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Exchange-Rate Exposure and the Financial Sector

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Abstract. In this study, we analyze the sensitivity of firms in Turkey's financial sector to fluctuations in exchange rates by using a market model. The existence of structural breaks is taken into account through the shifts in volatility by using the Iterated Cumulative Sum of Squares (ICSS) algorithm. We also aim to identify some firm-specific factors that indicate statistically significant exchange-rate exposure. The method we use is the binary logistic model. Our findings show that block/family ownership is important for exchange-rate exposure and that it increases the probability of observing significant exposure. Firm age is significant but its sign is different for different sectors. ROE has a positive impact on the banking and insurance sub-sectors, while firm size impacts that probability, as expected, with a negative sign.

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1. Introduction

Changes in exchange rates, unless they are expected, can impact the decision making and profitability of financial and non-financial firms. In particular, with the adoption of flexible exchange-rate regimes in the early 1970s, exchange-rate risk, contrary to expectations, has led to an increasingly riskier environment for firms with international transactions. However, a riskier environment does not necessarily mean higher risk at the firm level as

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firms can take advantage of risk-management practices in order to lower or completely eliminate that risk. Nevertheless, as illustrated by the financial crisis in Turkey in late 2000 and early 2001, the financial sector was not immune to changes in exchange rates, but more vulnerable than other sectors as a result of inadequate risk-management practices.[1]

Given the differences in risk-management practices, a firm's level of exposure to exchange-rate changes cannot be proxied by the standard deviation of relevant exchange rates or other more complex measures.[2] Based on the works of Dumas (1978), and Adler and Dumas (1980, 1984), the exchange-rate exposure of firms can be measured as the sensitivity of stock returns to exchange-rate movements. Some examples in the related literature are: Dominguez & Tesar (2001, 2006), Tai (2005), Fraser & Pantzalis (2004), Hahm (2004), Kıymaz (2003). Alternatively, one can use the sensitivity of cash flows to exchange-rate changes to measure exchange-rate exposure at the firm level (Martin & Mauer (2003, 2005)). Exchange-rate exposure can also show asymmetric behavior where currency appreciations and depreciations impact firm value differently, both in direction and in size (e.g., Bartov & Bodnar (1994), Koutmas & Martin (2003)). A recent and thorough survey of the literature on exchange-rate exposure is provided by Muller & Verschoor (2005).

Obviously, financial institutions play an important role in emerging markets, as evidenced by the financial crisis over the past decade or so. Inadequate risk-management practices can lead to a deterioration of bank balance sheets under unexpected exchange-rate changes. In the case of higher foreign currency liabilities rather than assets, this will reveal itself as a negative effect on the bank balance sheet (Hahm (2004)). The 2000-2001 financial crisis in Turkey exposed the vulnerability of banks and the financial sector to unexpected changes in currency value. For example, due to this crisis, around fifteen banks were taken over by Savings Deposit Insurance Fund (SDIF) over the 1999-2001 period.

This study investigates the exchange-rate exposure of firms in the financial sector – not only depository institutions – in Turkey from between January 1995 to September 2006. Our approach differs from earlier studies in two ways. Firstly, we employ the ICSS algorithm to identify structural

[1] For more detail on the crisis see Boratav and Yeldan (2002).
[2] E.g., GARCH or non-parametric measures to mention the few definitions. See Solakoglu (2005) for a range of risk measures at macro level.

breaks to estimate exposure levels for firms in the financial sector over different time periods. Secondly, we analyze the role of firm-specific factors on exposure level. Given the widespread problem of statistical insignificance with the exposure coefficient, we use logistic regression approach to identify factors that are relevant for the probability of observing a significant exposure to exchange-rate fluctuations for a period that we identify as stable.

The remainder of the paper is organized as follows. In section II, we discuss the data sources and report the estimation results of exchange-rate exposure models. Estimation results for the logistic regression are discussed in section 3. The last section presents our main conclusions and suggestions for further research.

2. Exchange Rate Exposure

The analysis is performed using monthly data at the firm level between January 1995 and September 2006. Firm level data and stock prices are obtained from *Istanbul Stock Exchange,*[3] while exchange-rate data is obtained from the statistical data web page of the Central Bank of Turkey.[4]

Considering the high correlation between monthly U.S. dollar (USD) and Euro returns, the analysis is conducted using USD only.[5] Moreover, given that more than 90% of international transactions in goods and services involve these two exchange rates,[6] the exclusion of other exchange rates should not be assumed to be overly restrictive.

Following earlier studies, exchange-rate exposure is calculated as the sensitivity of firm returns to exchange-rate movements. Specifically, we estimate the following market model:

$$R_{i,t} = \alpha + \beta_m R_{m,t} + \beta_s R_{s,t} + \varepsilon_{i,t}, \quad (1)$$

[3] www.ise.gov.tr

[4] Daily data on USD and Euro prices in terms of YTL are used to obtain monthly average prices.

[5] Between January 1999 and September 2006, the correlation coefficient between USD and Euro rate of return was 0.89.

[6] For 2006, about 49% and 44% of exports used Euro and USD, respectively. For imports, 38% and 59% of import-contracts were underwritten with these two currencies (source: Turkish Statistical Institute).

where $R_{i,t}$ is the return on firm stock, $R_{m,t}$ is the return on the market portfolio, and $R_{s,t}$ is the return on a portfolio consisting of USD only.[7]

Results of exchange-rate exposure estimations for the full sample are provided in table 1. It appears that average exchange-rate exposure for the firms in the financial sector is negative, though not overly significant as evidenced by mostly insignificant coefficient estimates. Given that the exchange rate is defined as the YTL value of a US dollar, a negative coefficient indicates a decline in firm value as a result of local currency depreciation. Interestingly, the "banking and special finance corporations" sub-sector faces with positive exposure to exchange-rate movements, implying that their firm value increases with a depreciation of local currency.[8] In other words, it appears that foreign-currency-denominated assets of these institutions outweigh foreign-currency-denominated liabilities. For the other sub-sectors though, average exposure beta is negative with most significant coefficients having the negative sign as well, i.e. a depreciating TL leads to a decline in firm value.

Table 1: Exchange rate exposure for full sample

Sector	# of Firms	# Significant	Direction[(a)]	Beta	σ_{beta}	Min Beta	Max Beta
Banks and Special Finance Corporations	12	1	(+)	0.066	0.254	-0.253	0.576
Insurance Companies	6	0	na	-0.105	0.272	-0.568	0.283
Financial Leasing and Factoring Companies	9	2	(-)	-0.139	0.391	-0.769	0.291
Holding and Investment Companies	18	2	(+), (-)	-0.125	0.367	-1.155	0.440
Real Estate Investments Trusts	9	2	(-)	-0.195	0.280	-0.587	0.204
Investments Trusts	20	1	(-)	-0.063	0.291	-0.871	0.434

(a): A plus sign indicates that the significant beta estimates are positive, while a negative sign indicates negative coefficient estimate. Given USD price of YTL is used in calculations, a positive sign indicates that firm value increases with YTL depreciation.

[7] Since Solakoglu (2005b) study does not find strong evidence for asymmetric exchange rate exposure, we do not apply asymmetry in the estimations.

[8] However, as we indicated earlier, this interpretation is based on the sign of the average exposure, and not on the significance. The number of statistically significant coefficients is limited implying that either firms are successful in hedging that risk or they do not have significant exposure.

Given that importers' and exporters' preferences for USD and Euro differ,[9] the movements in the USD-Euro exchange rate may also increase firms' exposure to exchange-rate risk. For financial firms, this parity risk can be important if foreign-currency-denominated assets and liabilities differ in the currency denominations. The market model is adjusted to reflect this additional risk, as shown by equation 2.

$$R_{i,t} = \alpha + \beta_m R_{m,t} + \beta_s R_{s,t} + \beta_p R_{p,t} + \varepsilon_{i,t} \quad (2)$$

In equation 2, $R_{p,t}$ is the return on USD-Euro exchange rate, while others have the same explanation as in equation 1. Table 2 presents results for model 2 for the period between February 1999 and September 2006. Our findings for the sensitivity of firm value to USD fluctuations are not significantly different from the previous findings. Although the average coefficient for parity risk implies a decline in firm value for all sub-sectors when USD depreciates against the Euro, the first sub-sector significant coefficient has the only positive sign. A positive coefficient, in that case, implies that USD liabilities should be higher than assets so that depreciation can increase firm value.

Table 2: Exchange rate exposure and Parity risk for full sample

Sector	# of Firms	# Significant[(a)]	Direction[(b)]	Beta	Parity
Banks and Special Finance Corporations	12	1,1	(+)	0.043	-0.082
Insurance Companies	6	0,1	na	-0.037	-0.365
Financial Leasing and Factoring Companies	9	2,3	(-)	-0.134	-1.044
Holding and Investment Companies	18	3,2	(-)	-0.138	-0.427
Real Estate Investments Trusts	9	2,0	na	-0.233	-0.315
Investments Trusts	20	1,3	(-)	-0.065	-0.495

(a) The number before the comma shows the number of significant for exposure beta, while the number after the comma shows the number of significant parity risk estimates.

(b): A plus sign indicates that the significant parity risk estimates are positive, while a negative sign indicates negative coefficient estimate. Since parity is denoted by the price of Euro in terms of USD, a positive sign indicates an increase in firm value as a result of USD depreciation.

[9] See footnote 6. In addition, a survey of the Turkish textile industry indicated that firms prefer USD for imports but Euro for Exports. Even a firm with both exports and imports indicate this preference as shown in Solakoglu and Ersin (2007).

However, as before, we observe a widespread finding of insignificant exchange-rate exposure and parity risk. Since we do not observe a perfect overlap between parity risk and exposure beta in terms of significance at the firm level, we use significance of either coefficients as an indication of exposure to the movements in the foreign exchange market.

In both tables 1 and 2, we utilize all available data points. However, world economies and the Turkish economy encountered several important crises and alterations during the considered timeframe, such as the introduction of the Euro. To determine the breakpoints in our series, we use the Iterated Cumulative Sum of Squares (ICSS) algorithm introduced by Inclan and Tiao (1994). The ICSS algorithm can be used to detect multiple breakpoints in a time series by testing for volatility shifts. Let's assume ε_t is the series in question with zero mean and σ^2_t as the unconditional variance. Inclan and Tiao (1994) define the cumulative sum of squares between time 1 and k as:

$$C_k = \sum_{t=1}^{k} \varepsilon_t^2, \text{ where t} = 1,...,\text{T and k} = 1,..,\text{T}$$

The centered and normalized cumulative sum of squares until time k is represented by the D_k statistics.

$$D_k = \frac{C_k}{C_T} - \frac{k}{T}, \quad \text{with } \text{D}_0 = \text{D}_\text{T} = 0$$

If there is no volatility shift in the series, the plot of D_k against k will oscillate around zero. On the other hand, with a volatility shift, we will observe D_k statistics drifting away from zero. Based on Inclan and Tiao (1994) study, an asymptotic critical value of 1.358 can be used to create boundaries to identify the point in time with a volatility shift.[10]

We use two series to identify the sudden changes in volatility. The time-points of the shifts can be used as the break points in the analysis. The

[10] Critical values are calculated from the distribution of D_k under the the null hypothesis of homogeneous variance. One can use the critical values to obtain upper and lower boundaries to detect volatility shifts. For details on the ICSS algorithm and some uses, please see: Inclan and Tiao (1994), Ewing and Malik (2005), Marcelo et al (2006).

series we consider are the return on market portfolio, as represented by the ISE100 index, and the return on US dollar. The breakpoints are presented in table 3.

Table 3: Return, Beta estimates, and Breaks

Series	# of Breaks	Period	Average Return	Standard Error	Exposure Beta	Parity Beta	# significant	Sig Exp Beta	Sig Parity Beta	Explanation
ISE100	2	Jan 1995 - Oct 2001	6.61%	28.30%	-0.341	na	8,na	-1.399	na	Turkish financial crisis in 2001
		Nov 2001 - Sep 2006	4.27%	20.26%	0.2214	-0.1519	8,4	1.027	-1.899	Post-crisis period
USD	5	Jan 1995 - Nov 1997	8.62%	25.86%	-0.257	na	2,na	-2.138	na	
		Dec 1997 - Sep 2000	7.73%	29.37%	-2.453	na	13,na	-3.990	na	Asian crisis period: Russian crisis
		Oct 2000 - Nov 2000*	-11.59%	28.46%	na	na	na	na	na	Turkish crisis first revealed itself in Nov of 2000; Technology bubble burst in USA
		Dec 2000 - Nov 2001	4.64%	28.50%	-0.350	-1.385	11,19	-0.769	-2.752	Crisis period in Turkey; European Monetary Union (Euro): September 11
		Dec 2001 - Sep 2006	3.95%	20.07%	0.239	-0.126	10,5	0.957	-1.268	Post-crisis period

*: Included in the Dec 2000-Nov 2001 period

There are 2 breakpoints identified by the ICSS algorithm when the market portfolio (ISE100) index is used. The first period, January 1995 to October 2001, corresponds to before the 2001 crisis in Turkey. Given the recent introduction of the Euro, and the stickiness of transactions denominated in US dollars in Turkey, we decided not to include a proxy for parity risk. A comparison of pre and post-crisis periods shows that only a small number of firms in the financial sector have significant exposure to exchange-rate movements.[11] Interestingly, exposure beta is positive post-crisis, while it is negative for the pre-crisis period. In other words, firm value is positively impacted by the depreciation of the local currency in the post-crisis period and is negatively impacted in the pre-crisis period. In addition, the depreciation of USD against Euro in the post-crisis period leads to a decline in firm value. This may imply that assets are mostly denominated in USD, and liabilities are mostly denominated in Euro.

[11] The reported number of significant cases will be underestimating the true number as our dataset includes firms that exist as of 2006. However, several companies in the financial sector, specifically in banking, went bankrupt after the crisis.

When USD return series is used to identify the breaks, ICSS algorithm returns 5 breakpoints. The breaks, as shown by the explanations in the last column of table 3, correspond mostly to crisis periods. Specifically, the period between October 2000 and November 2001 indicates a decline in firm value as a result of local-currency depreciations against USD or USD against Euro. The number of significant cases is much higher indicating the open positions of firms during this period. As before, in the last period, the sensitivity of firm value to movements in US dollar changes its sign from negative to positive. We believe that this was the result of the 2000-2001 crisis and the increased role of the Euro, and hence the importance of parity exchange rate between USD and Euro in the Turkish financial environment.

3. Firm-Specific Factors and Exchange Rate Exposure

Since both series indicate that there were no shifts in volatility, and hence a breakpoint, after 2001, we focus our attention to firm-specific factors and try to identify factors that cause firm value to be impacted by exchange-rate fluctuations. Instead of focusing on exposure coefficient estimates and firm characteristics, we focus on the existence of significant exposure and firm characteristics as indicated earlier. The analysis uses the logistic regression approach for the years 2004 to 2006. These years are selected based on the breaks identified by the ICSS algorithm, the availability of firm-specific data, and also by the stability of the Turkish economy during these years. Exposures and their significance are estimated by a 24-month rolling regression.

The model we use is given below.

$$Exposure_{it}=\alpha_{it}+\beta_1 Age_{it}+\beta_2 Size_{it}+\beta_3 (MC/BV)_{it}+\beta_4 ROE_{it}+u_{it} \quad (3)$$

where the *Exposure* variable is a binary variable taking values of 0 and 1, with 1 indicating statistically significant exposure to exchange-rate fluctuations. In determining the values for the exposure variable, we rely on the estimation results of equation 1 and set exposure equal to 1 when the exposure coefficient is statistically significant. The *Age* variable represents the firm's age, and the *Size* variable measures the size of the firm through the number of employees. Both size and age variables are in natural logarithms. Family ownership is also a binary variable and it shows the control of family or holding companies. The variable (MC/BV) is the ratio of market capitalization to book value. This variable captures the investor's perception

of the future cash-flow expectations. The last variable, ROE, represents the current accounting performance of the firm. Since our dependent variable is binary, we use logistic distribution as our link function to define the probability of detecting significant currency exposure. That is:

$$\Pr(exposure_t = 1 \mid I_t) = \frac{1}{1+\exp(-\widehat{exposure}_t)}$$

where $\widehat{exposure}$ represents the predicted value from the regression, and exp denotes exponential function in this equation. Through this link function, the probability of detecting significant exposure ranges between 0 and 1, and other problems associated with the linear probability model are eliminated (see, Greene, chap. 21, 1993).

We believe firm size and age are important determinants of exchange-rate exposure. Under the globally competitive business conditions, in order to have sustainable growth a firm must search for opportunities not only in the local market but also in foreign markets. Hence, it is natural for larger firms to have international transactions and a higher likelihood of exposing themselves to exchange-rate risk. Similarly, younger firms are expected to be in their growth stage and utilize all opportunities to grow. Hence, we should expect a positive relationship between size and currency exposure. On the other hand, larger and older firms are expected to have the necessary resources to hedge exchange-rate risk through several strategies. Hence, larger and older firms may not be sensitive to fluctuations in exchange rates. Thus, it may not be clear how size and age variables can impact firm-level exposure (Dominguez and Tesar, 2006). As discussed in the literature, family ownership can influence firm performance positively (see, for example, Demsetz and Villalonga (2001), Maury and Pajuste (2005), Maury (2006)). Moreover, these firms can have a lower exposure to exchange-rate movements as they can have a higher degree of risk aversion and thus take lower risks in international transactions.

Table 4 presents estimation results for the logistic regression. Results are presented for all firms, and for firms segmented into two groups of sectors with the first group – sectors 1,2 – including firms in "Banks and Special Finance Corporations" and "Insurance Companies", and the second groups including the remaining sub-sectors. For all firms, we find that firm age has a negative effect on the probability of having significant exposure to exchange-rate fluctuations. This should not be surprising as discussed earlier. On the other hand, family owned firms appear to have a higher

probability than others, indicating that these firms are either less concerned about the risk or that they do not have the required resources. The size of the firm and other variables do not show any significant impacts.

Table 4: Estimation results of Logistic regression

		Sectors	
Variable	**All Sample**	**1,2**	**3,4,5,6**
Age of the Firm	-0.8963***	1.9394*	-0.8240**
	0.1932	1.0095	0.3280
Family Ownership (Binary)	0.8793**	5.2948**	2.0373***
	0.3770	2.0705	0.6533
Size of the Firm	0.1058	-2.1045***	-0.5727
	0.0960	0.7849	0.2333
Market Cap/Book Value	0.1040	0.9036	0.0238
	0.0732	0.6284	0.2237
ROE	0.3920	19.6270**	0.2747
	0.6276	7.7456	0.8917
Log L	-94.63	-14.54	-51.55

***, **, * represents statistical significance at 1%, 5% and 10%, respectively.
Sectors 1 and 2 are "Banks and Special Finance Corporations" and "Insurance Companies".
Firm size is measured by the number of employees.
Both Age and Size variables are in natural logarithms.

For sub-sectors 1 and 2, firm age, family control and ROE all show positive and significant coefficient estimates. That is, the level of probability is positively associated with these variables. It is surprising that older firms are more likely to take currency risk, but perhaps older firms are the ones with a larger share of family ownership. Higher returns on equity, one can argue, can indicate higher risk-taking for higher profits. The size of the firm, on the other hand, leads to a decline in that probability. The second segment of sectors – sectors 3 to 6 – shows that only firm age and family control impact probability. While the probability of exposing firm value significantly to exchange-rate fluctuations declines with age, it increases with family control as in the first segment.

4. Concluding Remarks

We investigate the sensitivity of firm value to fluctuations in exchange rates using a market model for Turkey's financial sector. With the exception of the "Banking and Special Finance Corporations" sub-sector, we find that a depreciation of the local currency leads to a decline in firm value. Moreover, only a small number of firms show significant exposure to exchange-rate fluctuations indicating that most firms are successfully protecting themselves from currency risk.

By using the ICSS algorithm, we identify the breakpoints in our sample. A stable period is selected based on the breaks to analyze the role of firm-specific factors on significant exposure to exchange-rate movements. We use the logistic regression method and consider only significant exposures. Results indicate that larger firms are more likely to be impacted less by exchange-rate movements. Family ownership, on the other hand, causes an increase in the probability of observing significant exposure. Firm age seems to have different effects based on the sub-sectors, while ROE has only a positive effect for the banking and insurance sectors.

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