \quad (2.01) \quad (-1.62) \quad (0.29) \\ - & 2.7E - 8 D2LUSM? - 0.14 Change51? - 0.05 Dummy? \\ & (0.29) \quad (-4.27) \quad (1.47) \end{aligned} \quad (5)$$

Weighted result

$$R^2 = 0.19$$

$$\bar{R}^2 = 0.09$$

$$P(F\text{-statistics}) = 0.0$$

$$D - W = 1.88$$

Unweighted result:

$$R^2 = 0.12$$

$$\bar{R}^2 = 0.02$$

$$D - W = 2.002$$



Where “users” is international reserves for each country, GDP is gross domestic product, "mmy" is the ratio of imports to domestic income, BBP is measure the variability of balance of payment, SEXP is expected export revenues and M refers to actual stock of money held by each country. All variables are in the U.S. Dollar sand t-statistics are in parentheses.

Now, our hypothesis must be tested. The relevance of money market disequilibrium can be tested by examining Wald test ( $\theta_5 = \theta_6 = 0$  in equation 4). The null hypothesis can be rejected at any reasonable level of significance. Therefore, this term is to be eliminated.

The long run restriction relating to  $y$ ,  $\sigma$ ,  $Z$  and  $Rem$  (equation 4) can be examined by Wald test therefore our hypothesis is  $\theta_8 = \theta_9 = \theta_{10} = \theta_{511} = 0$ .

We can not reject this hypothesis; therefore we must hold this variable in our estimation.

Imposing this restriction, equation 5 is re-estimated with the following results:

$$\begin{aligned}
 Dlusres? &= 0.15 \text{ change51?} - 0.046 \text{ Dummy?} - 0.37 \text{ DLMMY} \\
 &\quad (-4.96) \quad (-1.24) \quad (1.95) \\
 -0.22 \text{ LUSGDP1?} &+ 0.11 \text{ DLUSGDP?} - 0.21 \text{ LBBP1?} + 0.179 \text{ LSEXP1?} \\
 &\quad (-3.13) \quad (1.67) \quad (-2.15) \quad (1.58) \\
 +0.36 \text{ DLSEXP?} &- 3.66 \text{ LMMY1?} \\
 &\quad (2.44) \quad (-2.15)
 \end{aligned} \tag{6}$$

Weighted Statistics :

$$R^2 = 0.19$$

$$\bar{R}^2 = 0.11$$

$$\text{Prob}(F\text{-statistics}) = 0.0$$

$$D - W = 1.90$$

Unweighted Statistics :

$$R^2 = 0.11$$

$$\bar{R}^2 = 0.03$$

$$D - W = 2.04$$

C-Alg=2.45	C – Mor = 4.15
C-Irn=2.53	C – Ban = 2.35
C-Kuw=2.97	C – Egy = 2.97
C-Nig=2.43	C – Nig = 2.43
C- Oman = 2.78	C – Sud = 2.28
C – Pak= 2.323	C – Mal = - 0.58
C – Suod = 2.53	C – Indo = -2.95
C – Bah = 2.65	

We used equation (6) to derive estimates for structural parameters. To do that, we first require to correspond between  $\theta$ -vector estimated and the level of difference parameters i.e. the  $\beta$ -vector. Table (1) contains the point estimates of the level of difference effects and equilibrium parameters:

Table 1: Structural and Reduced Parameters

Variables	$\theta$	Parameters	$\beta$ 's quantity
DLuGDP	0.11	$\beta_1+\beta_2$	$\beta_7= 0.18$
DLMMY	0.37	$\beta_2+\beta_8$	$\beta_8 = 3.88$
DLBBP	0	$\beta_3+\beta_9$	$\beta_9=0.06$
DLSEXP	0.36	$\beta_4+\beta_{10}$	$\beta_{10}=0.031$
Chage 51	-0.75	$\beta_6-1$	$\beta_6=0.85$
LUSGDP	-0.22	$\beta_1+\beta_6-1$	$\beta_1=-0.07$
LMMY1	-66.3	$\beta_2+\beta_6-1$	$\beta_2=-3.51$
LBBP1	-0.21	$\beta_3+\beta_6-1$	$\beta_3=-0.06$
LESXP1	0.179	$\beta_4+\beta_6-1$	$\beta_4=0.032$
Dummy	-0.046	$\beta_{12}$	-0.46

Therefore we obtain the following reduced term equation for expected demand for international reserve.

$$\begin{aligned}
 E(R_t / \bar{S}_t) = & -0.07LUSGDP_t - 3.51LMMY_t - 0.06LBBP_t + 0.329LSEXP_t \\
 & + 0.85LUSres_{t-1} + 0.18dlUSGDP + 3.88DIMMY + 0.06DLBBP \\
 & + 0.031DLSEXP - 0.46Dummy
 \end{aligned}
 \tag{7}$$

The present result show that, the impact of expected exporting revenues in long run and short run equal to 0.179 and 0.36, respectively. These elasticities implies that one percent increase in the expected exporting revenues will cause the amount of required reserves to increase by 0.17 percent in long run and by 0.3 percent in short run. Therefore, expected export revenues have positive long run and short run effect on demand for international reserves.

As we noted earlier, short run money market disequilibrium does not have any significant effect on demand for international reserves. Therefore, this parameter will be eliminated from our estimation.

The impacts of gross domestic product (GDP), openness of economics and variability in balance of payments are positive in short run and negative in long run. The multiplier of GDP are respectively equal to -0.07 percent in long run and 0.18 percent in short run. Furthermore, the multiplier of average propensity to import equal to 3.88 percent in short run and -3.51 percent in long run. Finally the multiplier of variability of balance of payment equal to 0.06 percent in short run and -0.06 percent in long run. This elasticity implies that a one percent increase in these parameters will cause the amount of the required reserves to increase in short run and to decrease in long run.

The effect of the long run disequilibrium (error correction term) is -0.15 and it is quite significant. This value implies a magnitude of 0.85, which corresponds to the parameters in lagged reserves, estimated in usual partial adjustment frame work.

The impact of Dummy variable equals to -0.46 percent. This elasticity implies that countries with flexibility exchange rate system hold fewer reserves than countries with fixed-rate system.

## **2- Optimal Composition of Reserves for Islamic Countries**

### ***2-1- The Theoretical Model***

The framework which we will use to access optimal diversification is the mean-variance approach<sup>1</sup>. In particular, assuming that the objective function takes a simple form;

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1 - Eichengreen and Turtelboom / 1998, pp. 19-24.

$$U = m(r) - \left(\frac{b}{2}\right) \text{var}(r)$$

Where  $m(R)$  is the mean (weighted average) return on the portfolio,  $\text{var}(r)$  is the variance of the portfolio return, and  $b$  is the coefficient of relative risk aversion. Portfolio shares can be calculated as a simple function of expected return and variance-covariance matrix of returns. In particular, if portfolio shares are given by a vector  $X$  and return on the various currencies have expected values, and covariance's given respectively by a vector  $\rho$  and matrix  $\Omega$ , then:

$$m(r) = X' \rho \quad (7)$$

and

$$\text{var}(r) = X' \Omega X \quad (8)$$

And optimal shares can be written as a function of these expected returns and covariance's;

$$X^* = \Omega^{-1} \rho$$

Our initial calculation uses annual ex-post returns since 1985 on the U.S Dollar, the Japanese Yen, and the Deutsche Mark. Annual returns on each currency are calculated as the previous year's average short term rate (on treasury bills or comparable instrument), plus the changes in the exchange rate from the end of the previous year to the end of current year. Returns are calculated using exchange rate of each country with each of the 3 currencies. In order to calculate the real returns, we use wholesaler price indices of United States, Japan and Germany. The returns are converted into real terms by subtracting the ex-post change in the price index from the nominal return.

## 2-2- The Empirical Results

In this study, we used annual data for 16 Islamic countries for the period 1985-2000. Reserves held in the form of different currencies and values using and of period exchange rate.

The results reveal that the dollar has the highest return and standard deviation in compare to Deutsche mark and yen. Yen has lowest return and standard deviation than the Mark and the Dollar. But, an asset with a lower return may still be held in positive proportions if it contributes to lowering the portfolio's standard deviation.

**Table 2: Mean and Variance of Nominal and Real Expected Returns of Islamic Countries**

	Nominal Expected Return		Real Expected Return	
	<i>Mean</i>	<i>Standard Deviation</i>	<i>Mean</i>	<i>Standard Deviation</i>
<b>Dollar</b>	1791.12	76.48	1789.2	76.38
<b>Mark</b>	1619.38	63.65	1617.6	63.19
<b>Yen</b>	6.42	6.10	5.65	6.3

Using these mean returns and their covariance structure, we proceeds to calculate optimal portfolio shares. Here we need to make some assumption concerning the degree of risk aversion. We restrict ourselves to a range of 1 to 3 for  $b$ . it turns out that in this range shares do not vary much. The following table gives this calculated share for  $b=1$  to 3, the three currencies (which accounted to 83 percent of foreign exchange reserves) are rescaled so that their shares sum to 1.

**Table 3: Estimated Shares and Actual Share for Dollar, Mark and Yen**

	<b>B=1</b>	<b>B=2</b>	<b>B=3</b>	<b>Actual Share</b>
<b>Dollar</b>	0.38	0.38	0.37	0.62
<b>Mark</b>	0.41	0.41	0.42	0.10
<b>Yen</b>	0.25	0.252	0.255	0.05

As can be seen from the table 3, each of the calculated shares is positive. Mark has highest optimal share than the dollar and the yen. While yen's share is considerably smaller. The results reveal that when degree of risk aversion is increased, optimal share of Mark and Yen will be increased but optimal share of Dollar will be decrease. Therefore, with increasing degree of risk aversion, the optimal share of those currencies which have smaller standard deviation will be increased in reserve portfolio.

In addition, the calculated shares do not correspond at all closely to actual share, suggesting that other motives influence composition of reserve holdings. The calculated share for Dollar is half of the actual share. Therefore, one should not give too much weight to this optimal share, since they do not incorporate all the reasons for holding reserves.

## **Conclusion and Summary**

Foreign exchange reserve as part of a country's assets can be used by monetary authorities to finance international transactions, to pay foreign debts, to stabilize the exchange rate by interfering in the foreign exchange market, and to finance balance of payment deficit.

The value of the foreign reserves held by a country changes with changes in exchange rate. Hence, monetary authorities hold a diversified mix of foreign currencies in their basket of foreign exchange reserves.

This paper employs a version of error correction model (ECM) to investigate the demand for international reserves and mean-variance approach to determine the currency composition of foreign exchange reserves.

The results reveal that for Islamic countries:

1) Short run money market disequilibrium does not have any significant effect on demand for international reserves.

2) Expected revenue from export has positive long run and short run effect on demand for international reserves.

3) Exchange rate Flexibility has a negative effect on demand for international reserves.

4) The impacts of gross domestic product (GDP), openness of economies and variability in balance of payments on international reserves are positive in short run and negative in long run.

5) The currency composition of reserves has been influenced by risk and return associated with holding reserves asset denominated in different currencies.

6) The actual level of the Dollar and the Mark held by these countries is more than what they need, by theoretical implications.

7) With increasing degree of risk aversion, the optimal share of those currencies which have smaller standard deviation will be increased in reserves portfolio.

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