MANAGEMENT OF EXCHANGE RATE RISK IN TURKISH BANKING SECTOR: A MODEL AND TESTS

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ABSTRACT

In this paper, exchange rate risk management in the Turkish banking sector is analyzed with a portfolio model in which bank asset and liabilities consist of foreign exchange and domestic currency denominated items. The objective is to determine theoretically how a change in domestic and foreign interest rates as well as the volatility of exchange rates affects the portfolio structure of a typical Turkish bank and to determine the optimal foreign exchange positions by maximizing a concave utility function. Additionally, the application of testing the explanatory power of the parameters that are determined in the theoretical part of the paper indicated that lending interest rates, interest rates of government securities and the exchange rate volatility have different impacts on the foreign exchange positions of the banking sector and the bank groups.

1. INTRODUCTION

In the past few years, the banks' exposure to exchange rate risk has grown in importance due to the continuing expansion of foreign currency business, greater variability of exchange rates, increase in foreign exchange deposits and foreign borrowing in Turkish banking sector. During the1989-1993 period, the short positions of banking sector increased significantly. The main reason behind this development was that the rate of return in Turkish lira (TL) denominated assets remained above the nominal depreciation rate of theTL.

In this study, a portfolio model for the Turkish banking sector is developed. While modeling the profit function of a typical Turkish bank, the bank's portfolio decisions, and returns and costs of the loans, government securities portfolio and deposits are considered. To concentrate the analysis on exchange rate risk, it is assumed that the rate of increases in the TL cost of the US dollar and the DM are stochastic. Further, the bank will be constrained in its portfolio decisions by the balance sheet constraint and volume of credits. In

order to find the optimal values of net foreign exchange positions, the profit function of the bank is derived and risk-averse bank's expected utility maximization problem, where utility is a function of expected profits and profit variability, is solved.

According to the results, the net US dollar and Deutsche Mark (DM) positions of a bank are functions of the variances of the rates of increase in the TL cost of the US dollar and DM, covariance between rates of change in theTL/$ and the TL/DM and interest rate differences. The variance terms are proxies for foreign exchange risk. The implications of the model are tested for the period of 1989-1993 using the data for the sector as a whole, as well as for banks grouped according to ownership status.

The results indicate that the net DM position of the banking sector is more sensitive to the changes in exchange rate volatility and the change in the return of loans extended in the US dollar. Further, from the estimation results of the bank groups separately, it is found out that government banks are more sensitive to the changes in interest rates compared to the changes in the volatility of foreign exchange rates. Similar to government banks, the estimation results related with private Turkish banks show that the effect of the foreign exchange rate risk on the behaviour of private Turkish banks is smaller. Again, the interest rate difference terms affect the net US dollar positions. However, the explanatory power of the variable showing the interest rate difference in the DM is low in explaining the net DM positions, as in the case of the whole sector. On the other hand, the foreign exchange rate risks and the changes in interest rates are affective in explaining the foreign exchange rate behavior of foreign banks.

2. BANK PORTFOLIO MODELS: THEORETICAL BACKGROUND

In order to understand the functioning of the financial sector of the economy, the theory of bank behaviour appears to be important. In this section of the study, firstly the literature on micro bank modeling, methodologies on the optimal portfolio selection, mainly centering on the banks' optimal behaviour under exchange rate uncertainty, will be presented and then I will derive a portfolio model for the Turkish banking system under exchange rate uncertainty.

Santomero (1984) surveys various approaches on the state of micro bank modeling. He defines a bank as a firm attempting to maximize an objective function in terminal wealth. The bank uses quantity and/or price variables as control variables. Some regulatory constraints may constrain the opportunity set of assets or liabilities, on the one hand, they restrict the domain of the solution for one or more of the endogenous variables on the other. The bank may be an expected value maximizer or a risk-averse investor. If the bank is viewed as selecting a mean-variance efficient portfolio, as in Koehn and Santomero (1980), some forms of wealth concavity are assumed. If mean-variance efficiency is not the focus of attention, expected profit maximization is assumed as in Klein (1971). In his model, the decision rule is to maximize a linear expected utility function. However, there are many various arguments on the concept of the assumption of utility function concavity.

In micro bank modeling literature, the explanations for the existence of banks are summarized in three basic categories. The first one is asset allocation models which are discussed in the surveys of Baltensperger (1980) and Santomero (1984) as in the context of reserve management models and portfolio composition

models. Portfolio composition models take two forms in the literature. The first group of studies seeks to obtain an optimal asset size from the maximization of expected profit of the bank with a linear profit function. These, in general, are treated as reserve management models. The second form of portfolio choice models of asset allocation uses risk and return as criteria. The results of this approach imply that covariance of rates across the balance sheet have important implications. Secondly, the banking literature also covers the modeling of the liability side of the balance sheet of a banking firm. In general, the theory covers two types of modeling, deposit modeling and capital decision modeling as in Baltensperger (1980) and Startz (1983). Thirdly, there are some studies on modeling both sides of the balance sheet of a banking firm. Klein (1971) considers the asset-liability management problem. Furthermore, there are some studies about the form and the impact of the insurance on the quantity of capital and risk held by the bank and the capital desicion of the banking firm as in Koehn and Santomero (1980).

In risk aversion models, again the assumption of expected profit maximization is valid. Here, to simplify the model, a linear utility function for bank profit is assumed. The approach can be generalized to let the bank maximize the expectation of a utility function, instead of expected profit. Many of these models cover the asset-liability interactions and the determination of the bank scale[1]. Santomero (1983) analyses the credit and interest rate risk simultaneously in a model.

[1] "Pyle (1971) and Hart and Jaffee(1974) apply general portfolio theory where they assume the assets with exogenous (but stochastic) rates of return, and with liabilities treated as negative assets".

Another debate in banking literature is related to the objective function of a banking firm. Santomero (1983) and many others have analyzed the behaviour of banks which prefer to increase expected profit and reduce profit variability which requires a utility ($U = U(E(\pi), \sigma^2\pi)$) maximization where "$\pi$" denotes the bank profits. The other view is that the bank maximizes the value of its outstanding shares, as determined in a capital asset pricing model.[2] Thus, in modeling the foreign exchange behaviour of banks I used direct utility maximization as presented in section 3.1.

Although the banks deal with a wide range of currencies in the United States, the dollar remains the most important currency in the banking activities. Therefore, current literature covers the concept "hedging foreign exchange risk with asset-liability management" to a smaller extend. However, there are many studies on hedging foreign exchange risk with currency futures, options, swaps and forward operations.

Goodman (1982) develops a two-period microeconomic model of the behaviour of a value maximizing bank where foreign exchange behaviour and asset-liability management decisions are made simultaneously. In this model, banks must choose the amount of funds they wish to borrow, the speculative position in foreign exchange position they wish to undertake, and how to distribute their assets between loans and securities. The optimal distribution of assets, liabilities and foreign exchange positions are found by maximizing the market value of the bank subject to the balance sheet constraint; reserves and securities plus loans plus fixed cost associated with entering the foreign exchange market equal to managed liabilities and deposits plus paid in capital.

[2] In this study I do not deal with these capital asset pricing models.

Kaufold and Santomero (1986) analyze the credit and exchange rate risk management in the international banking firm by using a portfolio model. The objective is to determine the proportions of assets and liabilities that should be allocated to both domestic and foreign markets, given the credit and exchange rate uncertainty. They argue that the bank's net foreign involvement depends on interest rate differences corrected for expected exchange rate changes, the variances and covariances of interest and exchange rates, consumption pattern and regulatory factors. They also illustrate that the response ofthe bank to these factors depends on the bank's objective, and the underlying structure of uncertainty in the loan portfolio.

The bank portfolio composition model is as follows**: *"The banking firm purchases both domestic and foreign loans, with the nominal expost returns on each uncertain in the respective currencies as a result of credit risk. On the liability side, the lending activity is financed from capital (assumed fixed over the horizon) and the issuance of deposits denominated in both domestic and foreign currency. The bank's profit depends on its portfolio decisions and the stochastic returns and costs of the loans and deposits.*"**[3] Furthermore, the bank is constrained in the portfolio decisions first by the balance sheet constraint, total loans must sum to deposits plus capital and second by the US banking regulations limiting the volume of deposits with a proportion of capital. In their study, they determine the optimal portfolio strategies which maximize the utility and the value of the banking firm.

Their analyses cover two cases. In the first case, the net dollar and foreign currency positions are derived by assuming that there is

no credit risk in the model, expost returns on the loan portfolio are known with certainty and exchange rate is uncertain. The results indicate that optimal portfolio composition depends on the known expected loan returns, exchange rate risk and consumption pattern, although it is unaffected by the capital constraint imposed by the regulatory authority. In the second case, the model is extended to allow for uncertainty in the loans returns with the addition of credit risk in both domestic and foreign currency lending. The results indicate that the capital constraint affects the bank's international portfolio composition when both domestic and foreign loans are risky. In this case, capital constraint is effective in determining the optimal portfolio structure. In modeling the exchange rate risk management in the Turkish banking system, I mainly based the model on the bank portfolio composition of Kaufold and Santomero (1986).

3. THE MODEL

Dealing with different currencies brings opportunities and risks analogous to dealing on different interest rate conditions. Currency or exchange rate risk may have different effects on the value of a bank's assets and on the value of its liabilities and this difference will mean a change in net worth (or capital) and the profit of the bank. For instance, if local currency assets exceed local currency liabilities, a bank stands to gain from appreciation of the local currency and to lose from its depreciation. If local currency liabilities exceed local currency assets the reverse is true. Again much risk can be avoided by a totally matched balance sheet, which means that the currency composition of assets correspond to that of liabilities. Currency risk can be avoided either by keeping separate the operations in different currencies, i.e. DM lending funded by DM borrowing, dollar lending

[3] Kaufold and Santomero (1986).

funded by dollar borrowing, etc., or it can be avoided by compensating spot mismatched position with offsetting forward positions.

Moreover, a bank can hedge its exposure to exchange rate risk by taking a position in currency futures, options or swaps. In this study I do not deal with such kind of off-balance sheet activities or derivatives, since in the Turkish banking system such activities are in their infancy and are expected to expand in the future, following similar developments in other western banking systems. Therefore, banks in Turkey deal mostly with the management of the structure of their balance sheets in case of exchange rate risks.

While analyzing the exchange rate risk management in the Turkish banking sector, a portfolio model will be developed where asset-liability management decisions in domestic currency and foreign currencies are made simultaneously. The objective is to determine how the portfolio structure of a bank, consisting of loans and deposits that are available in both domestic and foreign currency terms, is affected by a change in the volatility of foreign exchange rates.

3.1. Procedure for Modeling the Bank's Portfolio

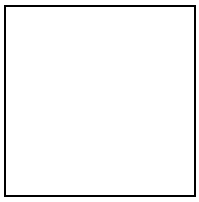
The asset side of the balance sheet of the bank will cover domestic loans and foreign loans extended (denominated in the DM and the US dollar). The liability side will cover domestic and foreign deposits and loans used (denominated in both currencies) and equity capital.

TABLE 3.4.1.1
BALANCE SHEET OF A BANK
(All values in domestic currency terms)

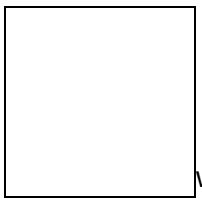
ASSETS	LIABILITIES & NET WORTH
Domestic Assets (DA)	Domestic Liabilities (DL)
US Dollar Assets (USDA)	US Dollar Liabilities (USDL)
DM Assets (DMA)	DM Liabilities (DML)
	Equity Capital (K)

In the model, "capital" is assumed to be fixed over the horizon. Assets and liabilities in terms of other currencies are ignored since in Turkey the foreign exchange positions of the banks are mostly in terms of the US dollar and the DM. Domestic assets cover the extended loans denominated in the TL. Besides, government securities are included the domestic assets due to its large share in "Securities Portfolio" in the consolidated balance sheet of the banking sector. Domestic and foreign liabilities are composed of the TL and foreign exchange deposits and loans used.

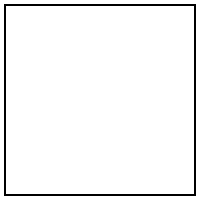
The banks' nominal profit will depend on its portfolio decisions and the returns and costs of the loans, government securities and deposits (cost function for the production of loans and deposits will be ignored).



(1)

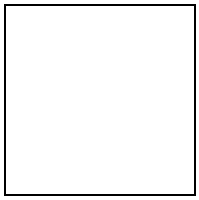


where the nominal returns are



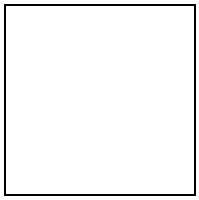
returns on domestic assets,

α_a = nominal rates of loans in terms of the US dollar,

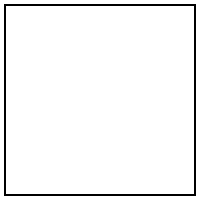


nominal rates of loans in terms of the DM,

α_l = nominal rates of deposits in terms of the US dollar,



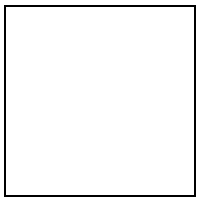
nominal rates of deposits in terms of the DM,



interest rate on deposits in domestic currency

In the analysis, it is assumed that nominal rates on loans, government securities and deposits are non-stochastic. Thus, there is no credit risk in the system.

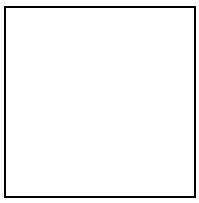
After converting the rates on foreign loans and deposits to domestic currency, the equation (1), the bank's nominal profit, can be written as following:



(2)

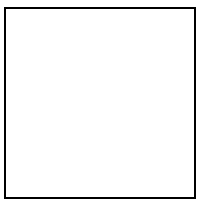
where the foreign currency rates in terms of domestic currency are

$$\alpha_a^* = \alpha_a + e_1 \quad (3)$$



(4)

$$\alpha_l^* = \alpha_l + e_1 \quad (5)$$



(6)

and where

e_1 = the rate of increase in the TL cost of the US dollar,

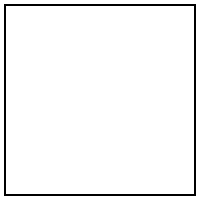
e_2 = the rate of increase in the TL cost of the DM.

To concentrate the analysis on exchange rate risk, I will assume that "e_1" and "e_2 are stochastic.

On the other hand, the bank will be constrained in its portfolio decisions by the balance sheet constraint,

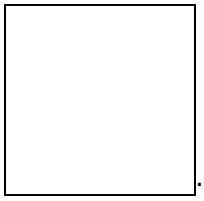
$$DA + USDA + DMA = DL + USDL + DML + K \quad (7)$$

Further, according to the Turkish banking regulations, the volume of credits extended must be a certain share of the bank's equity capital.

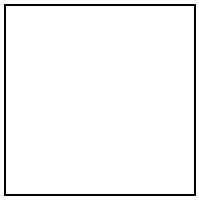


(8)

Assuming constraint (8) is binding, equations (7) and (8) indicate that,

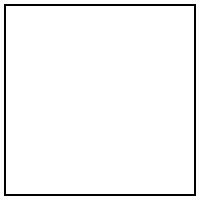


. (9)



(10)

Substituting the equations (3), (4), (5), (6), (9) and (10) into equation (2), the bank's profit can be rewritten as



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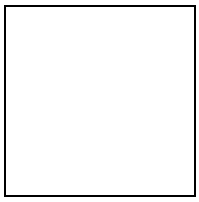

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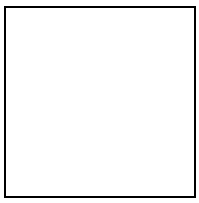
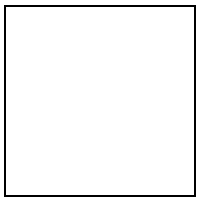


(13)

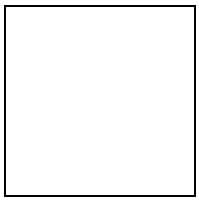
In equation (13), (α_a-i+e_1), (β_a-i+e_2),(α_l-r+e_1) and (β_l-r+e_2) denote the domestic interest rate differences in the TL terms.[4]

Santomero(1986) analyses the behaviour of banks and concludes that a bank has an objective in maximizing the utility by increasing expected profit and reducing profit variability as shown below

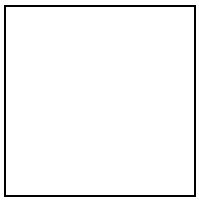


(14)

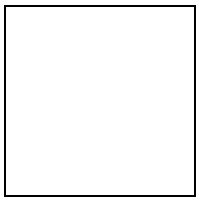
where

 the expected value of bank profits

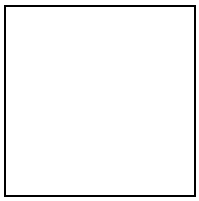
[4] Although I have determined these rates in the TL terms, I presented them as in the US dollar and the DM in the preceding sections in order not to confuse their difference.

 the variance of bank profits

Considering e_1 and e_2 as the only uncertainties, the expected profit and the variance of bank profits can be written as,



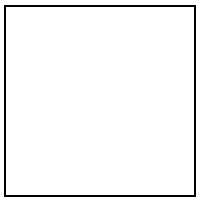
(15)



(16)

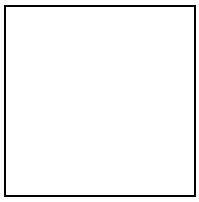
where σ^2_{e1} , σ^2_{e2}, ,σ_{e1e2} are the variance of the rate of increase in the TL cost of the US dollar (e_1), the variance of the rate of increase in the TL cost of the DM (e_2) and covariance of e_1 and e_2 respectively.

After taking the net foreign exchange positions into parentheses, the variance of the bank profits can be rewritten as

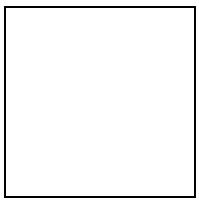


(17)

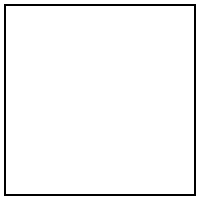
In addition, I have defined the interest rate differences in equation (15) as



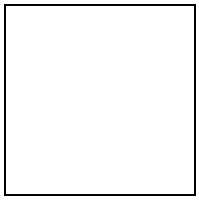
(18)



(19)

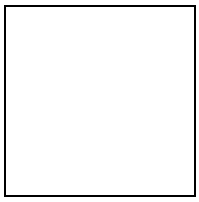


(20)



(21)

Then, according to equation (17), under only exchange rate uncertainty in the system, the market equilibrium is $\Psi_1 = \Psi_2$ and $\Omega_1 = \Omega_2$ which means that $i - r = \alpha_a - \alpha_l$ and $i - r = \beta_a - \beta_l$. Therefore, I can easily substitute "$\alpha_l - r - e_1$ " and "$\beta_l - r + e_2$ " with "$\alpha_a - i + e_1$ "and "$\beta_a - i + e_2$ " respectively in equation (15).



(22)

Suppose the bank chooses its foreign assets and foreign liabilities to maximize the concave utility function as shown in

equation (14). From equations (15) and (17), it can be seen that an increase in US dollar denominated assets matched by an identical rise in US dollar denominated liabilities or an increase in DM denominated assets matched by an identical rise in DM denominated liabilities does not effect the variance of profit, but raises (lowers) expected profit if $\Psi_1 \neq \Psi_2$ and $\Omega_1 \neq \Omega_2$.

Nevertheless, the differences (*USDA*-*USDL*) and (*DMA*-*DML*), in other words, the optimal foreign mismatch of the bank's portfolio, is uniquely determined. Differentiating the utility function, equation (14), with respect to the foreign mismatched positions, (*USDA*-*USDL*) and (*DMA*-*DML*), the optimal portfolio strategy of the bank can be derived.

Firstly, I have defined some of the components of equation (17) and (22) for the sake of simplicity as shown below;

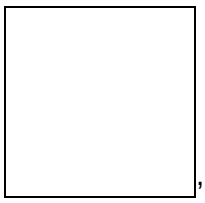
$$X = USDA - USDL \tag{23}$$

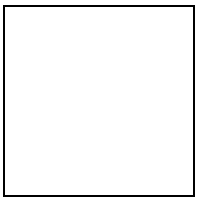
$$Y = DMA - DML \tag{24}$$

$$Z = \alpha_a - i - e_1^e \tag{25}$$

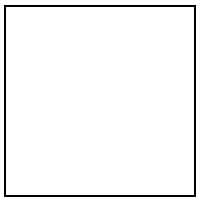
$$W = \beta_a - i - e_2^e \tag{26}$$

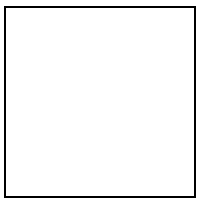
$$T = (1 - \delta)r + \delta l. \tag{27}$$

According to the discussion of the free extremum of  , the first order necessary condition may be stated in terms of the partial derivatives as follows;

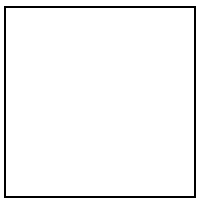
Maximize  (28)

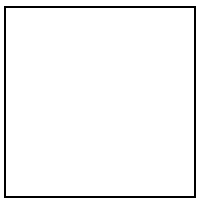
Subject to

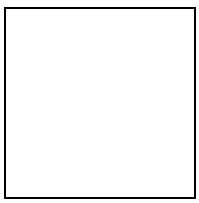
 (22)

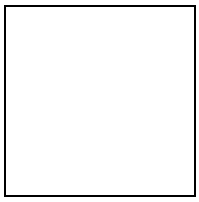
 (17)

The first order conditions are

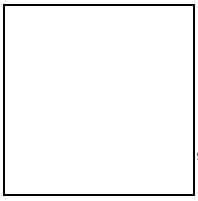
 (29)

 (30)

 (31)



(32)

From  , I can derive “X “and “Y” easily.

Firstly, I can derive “*u*” as in equation (33)

$$u_x = \frac{\alpha_a - i + e_1}{2X\sigma_{e1}^2 + 2Y\sigma_{e1e2}} \tag{33}$$

In other words,

$$X\sigma_{e1}^2 + Y\sigma_{e1e2} = \frac{\alpha_a - i + e_1}{2u} \tag{34}$$

and secondly,

$$u_Y = \frac{\beta_a - i + e_2}{2Y\sigma_{e2}^2 + 2X\sigma_{e1e2}} \tag{35}$$

or,

$$Y\sigma_{e2}^2 + X\sigma_{e1e2} = \frac{\beta_a - i + e_2}{2u} \tag{36}$$

If I write equations (34) and (36) in matrix notation,

$$\underbrace{\begin{vmatrix} \sigma_{e1}^2 & \sigma_{e1e2} \\ \sigma_{e1e2} & \sigma_{e2}^2 \end{vmatrix}}_{A} \underbrace{\begin{bmatrix} X \\ Y \end{bmatrix}}_{B} = \underbrace{\begin{bmatrix} \frac{\alpha_a - i + e_1}{2u} \\ \frac{\beta_a - i + e_2}{2u} \end{bmatrix}}_{C} \tag{37}$$

In order to find the optimal values of "*X*" and "*Y*", firstly I have to calculate the inverse of the matrix "*A*"

$$A^{-1} = \frac{\begin{vmatrix} \sigma_{e2}^2 - \sigma_{e1e2} \\ -\sigma_{e1e2}\sigma_{e1}^2 \end{vmatrix}}{\underline{\underline{|A|}}} \tag{38}$$

where $\underline{\underline{|A|}} = \sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2$ is the determinant of matrix A.

$$B_{1\times 2} = A^{-1}C_{2\times 2} \tag{39}$$

$$B = \frac{\begin{vmatrix} \sigma_{e2}^2 - \sigma_{e1e2} & \begin{bmatrix} \frac{\alpha_a - i + e_1}{2u} \\ \frac{\beta_a - i + e_2}{2u} \end{bmatrix} \\ -\sigma_{e1e2}\sigma_{e1}^2 \end{vmatrix}}{\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2} \tag{40}$$

$$\begin{vmatrix} X \\ Y \end{vmatrix} = \frac{1}{2}\frac{1}{\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2}\begin{bmatrix} \frac{\sigma_{e2}^2(\alpha_a - i + e_1)}{u} - \frac{\sigma_{e1e2}(\beta_a - i + e_2)}{u} \\ -\frac{\sigma_{e1e2}(\alpha_a - i + e_1)}{u} + \frac{\sigma_{e1}^2(\beta_a - i + e_2)}{u} \end{bmatrix} \tag{41}$$

Thus, the optimal portfolio strategies in terms of foreign currencies, the US dollar and the DM, is

$$X = \frac{1}{2u}\frac{\sigma_{e2}^2(\alpha_a - i + e_1) - \sigma_{e1e2}(\beta_a - i + e_2)}{\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2} \tag{42}$$

$$Y = \frac{1}{2u}\frac{\sigma_{e1}^2(\beta_a - i + e_2) - \sigma_{e1e2}(\alpha_a - i + e_1)}{\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2} \tag{43}$$

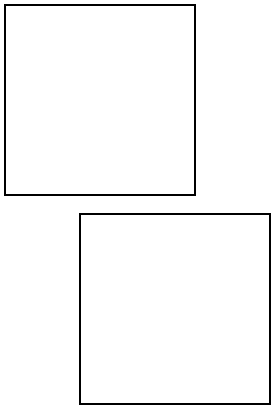
In equations (42) and (43), the term $u = \frac{-U_\sigma}{U_{\Pi^e}}$ represents the increase in expected profit required to compensate the bank for

bearing additional profit variability and the term in the denominator, $\left[\sigma_{e1}^2\sigma_{e2}^2-(\sigma_{e1e2})^2\right]\geq 0$, as long as $\left|\rho_{e1e2}\right|\leq 1$ where "ρ "is the correlation coefficient between e_1 and e_2. [5]

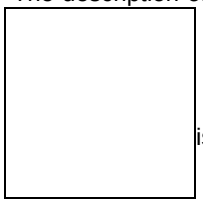
3.2. Comparative Static Analysis

Considering the equations (42) and (43), comparative-static analysis can be done in order to evaluate impact of the variables; the interest rates on bank lending and governments securities and the exchange rate volatility, on the foreign exchange positions of the banks.

First, the partial derivative of the net foreign exchange position of the bank denominated in US dollar with respect to the variance of the rate of increase in the TL cost of US dollar was taken as



(44)

[5]The description of "ρ" is referred to Ramanathan (1993, p.86) in which the quantity  is called the correlation coefficient between e_1 and e_2.

In all the derivatives that I have received from the comparative static analysis, the terms "*X*" and "*Y*" are defined as in equation (42) and (43), the term "*u*" is positive, indicating the risk averse behaviour of the bank, the term in the denominator, $\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right] \geq 0$, as long as $\left|\underline{\underline{\rho_{e1e2}}}\right| \leq 1$ where "ρ "is the correlation coefficient between e_1 and e_2 and the variance of e_1 and e_2 are positive statistically.

In the light of these assumptions, equation (44) implies that if the term $X < 0$ (the US dollar debts is larger than the total of US dollar holdings and receivables which means that the bank is in short position in US dollar), then the derivative $\frac{\partial X}{\partial \sigma_{e1}^2} > 0$ which means that an increase in the rate of increase in the domestic currency cost of the US dollar (the volatility of e_1 which is the term indicating the risk factor) will lead the bank to decrease its liabilities in terms of the US dollar and/or increase the bank's holdings in terms of the US dollar and hold a larger net position in the US dollar (a decrease in the short position in the US dollar). On the other hand, if the term $X > 0$ (long position in the US dollar), then the derivative $\frac{\partial X}{\partial \sigma_{e1}^2} < 0$ which means that an increase in foreign exchange risk will lead the bank to decrease the bank's holdings in terms of the US dollar, hold a smaller net position in the US dollar and to match its US dollar holdings and receivables with its the US dollar debts (a decrease in the long position in the US dollar).

Secondly, the partial derivative of the net foreign exchange position of the bank denominated in the US dollar with respect to the variance of the rate of increase in the TL cost of the DM was taken as

$$\frac{\partial X}{\partial \sigma_{e2}^2} = \frac{\sigma_{e1e2}\left[\sigma_{e1}^2(\beta_a - i + e_2) - \sigma_{e1e2}(\alpha_a - i + e_1)\right]}{2u\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]^2}$$

$$= \frac{\sigma_{e1e2}Y}{\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]} \qquad (45)$$

Assuming the term $\sigma_{e1e2} > 0$ (which means that e_1 and e_2 move in the same direction), then equation (45) implies that if the term, $Y < 0$, then the derivative $\frac{\partial X}{\partial \sigma_{e2}^2} < 0$ which means that an increase in foreign exchange risk will lead the bank to decrease the bank's holdings in terms of US dollar and hold a smaller net position in US dollars in order to increase its DM holdings. In other words, the bank sells US dollars in order to buy DM. If the term, $Y > 0$ then the derivative $\frac{\partial X}{\partial \sigma_{e2}^2} > 0$ which means that an increase in foreign exchange risk will lead the bank to increase the bank's holdings in terms of the US dollar and hold a larger net position in the US dollar in order to decrease its DM holdings. In other words the bank buys US dollar by selling its DM assets.

Thirdly, the partial derivative of the net foreign exchange position of the bank denominated in the US dollar with respect to the term, $\alpha_a - i + e_1$ was taken as

$$\frac{\partial X}{\partial(\alpha_a - i + e_1)} = \frac{\sigma_{e2}^2}{2u\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]} \qquad (46)$$

Thus, the equation (46) implies that the derivative $\frac{\partial X}{\partial(\alpha_a - i + e_1)} > 0$, i.e. an increase in the rate of increase in the interest rate difference term will lead a risk averse bank to increase the bank's holdings and receivables in terms of the US dollar and hold a larger net position in the US dollar (a decrease in the short position in the US dollar). Thus, the bank may prefer to extend credits in the US dollar.

Fourth, the partial derivative of the net foreign exchange position of the bank denominated in the US dollar with respect to the term, $\beta_a - i + e_2$ was taken as

$$\frac{\partial X}{\partial(\beta_a - i + e_2)} = \frac{-\sigma_{e1e2}}{2u\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]} \tag{47}$$

Taking the covariance of e_1 and e_2 as positive, equation (47) implies that the derivative $\frac{\partial X}{\partial(\beta_a - i + e_2)} < 0$ which indicates that an increase in the rate of increase in the interest rate difference term will lead a risk averse bank to hold a lesser net position in the US dollar (an increase in the short position in the US dollar) and buys the DM in order to extend credits in terms of the DM.

Fifth, the partial derivative of the net foreign exchange position of the bank denominated in the US dollar with respect to the covariance term, σ_{e1e2}, was taken as

$$\frac{\partial X}{\partial \sigma_{e1e2}} = \frac{(2\sigma_{e1e2}\sigma_{e2}^2)(\alpha_a - i + e_1) - (\beta_a - i + e_2)\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]}{2u\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]^2} \tag{48}$$

If the terms, $\beta_a + e_2 < i$ and $\alpha_a + e_1 > i$, then the equation (48) implies that the derivative $\frac{\partial X}{\partial \sigma_{e1e2}} > 0$ which indicates that, assuming e_1 and e_2 moving in the same direction, an increase in the covariance term, will lead the bank to hold a longer position in the US dollar. Seeing the TL interest rates above the return of assets in terms of the DM may lead the bank to hold a short position in the DM by increasing its US dollar assets and decreasing its DM assets.

Further, the same comparative static analysis for the net position of the bank in DM is done.

First, the partial derivative of the net foreign exchange position of the bank denominated in DM with respect to the σ^2_{e1} was taken as

$$\frac{\partial Y}{\partial \sigma^2_{e1}} = \frac{\sigma_{e1e2}\left[\sigma^2_{e2}(\alpha_a - i + e_1) - \sigma_{e1e2}(\beta_a - i + e_2)\right]}{2u\left[\sigma^2_{e1}\sigma^2_{e2} - (\sigma_{e1e2})^2\right]^2}$$
$$= \frac{\sigma_{e1e2} X}{\left[\sigma^2_{e1}\sigma^2_{e2} - (\sigma_{e1e2})^2\right]} \qquad (49)$$

In the light of these assumptions that I have presented above, equation (49) implies that assuming the term $\sigma_{e1e2} > 0$,if the term, X < 0, then the derivative $\frac{\partial Y}{\partial \sigma^2_{e1}} < 0$ which denotes that an increase in risk will induce the bank to decrease the bank's holdings in terms of DM and hold a smaller net position in DM in order to increase its US dollar holdings. In other words, the bank sells DM in order to buy US dollar. If the term, $X > 0$ then the derivative $\frac{\partial Y}{\partial \sigma^2_{e1}} > 0$ indicating that an increase in foreign exchange risk will lead the bank to increase the bank's holdings in terms of the DM and hold a larger net position in

DM in order to decrease its US dollar holdings. In other words, the bank buys DM by selling its US dollar assets.

Secondly, the partial derivative of the net foreign exchange position of the bank denominated in the DM with respect to the σ^2_{e2} was taken as

$$\frac{\partial Y}{\partial \sigma^2_{e2}} = \frac{-\sigma^2_{e1}\left[\sigma^2_{e1}(\beta_a - i + e_2) - \sigma_{e1e2}(\alpha_a - i + e_1)\right]}{2u\left[\sigma^2_{e1}\sigma^2_{e2} - (\sigma_{e1e2})^2\right]^2}$$
$$= \frac{-\sigma^2_{e1} Y}{\left[\sigma^2_{e1}\sigma^2_{e2} - (\sigma_{e1e2})^2\right]} \qquad (50)$$

Equation (50) implies that if the term $Y < 0$ then the derivative $\frac{\partial Y}{\partial \sigma^2_{e2}} > 0$ which indicates that an increase in foreign exchange risk will lead the bank to decrease its debts in terms of the DM and/or increase the bank's holdings in terms of DM and hold a larger net position in the DM. On the other hand, if the term $Y > 0$, then the derivative $\frac{\partial Y}{\partial \sigma^2_{e2}} < 0$ which indicates that an increase in foreign exchange risk will lead the bank to decrease the its holdings and receivables in terms of the DM, hold a smaller net position in the DM and to match its DM holdings and receivables with its DM debts.

Thirdly, the partial derivative of the net foreign exchange position of the bank denominated in the DM with respect to the term, $\alpha_a - i + e_1$ was taken as

$$\frac{\partial Y}{\partial(\alpha_a - i + e_1)} = \frac{-\sigma_{e1e2}}{2u\left[\sigma^2_{e1}\sigma^2_{e2} - (\sigma_{e1e2})^2\right]} \qquad (51)$$

Taking the covariance term as positive, the equation (51) implies that the derivative $\frac{\partial Y}{\partial(\alpha_a - i + e_1)} < 0$ which means that an increase in the rate of increase in the interest rate difference term will lead a risk averse bank to hold a lesser net position in the DM (an increase in the short position in the DM) and buys the US dollar in order to extend loans in terms of the US dollar.

Fourth, the partial derivative of the net foreign exchange position of the bank denominated in the DM with respect to the term, $\beta_a - i + e_2$,was taken as

$$\frac{\partial Y}{\partial(\beta_a - i + e_2)} = \frac{\sigma_{e1}^2}{2u\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]} \tag{52}$$

Thus, the equation (52) implies that the derivative $\frac{\partial Y}{\partial(\beta_a - i + e_2)} > 0$ which denotes that an increase in the rate of increase in the interest rate difference term will lead a risk averse bank to increase the bank's holdings in terms of the DM and hold a larger net position in the DM. Thus, the bank prefers to extend loans in the DM.

Fifth, the partial derivative of the net foreign exchange position of the bank denominated in DM with respect to the covariance term, σ_{e1e2}, was taken as

$$\frac{\partial Y}{\partial \sigma_{e1e2}} = \frac{(2\sigma_{e1e2}\sigma_{e1}^2)(\beta_a - i + e_2) - (\alpha_a - i + e_1)\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]}{2u\left[\sigma_{e1}^2\sigma_{e2}^2 - (\sigma_{e1e2})^2\right]^2} \tag{53}$$

If the term, $\alpha_a + e_1 < i$ and $\beta_a + e_2 > i$, then the equation (53) implies that the derivative $\frac{\partial Y}{\partial \sigma_{e1e2}} > 0$ which indicates that assuming e_1 and e_2 moving in the same direction, an increase in the covariance term, will lead the bank to hold a longer position in the DM. Seeing the TL interest rates above the return of assets in terms of US dollar may lead the bank to hold a short position in the US dollar by increasing its DM assets and decreasing its US dollar assets.

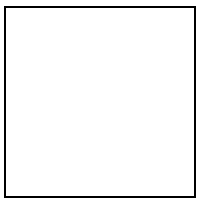
4. SELECTION OF DATA AND STATIONARITY ANALYSIS

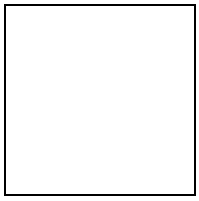
4.1. Selection of Data

The implications of the model discussed in section 3.2 are tested empirically using the monthly data for the period of 1989-1993. Foreign exchange holdings, receivables and liabilities of banks in the US dollar are taken from the Balance of Payments Division of the Central Bank of the Republic of Turkey (CBRT), weighted average of Treasury auction interest rates are taken from the Department of Money Markets and Fund Management and nominal interest rates on TL credits, nominal interest rates on foreign exchange credits are taken from the Department of Banking, and the rates of increase in the TL cost of the US dollar and the DM, the variances of the two exchange rates separately and the covariance of the two exchange rates are calculated according to the official exchange rates of the CBRT.

For exchange rates, the monthly average of the official exchange rate of the Central Bank of the Republic of Turkey, TL/$ and TL/DM selling rates are used. In calculating the rates of increase in the TL cost of the US dollar and the DM (e_1 and e_2 respectively), the yearly changes are taken.

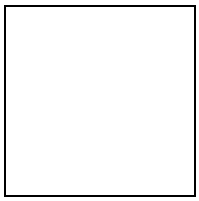
The time-varying measure of volatility of the exchange rates (σ_{e1}^2 and σ_{e2}^2) used in this study is a moving standard deviation of the growth rate of the nominal exchange rates expressed as

 and

 respectively,

where m = 3 is the order of moving average. In Koray (1993), "m" was taken as "12", but I prefer to take it as "3" in order to gain from degrees of freedom.

Moreover, for the time-varying measure of covariance of e_1 and e_2 (σ_{e1e2}), the moving standard deviation of the growth rate of the nominal exchange rates was adapted as



where m = 3 is the order of moving average.

Foreign exchange holdings and receivables (*USDA*) and liabilities (*USDL*) denominated in the US dollar and foreign exchange holdings and receivables and liabilities denominated in the DM on last Fridays of months have been used in place of the foreign exchange assets and liabilities of banks from their balance sheets. Since the data of (*DMA*) and (*DML*) is available in terms of US the dollar, I have converted all of them to domestic currency with the TL/$ selling rate. In addition, I have divided the banking sector into three groups

according to the ownership status as government, private and foreign. With this grouping, the total foreign exchange assets, receivables and liabilities for each bank group and for the whole sector was calculated[6].

While calculating the weighted average of Treasury auction interest rates and nominal interest rates on TL loans, I have taken the maximum of the annualized interest rates of auctions (3, 6, 9 or 12 months) held in a month and the monthly weighted average interest rates on short-term TL credits extended by the banks with the bank's source.

For the selection of nominal interest rates on foreign exchange loans, the monthly weighted average interest rates on short-term foreign exchange loans extended by the banks (α_a and β_a) is used. Due to the lack of the separation of foreign exchange credits extended by the banking sector into as US dollar and DM denominated credits, I have used the same rates for both of them in all the regressions.

4.2. Stationarity Analysis

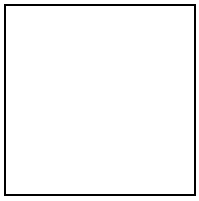
4.2.1. Theoretical Background

In order to find the structure of the relationship among various series, first I need to know whether the series are deterministic or stochastic, that is I have to know the order of integration of each series. The nature of the series, whether deterministic or stochastic has important implications for econometric analysis. A series is called stationary if its mean and variance do not change through time, and the covariance between values of the process at two time points will

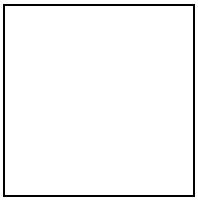
[6] Investment and development banks are not included into the estimations since the data are not reliable.

depend only on the distance between these time points and not on time itself. A nonstationary time series data may depart from its mean and variance with time. If this departure is consistently in one direction, then it can be said that the series exhibits a trend. If a time series contains deterministic linear trend then it can be made stationary by just detrending with a linear time trend. Further, if a time series contains a stochastic trend, namely, presence of unit roots, it can be made stationary by appropriate differencing. When there is a shock in the system, the response of the deterministic and stochastic series will be different. The effect of a shock will disappear through time in the trend stationary case. In contrast, the existence of unit root implies that a shock to the system will persist through time.

To determine the presence of the stochastic trend or linear time trend, the below regression is run.



(54)

where $\Delta Y(t) = Y(t)-Y(t-1)$,  is included for error autocorrelation and the residual series $u(t)$ is white noise. Testing for a unit root in $Y(t)$ requires testing $H_0 : \beta = 0$ versus $H_1 : \beta < 0$.

In the modeling strategy, unit root tests are applied according to the approach taken in Dolado and Jenkinson (1987)[7].

[7] For the details of unit root and stationarity analysis refer to Dickey and Fuller (1981), Engle and Yoo (1987), Engle and Granger (1987) and Fuller (1976).

In general, a series with unit root may become stationary by first differencing and seasonal differencing appropriate times. That is, if a series is integrated of order (*d*, *D*), then it can become stationary by first differencing d times and seasonal differencing *D* times (Ilmakunnas (1990, p. 79).

4.2.2. The Results of Unit Root Tests

Before estimating the equations, I have performed the unit root tests and the results are summarized in table 4.2.2.1.

In table 4.2.2.1, the term ΔY_t: the first difference of the dependent variable, *c*: constant term *T*: trend term, Y_{t-1} : the first lag of the dependent variable and Lags: lags of the dependent variable. The values in the table are the respective coefficients of variables and the values in the parentheses are the respective critical values computed for unit root tests from tables I, II and III of Dickey and Fuller (1981) and table 8.5.2 of Fuller (1976). The figures with a (*) are significant at 5 percent significance level.

In the general case, it is seen that the coefficients of Y_{t-1}'s are not significantly different from zero. According to equation (54) H_0: β=0 cannot be rejected. Therefore, there is evidence of unit-root in all the variables. For the remaining variables, I omit the trend term and check for the existence of unit root. It is seen that there is still evidence of unit root in all the variables in the case where there is no trend term, except *TDNPL*. After checking the significance of the constant terms, I decide that only the constant term of *TDNPL* is significant. Therefore, except for *TDNPL*, I estimated the equations one more time without the constant terms. I also applied diagnostic tests and concluded that the equations passed all the diagnostic tests (in every case).

Thus, it is concluded that *TDNPL* and *CVE* are stationary and there is unit root in all the other variables.

TABLE 4.2.2.1
Unit Root Tests (Without Constant Term)

ΔY_t	$Y(t-1)$	Lags
TDNPL(*)	-3.31 (-2.93)	1.2.....11
TDMNPL	2.18 (-1.95)	1,2,.....,12
GDNPL	0.85 (-1.95)	1,2,.....,12
GDMNPL	2.75 (-1.95)	1,2,.....,11
PDNPL	-1.19 (-1.95)	1,2,.....,12
PDMNPL	4.15 (-1.95)	1,2
FDNPL	2.43 (-1.95)	1,2,.....,7
FDMNPL	4.58 (-1.95)	1,2,.....,10
VDUSS	-0.28 (-1.95)	1,2,.....,9
VDODM	-1.65 (-1.95)	1,2,3
CVE	-1.96* (-1.95)	1,2,3,4
INTD1	-1.94 (-1.95)	1,2,.....,12
INTD2	-1.77 (-1.95)	1,2,.....,12

(*) with constant term

TDNPL = (total US dollar holdings and receivables of the banking sector – total US dollar liabilities of the banking sector)[8] ∗ (monthly average selling rate of TL/$),

TDMNPL = (total DM holdings and receivables of the banking sector – total DM liabilities of the banking sector) ∗ (monthly average selling rate of TL/$)[9]

GDNPL = (total US dollar holdings and receivables of the government banks – total US dollar liabilities of the government banks) ∗ (monthly average selling rate of TL/$)

GDMNPL = (total DM holdings and receivables of the government banks – total DM liabilities of the government banks) ∗ (monthly average selling rate of TL/$)

[8] All foreign exchange positions of the banks throughout the study are end-of-month values.
[9] All DM positions of the banks throughout the study are converted to the TL by multiplying with the TL/$ rate since they are available in terms of the US dollar.

PDNPL = (total US dollar holdings and receivables of the private Turkish banks – total US dollar liabilities of the private banks) ∗ (monthly average selling rate of TL/$)

PDMNPL = (total DM holdings and receivables of the private Turkish banks – total DM liabilities of the private banks) ∗ (monthly average selling rate of TL/$)

FDNPL = (total US dollar holdings and receivables of the foreign banks – total US dollar liabilities of the foreign banks) ∗ (monthly average selling rate of TL/$)

FDMNPL = (total DM holdings and receivables of the foreign banks – total DM liabilities of the foreign banks) ∗ (monthly average selling rate of TL/$)

VDUSS = Variance of the rate of increase in the TL cost of US dollar (σ_{e1}^2)[10]

VDODM = Variance of the rate of increase in the TL cost of DM (σ_{e2}^2)

CVE = Covariance of the rate of increase in the TL cost of US dollar with the rate of increase in the TL cost of DM

INTD1 = the monthly weighted average interest rates on short-term foreign exchange credits extended by the banks (α_a) – the weighted average of Treasury auction interest rates and nominal interest rates on TL credits[11] (i) + the rate of increase in the TL cost of US dollar (e_1)

INTD2 = the monthly weighted average interest rates on short-term foreign exchange credits extended by the banks (β_a)[12] – the weighted average of Treasury auction interest rates and nominal interest rates on TL credits[13] (i) + the rate of increase in the TL cost of US dollar (e_2)

5. ESTIMATION RESULTS AND THE DIAGNOSTIC TESTS

In Sections 3 and 4, the banking sector model with exchange rate risk and stationary analysis applied to the data that will be used in the estimations, are presented. Here, the equations (42) and (43) are not estimated directly since there is an identification problem in these equations and some assumptions have to be made in order to

[10]The calculation methods of the variance and covariance terms are as explained in part 4.1.

[11]The maximum of the yearly interest rates of auctions (3, 6, 9 or 12 months) held in a month and the monthly weighted average interest rates on short-term TL credits extended by the banks with the bank's source are used.

[12]Due to the lack of the separation of foreign exchange credits extended by the banking sector into as US dollar and DM denominated credits, the same rates are used for both of them in all the regressions

identify the variables effecting the net positions of banks in foreign currency. Instead, the explanatory power of the variables that are listed in the previous section in explaining all the net positions in the US dollar and the DM mentioned in the comparative static analysis (section 3.2) are analysed. The endogenous variables used in the estimations are as follows:

TDNPL = Net position of the banking sector denominated in the US dollar,

TDMNPL = Net position of the banking sector denominated in the DM,

GDNPL = Net position of the government banks denominated in the US dollar,

GDMNPL = Net position of the government banks denominated in the DM,

PDNPL = Net position of the private Turkish banks denominated in the US dollar,

PDMNPL = Net position of the private Turkish banks denominated in the DM,

FDNPL = Net Position of the foreign banks denominated in theUS dollar,

FDMNPL = Net position of the foreign banks denominated in the DM,

The exogenous variables are as follows:

VDUSS = Variance of the rate of increase in the Turkish lira cost of the US dollar (which shows the volatility of the exchange rate in other words the foreign exchange rate risk indicator)

VDODM = Variance of the rate of increase in the Turkish lira cost of the DM (which shows the volatility of the exchange rate in other words the foreign exchange rate risk indicator)

CVE = Covariance of the rate of increase in the Turkish lira cost of the US dollar with the rate of increase in the Turkish lira cost of the DM.

[13] I have taken the maximum of the yearly interest rates of auctions (3, 6, 9 or 12 months) held in a month and the monthly weighted average interest rates on short-term TL credits extended by the banks with the bank's source.

INTD1 = The monthly weighted average interest rates on short-term foreign exchange credits extended by the banks (α_a) – the weighted average of Treasury auction interest rates and nominal interest rates on Turkish lira credits (i) + the rate of increase in the Turkish lira cost of the US dollar (e_1)

INTD2 = the monthly weighted average interest rates on short-term foreign exchange credits extended by the banks (α_a) – the weighted average of Treasury auction interest rates and nominal interest rates on Turkish lira credits (i) + the rate of increase in the Turkish lira cost of the DM (e_2)

While estimating; the level of *CVE* and *TDNPL* will be used and the first difference of the other variables will be utilized in order to make them stationary[14]. The "general to the specific" approach is used throughout this section.[15] First, to get a rough idea of the maximum number of lags, some simple regressions are performed. After various attempts, the maximum number is constrained to four. In general, I do not omit the significant variables with the signs as we do not expect in order to see the difference of the foreign exchange risk behaviour among the banking groups. In addition, in some estimations, the lags of the variables are summed up in order to increase the significance of the variable and to improve the diagnostic tests. The diagnostic tests were applied to the estimations in order to determine the final specification.

The existence of error autocorrelation is analyzed, by testing for qth order residual autocorrelation (AR1 and AR12).[16] Under the null hypothesis, residuals are white noise and the distribution of the test statistics is F(q, T-k-q), where there are T observations and k regressors. Error autocorrelation is removed in all the equations by including the necessary polynomial lags.

[14] "Δ" denotes the first difference of the variables.
[15] See Hendry (1980)
[16] For more information see Godfrey (1978).

Further, a test for qth order autoregressive conditional heteroscedasticity (ARCH12) is performed.[17] Under the null hypothesis, variance of residuals are not autocorrelated, and the distribution of the test statistics is F(q, T-k-2q). qth order RESET is a test for specification error by using the square of the fitted values.[18] Under the null hypothesis of no specification error, the test statistics is distributed as F(q, T-k-q). Besides, the null hypothesis of normally distributed residuals (NORMALITY) are tested (based on a test of skewnewss and kurtosis of residuals)[19]. The normality of the residual terms are measured by Chi-square statistics.

5.1. Estimation Results of the Banking Sector

In Table 5.1.1A, the estimation results of the net position of the banking sector denominated in the US dollar are shown.

When Table 5.1.1A is examined, it is seen that the first lag of the dependent variable, (the variable indicating the sum of the first difference of the variance of the rate of increase in the Turkish lira cost of the US dollar of lag 1 and lag 2), third lag of the covariance the rate of increase in the Turkish lira cost of the US dollar with the rate of increase in the Turkish lira cost of the DM and the first lag of interest rate difference term in US dollar are highly significant and positively correlated with the dependent variable. I add the first lag of the dependent variable in order to remove the first degree autocorrelation problem. When I include the first and second lags of the variable "ΔVDUSS" separately, they are insignificant. Therefore, I add them up and include in this last specification.

[17] See Engle (1982).
[18] See Ramsey and Schmidt (1976).
[19] See Jargue and Bera (1980).

TABLE 5.1.1A
Estimation Results:
Net Position of the Banking Sector
Denominated in US Dollar[20]
Dependent Variable: *TDNPL*

Regressor	Coefficient	t-value
constant	0.044	0.39
TDNPL(-1)	0.761	9.14*
S2USS	0.091	2.14*
SODM	0.076	1.65
CVE(-3)	0.023	2.40*
ΔINTD1(-1) **	0.081	3.74*
ΔINTD2(-4)	-0.007	-0.40
d9205	1.292	2.40*

R^2 = 0.88; σ = 1.35;DW = 2.35 (1990.2 - 1993.2)

* "t" value is 2.02 for 5% significance level .

** "Δ" shows the first difference of tha variable

S2USS: The sum of the first difference of the variance of the rate of increase in the Turkish lira cost of the US dollar of lag 1 and lag 2 (ΔVDUSS(-1) + ΔVDUSS (-2))

SODM: The sum of the first difference of the variance of the rate of increase in the Turkish lira cost of the DM of the current level and lag 1.

d9205 is a dummy, being unity for t = 1992.5 and afterwards.

According to the estimation results above, an increase in foreign exchange risk (both TL/US dollar and TL/DM), the covariance term and the interest rate difference term (in US dollar) are leading to an increase in net position of banking sector in US dollar which means that the sector is preferring to stay in long position in response to higher foreign exchange rate risk and higher return from extending loans in foreign currency. The analysis of the net US dollar position of the banking sector implied that the sector was generally in long position in the US dollar during the period that is examined. On the other hand, the response of the sector to the rate of increase of

[20] Net positions are converted to the Turkish lira by multiplying with the average selling rate of TL/$.

the TL/DM and the interest rate difference term (in DM) are relatively lower. The t ratios of these variables are insignificant.

TABLE 5.1.1B
Diagnostic Tests:
Dependent Variable: *TDNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,28)=2.91 [0.199]	F(12,17)=0.66 [0.763]	F(12,17)=1,51 [0.212]	$Chi^2(2)$=0.203 [0.903]	F(1,28)=0.87 [0.358]

I also applied diagnostic tests and concluded that the equation passes all the diagnostic tests presented in Table 5.1.1B[21].

Next, net position of the banking sector denominated in DM is estimated as shown in Table 5.1.2A.

TABLE 5.1.2A
Estimation Results:
Net Position of the Banking Sector
Denominated in Deutche Mark[22]
Dependent Variable: Δ*TDMNPL*

Regressor	Coefficient	t-value
constant	-0.745	-4.07
ΔTDMNPL(-2)	-0.394	-2.52*
ΔVDUSS	0.239	2.04*
ΔVDODM(-2)	0.432	3.72*
CVE	0.052	3.59*
CVE(-3)	0.068	5.07*
ΔINTD1	-0.108	-2.54*
ΔINTD2(-1)	0.030	-1.03
d9301	-2.833	2.72*

R^2 = 0.66; σ = 1.38;DW = 1.51 (1989.11 - 1993.2)

When I examine Table 5.1.2A above, it is seen that the second lag of the dependent variable, the first difference of the variance term in the TL/US dollar, the first difference of the variance term in the

[21] The values in parenthesis are the respective probability values.
[22]Net positions are converted to Turkish lira by multiplying with the average selling rate of TL/$.

TL/DM, the current level and the third lag of the covariance term and the interest rate difference term in the US dollar are highly significant. The second lag of the dependent variable is added in order to remove the second degree autocorrelation problem.

According to the estimation results, an increase in foreign exchange risk (both TL/US dollar and TL/DM) and the covariance term are leading an increase in net position of banking sector in DM which means that the sector is preferring to increase its assets and/or decrease the liabilities in the US dollar in case of foreign exchange risk. Analysis of the net US dollar position of the banking sector implied that the sector was generally in short position in the DM during the period that is examined. Again, as in the first estimation, the response of the sector to the change in interest rate difference term (in DM) is relatively poor. The t ratios of this variable is insignificant and reverse of what I expect.

I also applied diagnostic tests and concluded that there is no autocorrelation problem and the equation passes all the diagnostic tests presented in Table 5.1.2B.

TABLE 5.1.2B
Diagnostic Tests:
Dependent Variable: Δ*TDMNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,29)=1.698 [0.203]	F(12,18)=0.58 [0.826]	F(12,18)=1.53 [0.327]	$Chi^2(2)$=2.059 [0.357]	F(1,29)=1.71 [0.201]

5.2. Estimation Results of the Government Banks

I estimated the net position of the government banks denominated in the US dollar as shown in Table 5.2.1A.

In Table 5.2.1A below, it is seen that the sum of the first and third lag of the interest difference term (in the US dollar) and the current level and the second lag of the interest rate difference term of the DM are highly significant. However, the current level of the first difference of the variance of the rate of increase in the TL/US dollar is significant and the TL/DM is insignificant and negatively correlated with the net position of the government banks denominated in the US dollar. Moreover, again as in total banking sector the explanatory power of volatility of the rate of increase in the TL/DM is poor and insignificance of the covariance term confirms this result.

TABLE 5.2.1A Estimation Results:
Net Position of the Government Banks
Denominated in US Dollar
Dependent Variable: Δ*GDNPL*

Regressor	Coefficient	t-value
constant	0.023	0.69
ΔVDUSS(-2)	0.057	2.55*
ΔVDODM(-3)	0.035	1.52
CVE	-0.005	-1.90
SINTD1	0.012	2.29*
ΔINTD2	-0.016	-2.61*
ΔINTD2(-2)	-0.015	-2.21*
d9301	0.891	4.28*

R^2 = 0.72; σ = 0.31;DW = 2.04 (1990.1 - 1993.2)

SINTD1: The sum of the first and the third lags of the first difference of the interest rate difference term in US the dollar.

According to the estimation results, an increase in the volatility of rate of increase in the TL/US dollar rate and the interest rate difference term of the US dollar is forcing the government banks to increase their net position in the US dollar. This means that the government banks prefer to increase their assets and/or decrease their liabilities in the US dollar when faced with foreign exchange risk. Analysis of the net US dollar position of the government banks indicated that they were both in short and long position in US dollar

during the 1989-1993 period. Besides, in case of an increase in the interest rate difference term in the DM, government banks are decreasing the net US dollar position, which implies that they are increasing the short position in US dollar in order to extend credits in DM terms.

TABLE 5.2.1B
Diagnostic Tests:
Dependent Variable: ΔG*DNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,29)=0.282 [0.600]	F(12,18)=1.29 [0.331]	F(12.18)=0.33 [0.974]	Chi^2(2)=0.768 [0.681]	F(1,29)=3.117 [0.088]

Next, the net position of the government banks denominated in DM is estimated as shown in Table 5.2.2A.

In Table 5.2.2A below, it is concluded that all the variables except the variance of the rate of increase of the TL/US dollar are highly significant, and the signs are as expected except the sign of the interest rate difference term of the DM. This indicates that government banks decrease the assets or increase the liabilities in the DM although the returns from loans extended in DM terms are high. Further, instead of putting them separately, the sum of the current level, first and second lags of the TL/DM rate is included in order the improve the significance of this term. This result again indicated that the government banks are not responsive enough to the developments in the foreign exchange rates. Therefore, these conclusions satisfied the increase in short position of government banks in the DM during the period that is examined.

TABLE 5.2.2A
Estimation Results:
Net Position of the Government Banks
Denominated in Deutche Mark
Dependent Variable: ΔG*DMNPL*

Regressor	Coefficient	t-value
constant	-0.112	-1.70
ΔGDMNPL(-2)	-0.459	-3.65*
ΔVDUSS(-1)	-0.071	-1.53
S2ODM	0.102	3.40*
CVE(-3)	0.017	3.14*
ΔINTD1(-1)	-0.062	-3.89*
ΔINTD2(-3)	-0.036	-2.64*
d9205	-2.301	-5.41*

R^2 = 0.69; σ = 0.58; DW = 2.39 (1990.11 - 1993.2)

S2ODM: The sum of the current level, first and second lags of the first difference of the variance term (TL/DM).

TABLE 5.2.2B
Diagnostic Tests:
Dependent Variable: ΔG*DMNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,29)=1.698 [0.203]	F(12,18)=0.83 [0.826]	F(12.18)=0.25 [0.990]	Chi^2(2)=2.059 [0.357]	F(1,29)=1.713 [0.201]

5.3 Estimation Results of the Private Turkish Banks

I almost reached the same results with the third estimation (net position of government banks in the US dollar) except the variance terms. Here, the volatility of the TL/US dollar rate is insignificant whereas the sum of the first and second lags of the variance of the TL/DM rate is significant. The covariance term is insignificant as in the third equation. The interest rate difference terms are significant and their signs are as expected. The results showed that the effect of the foreign exchange rate risk on the behaviour of private Turkish banks is small.

TABLE 5.3.1A
Estimation Results:
Net Position of the Private Turkish Banks
Denominated in US Dollar
Dependent Variable: ΔP*DNPL*

Regressor	Coefficient	t-value
constant	0.004	0.07
ΔPDMNPL(-1)	0.223	1.63
ΔVDUSS	0.028	0.69
S1ODM	0.091	2.70*
CVE(-3)	0.011	1.93
ΔINTD1	0.056	4.04*
ΔINTD2	-0.057	-4.59*
d9211	-3.919	-9.47*
d9105	-0.968	-2.56*

R^2 = 0.78; σ = 0.63;DW = 1.53 (1989.10 - 1993.2)

S1ODM: The sum of the first and second lags of the first difference of the variance term (TL/DM).

TABLE 5.3.1B
Diagnostic Tests:
Dependent Variable: ΔP*DNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,31)=0.831 [0.369]	F(12,20)=1.16 [0.367]	F(12,20)=1.37 [0.255]	Chi^2(2)=0.415 [0.812]	F(1,31)=1.573 [0.219]

The net DM position of Turkish private banks is estimated as presented in Table 5.3.2A. In table 5.3.2A, it is seen that the variances of both foreign exchange rates are not significant although the covariance term is found to be significant. The explanatory power of the variable showing the interest rate difference in the DM is low, consistent with the results of the second equation related with the whole sector. The interest rate difference term in the US dollar is negatively correlated with the net US dollar position which means that the private Turkish banks decreases their net position in the DM (by converting into the US dollar) when extending loan in terms of the US dollar is more profitable. Further, I add the second and third lags of the dependent variable in order to remove the second and third

degree autocorrelation. There is no problem of autocorrelation, and the test statistics are satisfactory (Table 5.3.2B).

TABLE 5.3.2A
Estimation Results:
Net Position of the Private Turkish Banks
Denominated in Deutche Mark
Dependent Variable: Δ*PDMNPL*

Regressor	Coefficient	t-value
constant	-0.544	-4.16
ΔPDMNPL(-2)	-0.387	-2.71*
ΔPDMNPL(-3)	-0.299	-2.03*
ΔVDUSS(-1)	0.042	0.47
ΔVDODM(-2)	0.048	0.63
CVE	0.043	3.93*
CVE(-3)	0.027	2.51*
ΔINTD1(-3)	-0.059	-2.31*
ΔINTD2(-1)	0.024	1.17
d9202	-2.229	-3.28*
d9208	-3.173	-4.55*
d9301	-1.861	-2.55*

R^2 = 0.76; σ = 1.02; DW = 1.77 (1990.1 - 1993.2)

TABLE 5.3.2B
Diagnostic Tests:
Dependent Variable: Δ*PDMNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,25)=0.182 [0.673]	F(12,24)=0 [0.835]	F(12,14)=0.27 [0.986]	Chi^2(2)=0.322 [0.851]	F(1,25)=1.711 [0.203]

5.4 Estimation Results of the Foreign Banks

Next, the net US dollar position of the foreign banks is estimated. The estimation results of the equation presented above showed that the term indicating the volatility of TL/US dollar rate, the covariance term, the fourth lag of the interest rate difference term in US dollar and the first difference of the interest rate difference term in DM are highly significant and the signs of the variables are as expected. On the other hand, the sign of the variance of the rate of increase in the TL/DM rate is the reverse of what is expected. During

the 1989-1993 period, the short positions of foreign banks are increasing continuously. As presented in the comparative static analysis section of the study, an increase in the TL/DM rate risk leads a risk averse bank to decrease the bank's holdings in terms of the US dollar and holds a smaller net position in the US dollar in order to increase its DM holdings. In other words, the bank sells its US dollar assets in order to buy DM. Additionally, there is no problem with autocorrelation and normality tests, the model passes all the diagnostic tests.

TABLE 5.4.1A
Estimation Results:
Net Position of the Foreign Banks
Denominated in US Dollar
Dependent Variable: ΔF*DNPL*

Regressor	Coefficient	t-value
constant	-0.038	-2.83
ΔVDUSS	0.027	2.71*
S4ODM	0.015	2.19*
CVE	0.005	3.96*
ΔINTD1(-4)	0.009	2.97*
ΔINTD2(-1)	-0.006	-2.17*
d9211	0.502	5.54*
d9301	-0.611	-6.95*

R^2 = 0.78; σ = 0.15; DW = 2.16 (1990.2 - 1993.2)

S4ODM: The sum of the current level, second and fourth lags of the first difference of the variance term (TL/DM).

TABLE 5.4.1B
Diagnostic Tests:
Dependent Variable: ΔF*DNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,28)=0.387 [0.539]	F(12,17)=0.57 [0.836]	F(12,17)=0.86 [0.596]	Chi^2(2)=1.709 [0.425]	F(1,28)=1.266 [0.610]

The estimation results of the net position of foreign banks in terms of the DM are very similar to the private Turkish banks as shown in Table 5.4.2A. The current level and third lag of covariance term, similar to the estimation results of the net position of the banking sector and the private Turkish banks, are highly significant. Besides, the second lag of the variance of rate of increase in the TL/DM rate is significant and positively correlated with the net DM position, consistent with the estimation results of the net DM position of the whole sector. As I mentioned before, an increase in the net DM position of a risk averse bank in case of an increase in the foreign exchange risk factor is expected if the bank is in short position in the DM. Since the short position of foreign banks has been increasing during the period that is examined, the sign of the variables are as expected. Although the sum of the current level and the first lag of the interest rate difference term in the DM is significant, these lags are insignificant when they are included into the equation separately. Thus, I again can conclude that the explanatory power of this variable is lower in explaining the changes in the net DM position consistent with the whole sector in the second equation. Additionally, the current level of the interest rate difference term in the US dollar is significant as in the estimation results of the net DM position of the sector and the net position of the private Turkish banks in the US dollar.

TABLE 5.4.2A
Estimation Results:
Net Position of the Foreign Banks
Denominated in Deutche Mark
Dependent Variable: ΔF*DMNPL*

Regressor	Coefficient	t-value
constant	-0.311	-2.34
ΔVDUSS(-1)	0.262	2.61*
ΔVDODM(-2)	0.235	2.31*
CVE	0.003	2.48*
CVE(-3)	0.004	4.40*
ΔINTD1	-0.009	-2.71*
SINTD2	0.004	2.30*
d9210	0.526	5.43*
d9212	-0.217	-2.55*
d9205	-0.199	-2.35*

R^2 = 0.81; σ = 0.15; DW = 1.94 (1989.11 -1993.2)

SINTD2: The sum of the current level and the first lag of the first difference of the interest rate difference term in the DM.

When the diagnostic test results is examined in Table 5.4.2B, it is seen that the model does not pass the test for the normality of residuals. There is no problem in other results.

TABLE 5.4.2B
Diagnostic Tests:
Dependent Variable: ΔF*DMNPL*

AR1	AR12	ARCH12	NORMALITY	LM RESET
F(1,29)=0.133 [0.717]	F(12,18)=0.66 [0.07]	F(12,18)=0.66 [0.763]	$Chi^2(2)$=0.925 [0.630]	F(1,29)=0.821 [0.372]

6. CONCLUSION

According to the results, the net US dollar and DM positions of a bank are functions of variance of the rate of increase in the Turkish lira cost of the US dollar and variance of the rate of increase in the Turkish lira cost of the DM which are proxies for the foreign exchange rate risk, covariance of the rate of increase in the Turkish lira cost of the US dollar with rate of increase in the Turkish lira cost of the DM

and the variables showing the interest rate difference terms in US dollar and the DM as mentioned before.

In the empirical part of the study, the focus of the analysis is on testing the explanatory power of the interest rate difference terms and the exchange rate volatility on the foreign exchange positions of the banking sector and the banking groups separately. It is found out that compared to the net US dollar positions, the net DM position of the banking sector is more sensitive to the changes in exchange rate volatility and the changes in the return of loans extended in the US dollar.

Further, from the estimation results of banking groups separately, it is concluded that government banks are more sensitive to the changes in interest rates compared to the changes in the volatility of foreign exchange rates. Besides, the effect of TL/US dollar rate volatility on the net US dollar positions and the effect of TL/DM volatility on the net DM positions are considerably important. When the asset sizes of government banks in Turkey are considered, it is seen that they are large-scaled and multiple-branched banks. Therefore, it is difficult for them to switch from one currency to another in case of foreign exchange rate risk in order to hedge themselves against foreign exchange rate risk.

Similar to government banks, the estimation results related with private Turkish banks showed that the effect of the foreign exchange rate risk on the behaviour of private Turkish banks is smaller. Again, the interest rate difference terms are significantly affecting the net US dollar positions, whereas, the explanatory power of the variable showing the interest rate difference term in DM is low, and consistent with the results of the net DM position of the whole sector.

On the other hand, according to the estimation results of the foreign banks, the foreign exchange rate risks and the changes in interest rates are highly effective in explaining the foreign exchange rate behaviour of foreign banks. In Turkey, foreign banks are small banks and have fewer branches, and they easily borrow from the European banking system. Although, during 1989-1993 period, they generally borrow in DM and lend in both currencies, the results indicate that they are more sensitive to the changes in the volatility of the TL/US dollar rate.

As a conclusion, this study indicates that the parameters, which are found in equations (42) and (43) related to the net foreign exchange positions in the US dollar and the DM are affective on the foreign exchange positions of banks.

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