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The Relationship Between Exchange Rates and Stock Prices: A Causality Analysis

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Abstract: This paper analyzes empirically the relationship between stock prices and exchange rates by using high-frequency data of exchange rates and aggregate stock indices of Turkey. With time-series techniques, this study provides evidence that a long-run stable relationship between stock indices and exchange rate exist. But our results indicate that causality relationship exists only from exchange rate to industry sector index.
Keywords: Stock prices, exchange rates, causality

Özet: Bu çalışma, hisse senetleri fiyatları ve döviz kuru arasındaki ilişkiyi günlük döviz kuru ve hisse senetleri indekslerini kullanarak ampirik olarak analiz etmektedir. Zaman serileri tekniklerinin sonuçları hisse senetleri indeksleri ve döviz kuru arasında uzun dönemde istikrarlı bir ilişki olduğunu kanıtlamıştır. Fakat, bulduğumuz sonuçlar nedensellik ilişkisinin sadece döviz kuru ve endüstri indeksi arasında varolduğunu ortaya koymaktadır.
Anahtar Kelimeler: Hisse senetleri fiyatları, döviz kuruları, nedensellik

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1. Introduction

Emerging markets have recently been of great importance to the worldwide investment community. The market capitalization, volatility, and returns have increased dramatically in these markets. While emerging markets are more volatile than developed markets, they tend to be relatively uncorrelated with each other and with developed markets. Many global investors choose to diversify their funds across these markets to reduce portfolio risk. Unfortunately, financial crisis characterized by dramatic fluctuations in stock and foreign exchange markets has been a common phenomenon in recent years in emerging countries. This realization directed researchers to investigate the link between stock market performance and the exchange rate. Makurjee and Naka (1995) and Ajayi and Mougoue (1996) found that stock market price is cointegrated with the exchange rate in eight industrial economies. Koutoulas and Kryzanowski (1996) provided evidence that stock market volatility responds significantly to exchange rate volatility in Canada. Kearney (1998) found similar results for Ireland. Fang (2000) found a negative depreciation effect in the stock return process in Taiwan over the Asian crisis.

Our goal in this paper is to contribute this body of literature by examining the relationship between stock prices and exchange rates in an emerging market, namely Turkish market. Turkey provides an interesting arena to investigate interrelations between stock and exchange markets for two reasons. First, Istanbul stock exchange (ISE) is one of the fastest growing emerging stock markets. Market capitalization and number of listed companies have increased dramatically in recent years. At the end of 1990, according to ISE, the market capitalization value was $18.74 billion and the number of listed company was 110. At the end of 2001, on the other hand, the market capitalization had increased to $47.69 billion and the number of companies had

increased to 310[1]. Second, Turkish economy witnessed two major financial crises in recent years. The stock and foreign exchange markets suffered fluctuations from these financial crises, which broke out in 1994 and in 2001. For example, the stock index dropped from a peak of 288.84 at the beginning of January to 150.97 at the end of April 1994. In the meanwhile the Turkish lira depreciated by 125.9% against the US dollar. The stock index was 11,539.99 at the beginning of January 2001 and dropped to 8022.72 at the end of March. Turkish lira depreciated 57.98% in that period. During the times of financial crises the Turkish central bank intervened in the foreign exchange market to dampen the prevailing expectations of depreciation in the Turkish lira. These intervention squeezed funds out available for the stock market, further exaggerated fluctuations in the stock market. The performance of the stock market is clearly linked to situations of the foreign exchange market. Surprisingly, little empirical research has examined the interaction between stock and exchange markets. Although some studies investigated the Istanbul stock exchange[2], none of them examined the causality relation between stock prices and exchange rates. Knowing the linkage between the two markets is important to global fund investors who are planning to invest in a small and open stock market such as Turkey.

The rest of the paper is organized as follows. In section 2, the time series method is briefly presented. Section 3 describes the data and provides the empirical analysis. Last section contains conclusions.

2. Time-Series Method

To analyze the relationship between exchange rates and stock indices, this paper focuses on causality among these variables using the method

[1] At the end of 1999 the market capitalization was $120 billion. It dropped to $47.6 billion at the end of 2001. The Turkish stock market in 2001 registered huge dollar losses due entirely to 113% devaluation in the Turkish Lira.

[2] See Kıymaz (2003), Durukan (1999), and Güneş and Saltoğlu (1998)

developed by Granger (1969). Since this technique is used in a number of economic studies, only brief explanations of this method is provided below.

A general specification of the Granger noncausality test in a bivariate (x, y) context can be expressed as:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + ... + \alpha_l y_{t-l} + \beta_1 x_{t-1} + ...\beta_l x_{t-l} + \varepsilon \quad (1)$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + ... + \alpha_l x_{t-l} + \beta_1 y_{t-1} + ...\beta_l y_{t-l} + \varepsilon \quad (2)$$

where ε is a white noise error. All time-series are in logarithm form. The constant parameter α_0 represents the constant growth rate of x in the first equation and y in the second equation, and thus the trend in these variables can be interpreted as general movements of these financial time-series in response to, say, changes in economic fundamentals. This specification is appropriate in the existence of cointegration between x and y that follows the unit root process, and thus can be used for our data as we will show in the next section.

We can obtain two tests from this analysis: the first test examines the null hypothesis that the exchange rate does not Granger-cause the stock index, and the second test examines the null hypothesis that the stock index does not Granger-cause the exchange rate. If we fail to reject the former null hypothesis and reject the latter, then we can conclude that currency movements are Granger-caused by a change in stock prices. Therefore this test involves the examination of the statistical significance of the parameters of x in Eq. (1) and those of y in Eq. (2). For example, the null hypothesis of x not Granger-causing y is tested using the joint parameter restrictions, $\beta_1 = \beta_2 = ... = \beta_l = 0$. Acceptance of this restriction raises evidence for the above null of noncausality.

3. Data Description and Empirical Analysis

Our sample data consist of daily closing prices of four aggregate indices: National 100, Financial Sector Index, Production Sector Index, and Service Sector Index. National 100 composed of National market companies and it is the main index of the ISE. The other three indices are the sectoral indices of ISE. Our daily data are obtained from the Central Bank of The Republic of Turkey. However, the original data source is the ISE. The starting date of sectoral indices in our sample has been determined by the data availability. The data for National 100 starts from January 4, 1990. Financial sector index and Production sector index start from January 2, 1991 while Service sector index starts from January 2, 1997. The last day for all indices is November 29, 2002. Exchange rate is expressed in terms of U.S. dollar. All variables are in natural logarithms. Three sets of this data set are analyzed: the full data set consisting all daily values of stock market indices and TL/U.S. dollar exchange rates: the subset covering the first financial crisis from 1993 to 1995; and the subset covering the second financial crisis from 2000 to 2002. We obtain similar results in two subsets. Therefore, we only report the results obtained from the full data set.

Before analyzing the relationship between exchange rates and stock indices, it is important to carry out a univariate analysis. The stationarity of each series was investigated by employing the unit root tests developed by Dickey and Fuller (1981). The test consists of regressing each series on its lagged value and lagged difference terms. The number of lagged differences to be included can be determined by the Akaike information criterion. Table 1 reports the Dickey-Fuller test statistics under the null hypothesis of a unit root. The table also presents the number of lagged difference terms included in the regression. The hypothesis of unit root against the stationary alternative is not rejected at the 5% level for exchange rates and stock indices with or without a deterministic trend. However, the first differences of these variables are

stationary under the test. Hence, we conclude that these variables are integrated of order 1. The results of these tests are reported in Table 2.

Table 1. Unit root tests (levels)

	Exchange Rate	ISE 100	ISE Finance	ISE Industry	ISE Service
Constant ADF Test Statistic	-0.932	-0.775	-1.689	-0.970	-1.811
Lag	2	1	4	3	4
Constant&Trend ADF Test Statistic	-1.136	-2.014	-1.018	-1.979	-1.301
Lag	2	4	4	4	4

Note: 5% critical value for ADF test with constant is –2.863 while it is –3.413 for the test with constant and trend.

Table 2. Unit root tests (First differences)

	Exchange Rate	ISE 100	ISE Finance	ISE Industry	ISE Service
Constant ADF Test Statistic	-36.077	-25.054	-25.908	-25.396	-18.527
Lag	2	4	4	3	4
Constant&Trend ADF Test Statistic	-46.827	-25.052	-25.331	-25.399	-18.610
Lag	1	4	3	3	4

Note: 5% critical value for ADF test with constant is –2.863 while it is –3.413 for the test with constant and trend

On the basis of the above unit-root tests, we performed the Johansen's cointegration test to see whether any combinations of the variables are cointegrated. This approach uses a maximum likelihood procedure that tests for the number of cointegration relationships and estimates the parameters of those cointegrating relationships. Likelihood Ratio (LR) test statistics and 5% critical values are reported in Table 3. The results suggest that there is a cointegrating relationship between exchange rate and stock indices.

Table 3. Johansen maximum likelihood cointegration tests

Maximum Eigenvalue test				Trace test			
Null	Alternative	Statistic	95% critical value	Null	Alternative	Statistic	95% critical value
ISE 100							
$r = 0$	$r = 1$	89.45*	15.67	$r = 0$	$r \geq 1$	95.74*	19.96
$r \leq 1$	$r = 2$	6.23	9.24	$r \leq 1$	$r \geq 2$	6.23	9.24
ISE Finance							
$r = 0$	$r = 1$	87.08*	15.67	$r = 0$	$r \geq 1$	93.34*	24.60
$r \leq 1$	$r = 2$	6.25	9.24	$r \leq 1$	$r \geq 2$	6.25	9.24
ISE Industry							
$r = 0$	$r = 1$	85.24*	15.67	$r = 0$	$r \geq 1$	93.04*	19.96
$r \leq 1$	$r = 2$	7.80	9.24	$r \leq 1$	$r \geq 2$	7.80	9.24
ISE Service							
$r = 0$	$r = 1$	41.00*	15.67	$r = 0$	$r \geq 1$	44.63*	19.96
$r \leq 1$	$r = 2$	3.63	9.24	$r \leq 1$	$r \geq 2$	3.63	9.24

* Indicates significance at 5% level

Note: r stands for the number of cointegrating vectors. Estimation has been performed with EVIEWS 3.1.

The existence of a long-run relationship between exchange rate and stock price means that both variables are causally related at least one direction. But, is change in exchange rates causing change in stock price or is change in stock price causing change in exchange rates? In order to answer this question we implement the Granger noncausality test. Taking into account that the results derived from this test may be sensitive to the selection of the lag length, the minimum final prediction error suggested by Akaike (1969) has been used. Table 4 reports the F-statistics and probability values constructed under the null hypothesis of noncausality. It can be observed that exchange rate affects all of the stock indices. But we have also observed the existence of opposite direction of causality where stock indices except Industry sector index, affect the currency. These results show that one-way causality exists only from exchange rate to Industry sector index.

Table 4: Granger causality test between stock indices and exchange rate

Null hypothesis:	Exchange rate does not Granger-cause stock index	Stock index does not Granger-cause exchange rate	Lags
ISE 100	2.663 (0.0464)	4.362 (0.0045)	3
ISE Finance	3.79 (0.0099)	4.54 (0.0035)	3
ISE Industry	4.34 (0.0045)	1.31 (0.2670)	3
ISE Service	4.05 (0.0070)	9.05 (0.0000)	3

Note: Figures in parentheses are the probability values.

4. Conclusion

This paper analyzes empirically the relationship between four stock indices and exchange rate in the Turkish market. Since the variables in this paper are nonstationary and present a unit root, the Johansen's cointegration technique has been applied. This methodology has allowed to obtain a cointegrating relationship among the variables. The cointegration results provide evidence of a unique cointegrating vector. In other words, a long-run stable relationship between stock indices and exchange rates exist. That means stock indices of ISE and exchange rates move together in the long-run. This result is similar to the results of the previous empirical studies related to the industrial economies.

We next performed Granger noncausality test. The results present some interesting evidence that partly supports the recent theoretical literature on the relationship between stock index and exchange rates. We find inconclusive evidence where causality relationship exists for both ways between the composite index and exchange rates, financial sector index and exchange rate, and service sector index and exchange rate. We also find that causality relation exist from the exchange rate to the industry sector index in a unique direction.

Many investors in Turkey believe that any change in exchange rate will cause a change in stock indices. For example if exchange rate increases then they expect to see a decrease in stock prices. The reason for this is that investors

would prefer to sell their stock to buy foreign currency. In this study, we tried to examine whether statistical evidence supports this belief. Our findings suggest that these macroeconomic variables move together in the long-run but variation in exchange rates do not cause a variation in three indices of the ISE. The results of this paper also indicate that change in exchange rate causes, in Granger sense, change in industry sector index.

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