

Exchange Rate Exposure and Firm-Specific Factors: Evidence from Turkey

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Abstract: This study examines the relationship between exchange rate exposure and firm-specific factors - firm size, maturity, level of international activity, a measure of natural-hedging - using panel data approach. Exchange rate exposure of Turkish firms between 2001 and 2003 is estimated using capital market approach. Results show that the size of the firm and the level of international activity are significant in lowering the exposure. In addition, firms that can be characterized as net-exporters or net-importers are more likely to have significant exposure to exchange rate movements.

JEL Classification Codes: F31, G15.

Keywords: Exchange rate exposure, Capital market approach, Firm-level exposure, Logistic regression.

1. Introduction

Exchange rate movements have been a big concern for investors, analyst, managers and shareholders since the breakdown of Bretton Woods system in the 1970s. Contrary to expectations, exchange rate risk, as measured by volatility¹, has increased tremendously with the breakdown affecting cash flows and stock prices of firms. However, an increase in risk does not necessarily imply an increase in the firms' exposure to risk. As suggested by Dumas (1978) and Adler and Dumas (1980, 1984), exchange rate exposure of firms can be measured by the sensitivity of stock returns to exchange rate

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¹ Many alternatives are used in the literature ranging from standard deviations to conditional volatility from a GARCH type model. For some examples, see Jorion (1995), Solakoglu (2005).

movements. Alternatively, one can also quantify the exposure as the sensitivity of cash flows to exchange rate movements.

There are many studies investigating the exchange rate exposure either at the firm level or at the industry level. Some studies use the capital market approach to measure exchange rate exposure by regressing firm returns on market portfolio return and a return on an exchange rate measure (e.g., Dominguez & Tesar (2001, 2006), Tai (2005), Fraser & Pantzalis (2004), Hahm (2004), Kıymaz (2003)), while others use cash-flow methodology to capture the sensitivity of cash flows to exchange rate movements (e.g., Martin & Mauer (2003, 2005)²). In addition, it is also argued that appreciations and depreciations of currencies can influence how firm returns respond to exchange rate movements, indicating asymmetries in the exposure (e.g., Bartov & Bodnar (1994), Koutmas & Martin (2003))³.

This study utilizes capital market approach to identify exchange rate exposure for Turkish firms between 2001 and 2003. Our main objective is to investigate the factors that influence exchange rate exposure at the firm level. Our approach differs from earlier studies in three ways. First, we employ panel data approach to consider the variations over time as well as variations over firms to analyze the role of firm-specific factors on exposure. Second, along with these factors, we evaluate the role of natural hedging strategies on the exposure level of firms. Last, we try to identify firm-specific factors that raise the probability of significant exchange rate exposure using logistic regression.

The remainder of the paper is organized as follows. Section II discusses the model specification and data sources, along with the results. Last section presents our main conclusions and suggestions for further research.

² Martin & Mauer (2005) compares capital market and cash-flow approaches for the U.S. banks and find that cash-flow approach is better in detecting significant exposure coefficients.

³ Muller & Verschoor (2005) provides a good survey on theoretical foundations and empirical evidence on exposure.

2. Model Specification, Implementation and Results

The analysis is performed using weekly⁴ data at the firm level between the years 2001 and 2003. Daily stock prices, market index⁵ and exchange rates for USD and Euro are obtained from www.analiz.com for 137 firms in Turkey. Only these firms are used in the analysis, because either they had international transactions or had non-missing data for the analysis⁶. Other firm level data is obtained from *Istanbul Stock Exchange*⁷.

For the firm-level identification of exchange rate exposure, only two exchange rates are used: TL/Euro and TL/USD. Given that 70% of international transactions in goods and services, for the top 18 trading-partners, involve these two exchange rates, this should not create a significant constraint on the analysis. Furthermore, given the high correlation between weekly returns of Euro and USD, a portfolio of these two currencies with equal weights is used in the analysis⁸.

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

$$R_{i,t} = \alpha + \beta_m R_{m,t} + \beta_s R_{s,t} + \varepsilon_{i,t}, \quad i=1 \text{ to } 137 \quad (1)$$

where $R_{i,t}$ is the firm return, $R_{m,t}$ is the return on the market portfolio, and $R_{s,t}$ is the return on a portfolio consisting of Euro and USD. Average exposure beta is found as 0.4164 for 2003⁹ which is close to 2001 and 2002

⁴ Weekly prices are obtained by taking weekly averages of daily prices. As indicated by Mark (1990), exchange rate movements are dominated by nominal exchange rate movements in the short-run and hence the choice of nominal or real exchange rates in estimations lose its importance when high-frequency data is used.

⁵ Index includes 100 firms traded in Istanbul Stock Exchange.

⁶ About 87% of the firms are in manufacturing, and about 10% are in construction industries. The remaining firms are operating in other industries.

⁷ www.ise.gov.tr

⁸ Utilizing only price of euro or price of USD did not lead to any significant differences in the results.

⁹ Kıymaz (2003) finds 51 significant beta coefficient for 109 firms he investigated for 1991-1998 period. Contrary to his findings, for the 137 firms, only about 8% of the firms for 2003 had a significant beta coefficient. This indicates that either risk

values. Since price of foreign currency in terms of local currency is used for the analysis, a positive β_s coefficient indicates a positive change in the firm value due to a depreciation. To test the asymmetry, we also estimated the following model.

$$R_{i,t} = \alpha + \beta_m R_{m,t} + (\beta_s + \beta_{s,D} D_t) R_{s,t} + \varepsilon_{i,t}, \quad i=1 \text{ to } 137 \quad (2)$$

where $D_t = 1$ if $R_{s,t} < 0$. In this formulation, exposure beta will be equal to $(\beta_s + \beta_{s,D} D_t)$ when $R_{s,t}$ is less than zero, and β_s otherwise. Asymmetry can be tested by simply testing the significance of β_s ¹⁰. $\beta_{s,D}$ coefficient was significant for only 5% of the firms, and thus exposure betas from symmetric model are used in the remainder of the paper. Exposure betas are estimated for equation (1) for 2001, 2002 and 2003 to test the impact of firm-specific factors on the size of exposure. In estimations, week 1 of 2000 is used as the starting observation and it is kept constant as new information is added for the next year¹¹.

Following Dominguez & Tesar (2001, 2006), we analyze whether firm-specific factors have a significant impact on firms' exposure to exchange rate movements. The factors we consider are: firm size, firm maturity, level of international transactions, and a measure of risk adaptation. We hypothesize that larger the firm size, lower the exposure beta should be. Larger firms should have sufficient resources, in terms of personnel and knowledge, to hedge their risk in international transactions leading to lower exposure¹². Firm maturity is the number of years the firm is in operation. Hence, we expect older firms to be the firms that are managed more efficiently. As a result, maturity should also indicate a lower exposure level. Level of international activity is measured by two factors: share of export revenue in total revenue and share of import expenditures in total cost. The first measure should be more relevant for an exporter, and the second measure should be more relevant for an importer. Firms with high

and hence exposure is lower in Turkey now than before due to lower volatility in exchange rates, or firms can use hedging techniques effectively.

¹⁰ The average exposure beta, for year 2003, was 0.5836 for asymmetric capital market model. The $\beta_{s,D}$ value was -0.2159.

¹¹ In other words, 2000 and 2001 information is used to estimate the exposure beta for 2001, and information for 2000-2002 is used to estimate exposure beta for year 2002, and so on.

¹² It is also possible to see higher exposure as larger firms are most likely the firms with higher level of international transactions.

level of international activity are the ones with greater exposure. However, they are also the ones with the incentive to hedge their exposure. As a result, level of international activity can lead to higher or lower exchange rate exposure. Nevertheless, there is no well developed market to hedge in Turkey and thus we should expect a higher exposure level for firms with higher level of international activity. Finally, firms can use export revenue to cover their import cost as a method to lower their exposure to exchange rate risk. As a result, firms that have exports and imports close in value should be impacted less by the exchange rate movements leading to lower exposure betas¹³.

To test the hypotheses discussed above, we use estimated exposure betas as the dependent variable and estimate the following equation.

$$\beta_{i,t} = \alpha + \beta_1 Size_{i,t} + \beta_2 Mat_{i,t} + \beta_2 Pis_{i,t} + \beta_2 Pic_{i,t} + \beta_2 Hedge_{i,t} + \epsilon_{i,t} \quad (3)$$

where $\beta_{i,t}$ is the exposure beta for firm i in year t . *Size* of the firm is identified by using the average number of employees during these three years. *Mat* is the firm maturity and is calculated by the difference between year t and the establishment year. *Pis* and *Pic* are percentage of export revenue in total sales and percentage of import cost in total cost. To have a proxy for *Hedge*, first the ratio of import revenue to export revenue is calculated¹⁴. When this ratio equals one, export revenue and import cost will be equal to each other and hence exposure to exchange rate risk might be lower. However, if this ratio is above or below unity, when all else equal, exposure should increase. Therefore, we calculated *Hedge* variable as [(value of imports/value of exports)-1]. Hedge variable takes the value of 0 under perfect overlap, becomes positive for net importers and becomes negative for net exporters. Table 1 presents the estimation results for equation (3).

¹³ Certainly timing is also important for payments and receipts. However, even if they do not overlap, firms with exports and imports close in value should be faced with a lower risk.

¹⁴ The median value for this ratio is 79% for 2003. In other words, for a firm at the median, value of imports is 79% of the value of exports.

Table 1: Exchange Rate Exposure and Firm Characteristics

	Size	Maturity	Pis	Pic	Hedge
Least Squares	-0.000024 (.000229)	0.001052 (.021356)	0.001404 (.002175)	0.000406 (.001073)	-0.000245 (.002315)
Fixed Effects	-0.000008* (.000004)	-0.003467 (.005652)	-0.000055* (.00003)	-0.000021 (.00002)	0.000034 (.000039)
Random Effects	-0.000008* (.000004)	-0.003363 (.005587)	-0.000055* (.00003)	-0.000021 (.00002)	0.000033 (.000039)
LM Test: 392.70***					
Hausman Chi-square test: 0.37					

Standard errors are provided in parantheses.

***, **, and * represent significance at 1%, 5% and 10% levels, respectively.

Lagrange Multiplier (LM) test indicates that GLS should be preferred over OLS¹⁵. Moreover, low values of Hausman test statistics favors random-effects model over fixed-effects model¹⁶. Thus, these tests, presented in Table1, indicate random effects model is more relevant for our model. As we discussed earlier, size of the firm is expected to have a negative relationship with exchange rate exposure, and results provide evidence consistent with this expectation. In addition, as the share of export revenue increases, exposure beta becomes lower. Both firm size and share of export revenue in total indicate that larger firms with greater dependence on international sales have the necessary resources and the incentive to lower their exposure. Results in Table 1 do not show any significant impact of firm maturity, share of import expenditures in total cost and hedge ratio on exposure. Given that local currency was mostly depreciating during this period, share of import expenditures in total cost should particularly impact exposure level. The only explanation that comes to mind is the mark-up pricing, as discussed in Dominguez and Tesar (2001). In particular, it is

¹⁵ High values of LM test favor GLS over OLS suggesting some exogenous factors, which may be correlated with the dependent variable and possibly omitted from the model, are not correlated with the right hand side variables.

¹⁶ The null hypothesis states no correlation, thus large values of the Hausman's X^2 test suggest statistical preference for a fixed effects model specification. Fixed-effects estimation assumes that differences across firms can be captured by differences in the constant term. However, if the differences between firms are not just parametric shifts of the regression function, it may be more appropriate to view individual specific constant terms as randomly distributed across cross-sectional units with random-effects model.

surprising for not finding a significant negative relationship between Hedge variable and exposure level¹⁷.

Table 2: Exposure and Trade Characteristics

(A) Cover<75%	Size	Maturity	Pis	Pic	Hedge	
Fixed Effects	-0.000004 (.000006)	0.000148 (.00785)	-0.000072* (.00003)	-0.000044** (.000025)	-0.000013 (.000071)	Avg Emp: 848 Avg. Pis: 46%
Random Effects	-0.000004 (.000006)	0.000221 (.007817)	-0.000071* (.00003)	-0.000044** (.000025)	-0.000013 (.000071)	Avg. Pic: 20% Beta: 0.9338
LM Test: 193.06***						
Hausman Chi-square test: 0.48						
(B) 75%≤Cover<125%	Size	Maturity	Pis	Pic	Hedge	
Fixed Effects	-0.00001 (.000007)	-0.00551 (.011331)	0.001705 (.00104)	0.000036 (.000028)	0.000088 (.000053)	Avg Emp: 1361 Avg. Pis: 36%
Random Effects	-0.000006 (.000005)	-0.00224 (.003306)	0.000214 (.000843)	0.00003 (.000028)	0.000064 (.000052)	Avg. Pic: 42% Beta: -0.0301
LM Test: 26.39***						
Hausman Chi-square test: 15.89***						
(C) Cover ≥125%	Size	Maturity	Pis	Pic	Hedge	
Fixed Effects	-0.00001 (.000007)	-0.005668 (.010035)	0.000075 (.000101)	-0.000044 (.00005)	0.000036 (.000064)	Avg Emp: 887 Avg. Pis: 13%
Random Effects	-0.00001 (.000006)	-0.00409* (.00357)	0.000052 (.000099)	-0.000032 (.000049)	0.000021 (.000063)	Avg. Pic: 40% Beta: -0.0617
LM Test: 132.69***						
Hausman Chi-square test: 7.50						

Standard errors are provided in parantheses.

***, **, and * represent significance at 1%, 5% and 10% levels, respectively.

Cover is defined as the average value of imports over average value of exports for the 2001-2003 period.

In order to investigate the role of risk adaptation in more details, we estimate the same model for three sub-groups. Sub-groups are determined by the average ratio of [(value of imports/value of exports)] for 2001-2003 period. If this ratio – coverage – is equal to one, *Hedge* ratio will be equal to zero. Results are presented in Table 2. Since LM test favors fixed/random-effects model in all estimations, LS model results are not presented. For firms with coverage ratio less than 75% - net exporters -, we find that level of

¹⁷ Instead of using [(value of imports/value of exports)-1], we also tried absolute value of the Hedge ratio in estimations to capture the effects with the expectation that departures from a ratio of one can have the same effect regardless of the sign. However, results, which are not presented, were not significantly different.

international activity is important and it lowers the level of exposure. This group of firms also has the lowest trade volume of all¹⁸. In addition, firms in this group rely more on export revenue than others and appear to include smaller firms. Average exposure is much higher indicating that net exporters' sensitivity to exchange rate movements are higher.

Neither for group 2 nor for group 3 in table 2, we do not find any relationship between exchange rate exposure and firm-specific factors, except for age of the firm for group 3 under random-effects model. Group 2 includes firms with balanced export and import revenues and firms with largest trade volume. In addition, average beta coefficient is the smallest in this group with a negative sign. This group also has the largest firms, measured by the average number of employees, in the sample. Firms in group 3 can be characterized as net-importers. Their average beta coefficient is smaller than group 1 but larger than group 2 firms. Both for group 2 and 3 average exposure beta is negative, indicating the negative effect of a depreciation of local currency on firm returns. As noted earlier, if firms can pass-along some or all of the exchange rate changes to local prices, some or all of the risk will be passed to consumers and hence exposure should be small and insignificant. Our results indicate this might be the case for Turkey.

In the above analyses, estimated exposure betas are used to test the impact of firm-specific factors on the sign and the size of the exposure. However, not all firm-level estimated exposure betas were statistically significant. As a result, there might not be a relationship between exposure betas and firm-specific factors. On the other hand, same factors might explain why some firms' exposure betas are significantly different from zero. In other words, a significant exposure beta indicates that exposure exists, while non-significance indicates that there is no exchange rate exposure. Hence, a binary variable is created taking the value of one to indicate existence of exposure, and zero to indicate lack of exposure. This binary variable can be used to evaluate the impact of the same firm-specific factors on the existence probability of exposure using logistic regression¹⁹.

¹⁸ Trade volume is calculated as the average of imports and exports over 2001-2003 periods. Values are not presented for the sake of brevity.

¹⁹ Instead of using logistic regression which uses logistic distribution as the link function, one can also use probit regression which uses normal distribution as the link function for estimation. In most cases, as in this one, results should be similar. For details on logistic regression, see Greene (1997, chapter 19).

In other words, we try to identify the factors that significantly impact the likelihood of exposure at the firm level. Table 3 presents results for logistic regression for 2003 only.

Table 3: Likelihood of Exposure

Size	Maturity	Pis	Pic	Hedge
0.000181	-0.0209	-0.0103	-0.022	0.0726*
(.000333)	(.0257)	(.0167)	(.0207)	(.0392)

% concordant: 68.7

c-value: 0.663

Standard errors are provided in parantheses.

***, **, and * represent significance at 1%, 5% and 10% levels, respectively.

It appears that *Hedge* factor is the only factor that has a significant impact on the likelihood of exposure. In addition, positive sign indicates that any deviation of *Hedge* ratio from zero causes an increase in the probability of firm returns sensitivity to exchange rate movements. Thus, *Hedge* ratio, or natural hedging strategy, may not impact the size of the estimated beta coefficients directly, but it has a significant impact on the likelihood of significant exposure at the firm level.

3. Concluding Remarks

In this study, exchange rate exposure is estimated using firm-level data between 2001 and 2003 for Turkey. Exposure is estimated as the sensitivity of firm returns to exchange rate movements, and estimated exposure coefficients are used to test the relationship between exposure level and firm-specific factors. These factors were: firm size, firm maturity, level of international transactions, and a measure of risk adaptation.

Results indicate that the size of the firm and the share of export revenue in total revenue have a negative effect on the exposure level. That is, larger firms and firms with a larger dependence on export revenue have lower exposure to exchange rate risk. This may indicate that these firms may have the incentives and resources to lower or eliminate their exposure. Level of international activity, as measured by share of export revenue in total revenue and share of import expenditures in total cost, is found to be important for firms that can be characterized as net exporters. The exposure

level was also much larger for these firms than firms characterized as net importers. This finding may also indicate the differences in industry structures that exporters and importers face. We suspect exporters operate in a highly competitive environment, while importers may have some degree of market power to pass-along some or all changes in costs to their customers. Although we do not find *Hedge* variable as a significant factor in influencing exposure level, we do find that it increases the likelihood of having a significant exposure to exchange rate movements.

References

- Adler, M. & B. Dumas (1980) "The exposure of long-term foreign currency bonds," *The Journal of Financial and Quantitative Analysis*, 15, 973-994.
- Adler, M., Dumas, B. (1984) "Exposure to currency risk: definition and measurement," *Financial Management*, 13, 41-50.
- Bartov, E., Bodnar, G.M. (1994) "Firm valuation, earnings expectations and the exchange-rate exposure effect", *Journal of Finance*, 49, 1755-1785.
- Dominguez, K.M.E., Tesar, L.L. (2001) "Trade and exposure", *American Economic Review Papers and Proceedings*, 91, 367-370.
- Dominguez, K.M.E., Tesar, L.L. (2006) "Exchange rate exposure", *Journal of International Economics*, 68, 188-218.
- Dumas, B. (1978) "The theory of the trading firm revisited", *Journal of Finance*, 33, 1019-1029.
- Fraser, S., Pantzalis, C. (2004) "Foreign exchange rate exposure of US multinational corporations: a firm-specific approach", *Journal of Multinational Financial Management*, 14, 261-281.
- Greene, W.H. (1997) *Econometric Analysis*, 3rd edition, Prentice-Hall
- Hahm, Joon-Ho (2004) "Interest rate and exchange rate exposures of banking institutions in pre-crisis Korea", *Applied Economics*, 36, 1409-1419.
- Jorion, P. (1995) "Predicting volatility in the foreign exchange market, *The Journal of Finance*", Vol. L, No. 2, 507-528.
- Kiyamaz, H. (2003) "Estimation of foreign exchange exposure: an emerging market application", *Journal of Multinational Financial Management*, 13, 71-84.
- Koutmas, G. & A.D. Martin (2003) "Asymmetric Exchange Rate Exposure: theory and evidence", *Journal of International Money and Finance*, 22, 365-383.

- Mark, N.C. (1990) “Real and nominal exchange rates in the long run: An empirical investigation”, *Journal of International Economics*, 28, 115-136.
- Martin, A.D., Mauer, L.J. (2003) “Exchange rate exposures of US banks: a cash flow-based methodology”, *Journal of Banking and Finance*, 27, 851–865.
- Martin, A.D., Mauer, L.J. (2005) “A note on common methods used to estimate foreign exchange exposure”, *Journal of International, Financial Markets Institutions and Money*, 15, 125–140.
- Muller, A., Verschoor, W.F.C. (2005) “Foreign exchange risk exposure: Survey and suggestions”, *Journal of Multinational Financial Management*, article in press.
- Solakoglu, M.N. (2005) “Exchange rate volatility and real exports: A sensitivity analysis,” *Journal of Economic and Social Research*, Vol. 7.
- Tai, Chu-Sheng (2005) “Asymmetric currency exposure of US bank stock returns”, *Journal of Multinational Financial Management*, 15, 455-472.