Int. J. Manag. Bus. Res., 2 (2), 95-107, Spring 2012

Assessing the Exchange Rate Fluctuation on Tehran's Stock Market Price: A GARCH Application

[1] *M. Khalili Araghi,* [*2] *M. Mohazzab Pak*

[1, 2] *Department of Business Management, School of Management and Economics, Science and Research Branch, Islamic Azad University (IAU), Tehran, Iran*

ABSTRACT: This paper empirically investigates the exchange rate effects of Iranian Rial against Dollar (Rial vs.US) on stock prices in Iran. The sample period for the study has been taken from March 20, 2004 to March 20, 2010 using daily nominal exchange rate of Rial /us and daily closing values of Tehran Stock Exchange. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model has been used in modeling the relationship between exchange rate volatility and stock market volatility, as it has been proven to give superior results.

The paper presents an introduction to the topic, a review of the literature, data used and methodology applied the obtained findings and the corresponding conclusion. For our study, two hypotheses have been formulated and tested with appropriate econometric tests. It was found that both data series were stationary at level form and positive correlation exists between exchange rates and stock market prices and causality exists directionally between the two variables. Positive significant relationship between volatility in stock Prices and in exchange rates has been confirmed by the estimated GARCH model.

Keywords: *Stock prices , Exchange rates, Volatility, Granger causality , GARCH*

INTRODUCTION

In the recent years, offering a good environment for investment, and has made policy changes to facilitate cross-country investment. An increased high level of cross-border equity flows create a higher demand for and supply of currencies in which international equity prices are denominated, leading to some degree of interdependence between stock prices and exchange rate fluctuations.

Since the early 1990s, the relationship between foreign exchange markets and stock markets has fascinated many researchers and academics. What should we expect? Should we assume that changes in exchange rates affect the competitiveness of a firm, which in turn will influence its earnings or its cost of funds and hence its stock prices? Or should we assume that a rising stock market would attract capital which will increase the demand for domestic currency and cause exchange rate to appreciate?

Theoretical links between stock prices and exchange rates have taken two major forms. The "Flow-oriented" models of exchange rates (Dornbusch and Fischer, 1980) concentrate on the current account of the balance of payment. These models hypothesize that exchange rates changes influence international competitiveness and trade balance, impacting real income and output. Stock prices react to exchange rate changes and create a link between current

***Corresponding Author, Email:** *Meissampa@gmail.com*

investment and consumption decisions.

Innovations in the stock market impact the aggregate demand through wealth and liquidity effects, influencing money demand and exchange rates (Gavin, 1989). The second approach, the “Stock-oriented” models of exchange rates (Branson, 1983; Frankel, 1983), focuses on the capital account as a significant determinant of exchange rate dynamics. Since the values of financial assets are determined by the present values of their future cash flows, expectations of relative currency values impact internationally held financial assets. Therefore, stock price innovations may affect, or be affected by, exchange rate dynamics.

Early empirical studies have focused on the relation between stock returns and exchange rates using U.S. data. Aggarwal (1981) finds that the US stock prices and the trade-weighted dollar value are positively correlated. Soenen and Hennigar (1988) document a strong negative correlation between US stock indexes and a fifteen currency-weighted value of the dollar. Bahmani, Oskooee and Sohrabian (1992) show that there is a positive link between stock prices measured by the S&P 500 index and effective exchange rates of the dollar.

Newer studies investigate the relationship between stock prices and exchange rates for additional industrialized economies. Ajayi and Mougoue (1996) report significant short-run and long-run relations between the two variables for several industrial economies. Ajayi, Friedman, and Mehdian (1998) describe the relationship between the two variables. Their results show that in industrialized countries, it is the stock markets that influence the currency markets. Nieh and Lee (2001) find significant short-run linkage and no long-run relationship between stock prices and exchange rates for the G-7 countries. Stavarek (2005) shows a stronger causality in countries with developed capital and foreign exchange markets than in others. Yutaka (2006) focuses on relationship between exchange rate and stock price during the easing of the monetary policy in Japan.

Studies on the examination of the stochastic behavior of the stock prices and exchange rates, primarily employing auto-regressive conditional heteroskedastic (ARCH) methodology of Engle (1982). In addition, (G) ARCH model has been used to study volatility spillovers between markets in different national countries and between different assets. For example, Hamao et al. (1990) investigate the price and volatility spillovers in three major stock markets (New York, Tokyo, and London). Koutmos and Booth (1995) find asymmetric volatility spillovers across the New York, Tokyo, and London stock markets. So (2001) studies the dynamic spillover effect between interest rate and exchange value of US dollar.

However, empirical evidence on the influence of foreign exchange market volatility on stock market is largely inconsistent. Although, economic theory suggests that foreign exchange changes can have an important impact on the stock price by affecting cash flow, investment and profitability of firms, there is no consensus about these relationship and the empirical studies of the relationship are inconclusive (Joseph, 2002; Vygodina, 2006).

The present study attempts to study the dynamics between stock prices volatility and exchange rates. It employs data over a period of six years - March 20, 2004 to March 20, 2010 - to capture this relationship in shape of a quantitative model.

Literature Review

Franck and Young (1972) were among the first authors to analyze the relationship between stock prices and exchange rates. Using correlation regression analyses, they reported no significant interaction. Aggarwal (1981), on the other hand, found a positive correlation between effective exchange rate of the US dollar and stock prices. In 1987, Solnik analyzed the relationship between exchange rates, interest rates and changes in inflationary expectations, on stock prices. For the nine industrialized countries investigated, Solnik did not find any significant relationship between exchange rates variations and stock prices. Contrary to Solnik (1987), Soenen and Hennigan (1988) reported strong negative interaction using monthly data of the U.S. dollar effective exchange rate and U.S. stock market index during 1980-1986. Jorion (1990) found a weak link between stock returns of US multinational companies and the effective US dollar exchange rate for the period 1971-1987. Ma and Kao (1990) explained differences among countries by the nature of their economies, specifically by the strength of export or import sectors. According to these researchers, an appreciating currency negatively affects the domestic stock market for a country with a large export sector and positively affects the domestic stock market for an import-dominant country.

Early empirical studies, however, omit to recognize the fact that most financial variables are non-stationary. To account for this problem, Bahmani-Oskooee and Sohrabian (1992) used co-integration to investigate the relationship between monthly data on S&P 500 index and US dollar effective exchange rate for the period 1973-1988. They showed bi-directional causality, at least in the short run. Other papers also studying the causality between stock indices and exchange rate used the same econometric procedures have reported diverse results.

Najang and Seifert(1992), employing GARCH framework for daily data from the U.S, Canada, the UK, Germany and Japan, showed that absolute differences in stock returns have positive effects on exchange rate volatility. Ajayi and Mougoué in 1996 picked daily data from 1985 to 1991 for eight advance economic countries; employed error correction model and causality test and eventually discovered that increase in aggregate domestic stock price has a negative short-run effect and a positive long-run effect on domestic currency value. On the other hand, currency depreciation has both negative short-run and long-run effect on the stock market. Abdalla and Murinde (1997) used data from 1985 to 1994, giving results for India, Korea and Pakistan that suggested exchange rates Granger cause stock prices. But, for the Philippines the stock prices lead the exchange rates. Furthering into Indian context, work in this area for the Indian Economy has not progressed much.

Abhay Pethe and Ajit Karnik (2000) has investigated the inter – relationships between stock prices and important macroeconomic variables, viz., exchange rate of rupee vis - a -vis the dollar, prime lending rate, narrow money supply, and index of industrial production. The analysis and discussion are situated in the context of macroeconomic changes, especially in the financial sector, that have been taking place in India since the early 1990s. In 1998, Ajayi et al., investigated the causal relations for seven advanced markets from 1985 to 1991 and eight Asian emerging markets from 1987 to 1991 and supported unidirectional causality in all the advanced economies but no consistent causal relations in the emerging economies. They explained the different results by the differences in the structure and characteristics of financial markets between these groups. In 2003, Kim showed that S&P's common stock price is negatively related to the exchange rate. Contemporarily, Smyth and Nandha studied the relationship for Pakistan, India, Bangladesh and Sri Lanka over the period 1995-2001 and proved no long run relationship between variables. Unidirectional causality was seen running from exchange rates to stock prices for only India and Sri Lanka. Also, Ibrahim and Aziz analyzed dynamic linkages between the variables for Malaysia, using monthly data over the period 1977-1998 and their results showed that exchange rate is negatively associated with the stock prices.

Again in 2004, Griffin stated foreign flows are significant predictor of returns in Thailand, India, Korea, Taiwan and in 2005, Doong et al. showed that these financial variables are not cointegrated. Bidirectional causality could be detected in Indonesia, Korea, Malaysia and Thailand and significantly negative relation between the stock returns and the contemporaneous change in the exchange rates for all countries except Thailand. Ozair (2006) and Vygodina (2006) worked with US data. While Ozair proved no causal linkage and no Cointegration between these two financial variables, the latter claimed causality from large-cap stocks to exchange rates. Kurihara (2006) takes Japanese stock prices, U.S. stock prices, exchange rate, Japanese interest rate etc.(period March 2001- September 2005).The results showed that exchange rate and U.S. stock prices affected Japanese stock prices. Consequently, the quantitative easing policy implemented in 2001 has influenced Japanese stock prices. Pan et al. (2007) employed data of seven East Asian countries over the period 1988 to 1998, proving bidirectional causal relation for Hong Kong before the 1997 Asian crises and unidirectional causal relation from exchange rates and stock prices for Japan, Malaysia, and Thailand and from stock prices to exchange rate for Korea and Singapore. During the Asian crises, only a causal relation from exchange rates to stock prices is seen for all countries except Malaysia.

Contemporarily, Erbaykal and Okuyan studied 13 developing economies, using different time periods and indicated causality relations for eight economies-unidirectional from stock price to exchange rates in the five of them and bidirectional for the remaining three. No causality was detected in Turkey; the reason of difference may be the time period used. However, Sevuktekin and Nargelecekenler found bidirectional causality between the two financial variables in Turkey, using monthly data from 1986 to 2006.

RESEARCH METHOD

The data sets used in this study are daily closing prices of Tehran price index and exchange rate (Rial/1USD). Data has been taken from Tehran Stock Exchange , the currency site (http://market.tse.ir) and Central Bank of the Islamic Republic of Iran , the currency site (http://www.cbi.ir).The data was collected from March 20, 2004 to March 20, 2010. The sample period spanned approximately 6 years. Line plots of the two time series - namely, Stock prices and Exchange Rates- are shown in figure 1 and 2 respectively. In this study, daily closing prices are considered as the daily observations and natural log price is computed, in Which r = ln P(t)/P(t-1) ,where P(t) is the closing price of the t^{th} day. Similarly, natural logarithm of the daily exchange rate relatives have been computed as ln E(t)/E(t-1). The values so obtained have been employed for studying the relationship between stock prices and exchange rates. Line plots of the two, so obtained, normalized series are shown in Fig 3 and 4 respectively.

After reviewing the existing literature, following hypotheses are formulated in order to study the behavior of the two variables and were then put on test for the collected data to address the objective of the study:

Hypothesis 1: Correlation exists between the two variables-Stock prices and Exchange rates.

Hypothesis 2: No Causality exists between stock prices and exchange rates in any either direction.

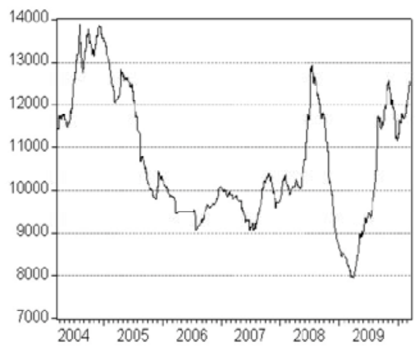

Figure 1: Line plot of stock prices

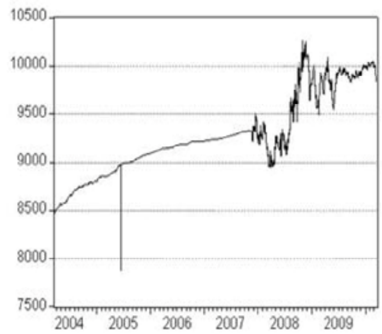

Figure 2 : Line plot of exchange rates

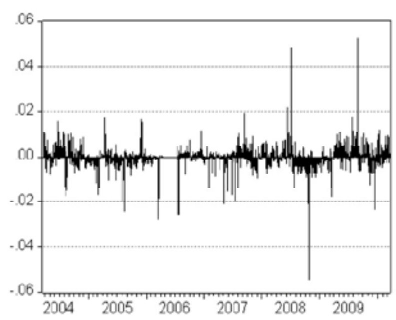

Figure 3 : Line plot of Log-normal stock prices

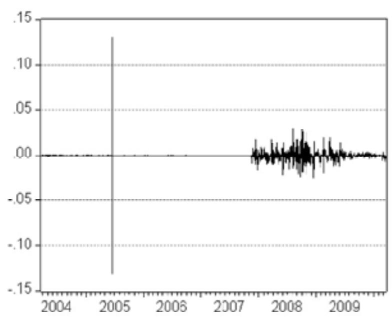

Figure 4 : Line plot of Log-normal exchange rates

Following methods/tools are used to test the above hypotheses and subsequently draw inferences about the behavior and dynamics of the two variables. The tests- namely, the JB Test, Correlation test, Unit root test and Granger Causality test- were conducted with the aid of Eviews software (version 7.0).

Normality Test

The Jarque-Bera (JB) test [Gujarati (2003)] is used to test whether stock prices and exchange rates individually follow the normal probability distribution. The JB test of normality is an asymptotic, or large-sample, test. This test computes the skewness and kurtosis measures and uses the following test statistic:

$$JB = n\,[S^2/6 + (K-3)^2/24] \quad (1)$$

Where n = sample size, S = skewness coefficient, and K = kurtosis coefficient. For a normally distributed variable, S = 0 and K = 3. Therefore, the JB test of normality is a test of the joint hypothesis that S and K are 0 and 3 respectively.

Unit Root Test (Stationarity Test)

Empirical work based on time series data assumes that the underlying time series is stationary. Broadly speaking a data series is said to be stationary if its mean and variance are constant (non-changing) over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed [Gujrati (2003)].A unit root test has been applied to check whether a series is stationary or not. Stationarity condition has been tested using Augmented Dickey Fuller (ADF) [Dickey and Fuller (1979, 1981), Gujarati (2003), Enders (1995)].

Augmented Dickey–Fuller (ADF) Test

Augmented Dickey-Fuller (ADF) test has been carried out which is the modified version of Dickey-Fuller (DF) test. ADF makes a parametric correction in the original DF test for higher-order correlation by assuming that the series follows an AR (p) process. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression. The Augmented Dickey-Fuller test specification used here is as follows:

$$\Delta Y_t = b_0 + \beta\, Y_{t-1} + \mu_1\, \Delta Y_{t-1} + \mu_2\, \Delta Y_{t-2} + \ldots + \mu_p\, \Delta Y_{t-p} + e_t \quad (2)$$

Yt represents time series to be tested, b_0 is the intercept term, β is the coefficient of interest in the unit root test, μ_i is the parameter of the augmented lagged first difference of Yt to represent the p^{th}-order autoregressive process, and et is the white noise error term.

Correlation Test

Correlation is a concept for investigating the relationship between two quantitative, continuous variables. Correlation coefficient (r) measures the strength of the association between the two variables and is calculated as

$$r_{xy} = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2 \sum_{i=1}^{n}(y_i - \overline{y})^2}} \quad (3)$$

Granger Causality Test

According to the concept of Granger's causality test (1969, 1988), a time series x_t Granger causes another time series y_t if series y_t can be predicted with better accuracy by using past values of x_t rather than by not doing so, other information is being identical. If it can be shown, usually through a series of F-tests and considering AIC on lagged values of x_t (and with lagged values of y_t also known), that those x_t values provide statistically significant information about future values of y_t time series then x_t is said to Granger-cause y_t i.e. x_t can be used to forecast y_t . The pre-condition for applying Granger Causality test is to ascertain the stationarity of the variables in the pair. Engle and Granger (1987) show that if two non-stationary variables are co-integrated, a vector auto-regression in the first differences is unspecified. If the variables are co-integrated, an error-correcting model must be constructed. In the present case, the variables are not co-integrated; therefore, Bivariate Granger causality test is applied at the first difference of the variables. The second requirement for the

Granger Causality test is to find out the appropriate lag length for each pair of variables. For this purpose, we used the vector auto regression (VAR) lag order selection method available in Eviews. This technique uses six criteria namely log likelihood value (log L), sequential modified likelihood ratio (LR) test statistic, final prediction error (F & E), Akaike information criterion (AIC), Schwarz information criterion (SC) and (HQ) information criterion for choosing the optimal lag length. Among these six criteria, all except the LR statistics are monotonically minimizing functions of lag length and the choice of optimum lag length is at the minimum of the respective function and is denoted as a associated with it.

Since the time series of exchange rates is stationary or $I_{(0)}$ from the ADF test, the Granger Causality test is performed as follows:

$$\Delta N_t = \alpha_1 + \beta_{11}\Delta N_{t-1} + \beta_{12}\Delta N_{t-2} + \cdots + \beta_{1n}\Delta N_{t-n} + \gamma_{11}F_{t-1} + \gamma_{12}F_{t-2} + \cdots + \gamma_{1n}F_{t-n} + \varepsilon_{1,t} \tag{4}$$

$$\Delta N_t = \alpha_1 + \beta_{11}\Delta N_{t-1} + \beta_{12}\Delta N_{t-2} + \cdots + \beta_{1n}\Delta N_{t-n} + \gamma_{11}F_{t-1} + \gamma_{12}F_{t-2} + \cdots + \gamma_{1n}F_{t-n} + \varepsilon_{1,t} \tag{5}$$

where n is a suitably chosen positive integer; β_j and γ_j, j = 0, 1… k are parameters and α's are constant; and u_t's are disturbance terms with zero means and finite variances.

Garch

Most economic and financial time series and especially conditional stock market volatility has always been studied using the ARCH and GARCH models introduced by Engle (1982) and Bollerslev (1986) respectively. These models help to study volatility clustering. Assuming linearity, the first and second conditional moments of price series (given its past behaviors) can be jointly estimated by GARCH (p,q) in order to characterize the dependence of future observations on past values.

Consider a univariate stochastic process for stock market prices where the information set Ω_t of monthly prices is defined to be $\{r_t, r_{t-1}, \ldots, r_{t-q}, \ldots, 1\}$. The jointly estimated GARCH (1,1) model introduced by Bollerslev (1986) is given by,

$$r_t = \mu + \varepsilon_t, \varepsilon_t = \sigma_t z_t, z_t : N(0,1) \tag{6}$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \tag{7}$$

Where σ^2_t is measurable with respect to Ω_{t-1} and $\omega > 0$, $\alpha > 0$, $\beta \geq 0$ and $\alpha + \beta < 1$ such that the first two moments of the unconditional distribution of the series is time invariant. It should be noted that the conditional variance σ^2_t is only linear in the squares of the past values and not in information set r_{t-1}.

RESULTS AND DISCUSSION

The analysis of the data as per the given sequence yielded the following results, exact tables and figures related to which have been provided in the appendix.

First, normality test was applied on both the series to determine the nature of their distributions. For this purpose, Jarque-Bera statistics were computed, which are shown in table 1 along with descriptive statistics for the two series. Skewness value 0 and kurtosis value 3 indicate that the variables are normally distributed. The skewness values for Stock prices and exchange rates are 0.420992 and 0.386422 respectively. The skewness coefficient, in excess of unity is taken to be fairly extreme. High or low kurtosis value indicates extreme leptokurtic or extreme platykurtic. The kurtosis values for Stock price and exchange rates are 2.094442 and 2.320910 respectively. From the obtained statistics, it is evident that both the variables are non-normally distributed.

Second, having recognized the non-normal distribution of the two variables, the question of stationarity of the two time series posed concerns. The simplest check for stationarity is to plot time series graph and observe the trends in mean, variance and autocorrelation. A time series is said to be stationary if its mean and variance are constant over time. The line plots for the two series (log normal value of relatives) are shown in figure 3 and 4 respectively. As seen in the plots, for both the series, the mean and variance appear to be constant as the plot trends neither upwards nor downwards. At the same time, the vertical fluctuations also indicate that the variance, too, is not changing. This suggests that stationarity may be present in both the series in their level forms.

Since in addition to visual inspection, formal econometric tests are also needed to unambiguously decide the actual nature of time series, ADF test was performed to check the stationarity of the time series. The results are shown in table 2 and table 3.

Table 1 : Descriptive statistics

	EXCHANGERATE	STOCKPRAICE
Mean	9283.118	10702.77
Median	9219.000	10147.00
Maximum	10268.00	13882.00
Minimum	7878.000	7955.400
Std. Dev.	418.5282	1469.565
Skewness	0.386422	0.420992
Kurtosis	2.320910	2.094442
Jarque-Bera	96.67187	139.6463
Probability	0.000000	0.000000
Sum	20348595	23460474
Sum Sq. Dev.	3.84E+08	4.73E+09
Observations	2192	2192

Table 2: Results of ADF test on stock prices

Null Hypothesis: STOCKPRICES has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic based on SIC, MAXLAG=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.63970	0.0000
Test critical values:	1% level	-3.433146	
	5% level	-2.862661	
	10% level	-2.567413	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(STOCKPRICE)
Method: Least Squares
Sample (adjusted): 3/27/2004 3/20/2010
Included observations: 2185 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
STOCKPRICE(-1)	-0.467618	0.034284	-13.63970	0.0000
D(STOCKPRICE(-1))	-0.222856	0.033779	-6.597444	0.0000
D(STOCKPRICE(-2))	-0.201660	0.031746	-6.352198	0.0000
D(STOCKPRICE(-3))	-0.131196	0.029358	-4.468868	0.0000
D(STOCKPRICE(-4))	-0.115275	0.025775	-4.472390	0.0000
D(STOCKPRICE(-5))	-0.130923	0.021250	-6.160954	0.0000
C	1.94E-05	8.22E-05	0.236379	0.8132
R-squared	0.349837	Mean dependent var		-3.18E-21
Adjusted R-squared	0.348046	S.D. dependent var		0.004760
S.E. of regression	0.003844	Akaike info criterion		-8.281569
Sum squared resid	0.032178	Schwarz criterion		-8.263342
Log likelihood	9054.614	F-statistic		195.3213
Durbin-Watson stat	2.010705	Prob(F-statistic)		0.000000

Table 3: Results of ADF test on exchange rates

Null Hypothesis: EXCHANGERATE has a unit root				
Exogenous: Constant				
Lag Length: 3 (Automatic based on SIC, MAXLAG=25)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-31.32358	0.0000
Test critical values:	1% level		-3.433143	
	5% level		-2.862660	
	10% level		-2.567412	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(EXCHANGERATE)				
Method: Least Squares				
Sample (adjusted): 3/25/2004 3/20/2010				
Included observations: 2187 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCHANGERATE(-1)	-1.989903	0.063527	-31.32358	0.0000
D(EXCHANGERATE(-1))	0.480113	0.052985	9.061226	0.0000
D(EXCHANGERATE(-2))	0.221670	0.038462	5.763365	0.0000
D(EXCHANGERATE(-3))	0.077002	0.021354	3.605987	0.0003
C	0.000135	9.59E-05	1.408162	0.1592
R-squared	0.718056	Mean dependent var		-3.97E-21
Adjusted R-squared	0.717539	S.D. dependent var		0.008429
S.E. of regression	0.004480	Akaike info criterion		-7.976309
Sum squared resid	0.043785	Schwarz criterion		-7.963299
Log likelihood	8727.094	F-statistic		1389.282
Durbin-Watson stat	2.006002	Prob(F-statistic)		0.000000

Comparing the obtained ADF statistics for the two variables with the critical values for rejection of hypothesis of existence of unit root, it becomes evident that the obtained statistics for Stock prices and exchange rates, -13.63970 and -31.32358 respectively, fall behind the critical values even at 1% significance level (-3.433146) (thus, giving probability values 0.00); thereby, leading to the rejection of the hypothesis of unit root for both the series. Hence, it can be concluded on the basis of ADF test statistics that stock prices as well as exchange rates are, both, found to be stationary at level form. It may be noted here that as a consequence of stationarity at level form in both the series, Johansen Cointegration test cannot be applied to the variables to determine long-term relationship between them.

Third, Pearson's Correlation test was conducted between stock prices and exchange rates. Correlation test can be seen as the first indication of existence of any interdependency between the time series. Table 4 shows the correlation coefficients between stock prices and exchange rates. From the derived statistics, we observe the coefficient of correlation to be 0.039259 , which is indicative of mild positive correlation between the two series. Thus, we may state that the two series are weakly correlated as the coefficient of correlation depicts some interdependency between the two variables. However, correlations may be spurious. The correlation needs to be further verified for the direction of influence by the Granger causality test.

Table 4 : Results of Pearson's correlation test

	STOCKPRICES	EXCHANGERATE
STOCKPRICES	1.000000	0.039259
EXCHANGERATE	0.039259	1.000000

Fourth, to capture the degree and the direction of any long term correlation between Stock prices and exchange rates, Granger Causality Test was conducted. Results are presented in table 5 . Judging by the statistics given in the table, we can certainly reject the null hypotheses "Exchange Rates do not Granger cause Stock prices " as the F-statistic for these hypotheses are 2.25909 respectively. In other words, Based on the Probability values reported in the table, the hypothesis that Stock Prices does not Granger Cause Exchange Rates cannot be rejected, but the hypothesis that Exchange Rates does not Granger Cause Stock Prices can be rejected. Therefore, it appears that Granger causality runs one way, from Exchange Rates to Stock Prices , but not the other way.

Fifth, when the existence and direction of causal relationship between the variables was determined, the final step is to model the observed relationship. The aim of this step is to develop a model to explain the Stock Prices on the basis of lagged values of itself and of exchange rates. The model used in the study was GARCH (1,1). In order to determine the nature of Stock Prices and exchange rate volatility, a GARCH (1,1) model was employed for each of them to estimate their conditional variance. Then the volatility of the exchange rate was introduced in the conditional variance of the stock market prices equation using GARCH (1,1) framework, with the following set of equations :

- ✓ Conditional Mean Equation :

$$\mathbf{stockprices_t = \alpha + \beta * stockprices_{t-1} + \gamma * exchangerates_t + \varepsilon_t \,;\ \varepsilon_t = \sigma_t\, z_t, z_t : N(0,1)} \quad (8)$$

- ✓ Conditional Variance Equation :

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon^2{}_{t-1} + \beta_1 \sigma^2{}_{t-1} + \gamma_1 * \mathrm{VolaExchangeRates}_t \quad (9)$$

Exchange Rates refer to the log normal relatives of exchange rate values. VolaExchangeRates refer to the conditional variance series extracted by employing GARCH(1,1) on log normal relatives of exchange rate values.

Fitted GARCH (1,1) on Stock Prices and on exchange rates have been shown in table 6 and table 7 The final fitted model for the relationship with the above specification has been given in table 8 The estimated model, thus, becomes:

Table 5 : Results of granger causality test

Pairwise Granger Causality Tests Sample: 3/20/2004 3/20/2010 Lags: 14			
Null Hypothesis:	Obs	F-Statistic	Probability
STOCKPRICE does not Granger Cause EXCHANGERATE	2177	0.87096	0.59081
EXCHANGERATE does not Granger Cause STOCKPRICE		2.25909	0.00474

Table 6: GARCH (1,1) model on stock prices

Dependent Variable: STOCKPRICE				
Method: ML - ARCH (Marquardt) - Normal distribution				
Sample (adjusted): 3/21/2004 3/20/2010				
Included observations: 2191 after adjustments				
Convergence achieved after 13 iterations				
Variance backcast: ON				
GARCH = C(1) + C(2)*RESID(-1)^2 + C(3)*GARCH(-1)				
	Coefficient	Std. Error	z-Statistic	Prob.
Variance Equation				
C	1.99E-06	6.00E-08	33.20389	0.0000
RESID(-1)^2	0.224807	0.009744	23.07118	0.0000
GARCH(-1)	0.707242	0.007155	98.84964	0.0000
R-squared	-0.000101	Mean dependent var		4.15E-05
Adjusted R-squared	-0.001015	S.D. dependent var		0.004137
S.E. of regression	0.004139	Akaike info criterion		-8.347993
Sum squared resid	0.037486	Schwarz criterion		-8.340199
Log likelihood	9148.226	Durbin-Watson stat		1.320272

Table 7: GARCH (1,1) model on exchange rates

Dependent Variable: EXCHANGERATE				
Method: ML - ARCH (Marquardt) - Normal distribution				
Sample (adjusted): 3/21/2004 3/20/2010				
Included observations: 2191 after adjustments				
Convergence achieved after 20 iterations				
Variance backcast: ON				
GARCH = C(1) + C(2)*RESID(-1)^2 + C(3)*GARCH(-1)				
Variance Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	3.70E-05	1.98E-07	187.0502	0.0000
RESID(-1)^2	0.126904	0.026850	4.726487	0.0000
GARCH(-1)	0.017069	0.003151	-5.416851	0.0000
R-squared	-0.000181	Mean dependent var		6.75E-05
Adjusted R-squared	-0.001095	S.D. dependent var		0.005023
S.E. of regression	0.005026	Akaike info criterion		-7.907091
Sum squared resid	0.055272	Schwarz criterion		-7.899297
Log likelihood	8665.218	Durbin-Watson stat		2.809648

Table 8: Final GARCH (1,1) model of the two variables

Dependent Variable: STOCKPRICE				
Method: ML - ARCH (Marquardt) - Normal distribution				
Sample (adjusted): 3/22/2004 3/20/2010				
Included observations: 2190 after adjustments				
Convergence achieved after 401 iterations				
Variance backcast: ON				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1) + C(7)*VARIANCESERIES_EXCHANGE				
	Coefficient	Std. Error	z-Statistic	Prob.
STOCKPRICE(-1)	0.412280	0.027246	15.13173	0.0000
EXCHANGERATE	0.008910	0.029181	0.305345	0.7601
C	-3.24E-06	7.18E-05	0.045091	0.9640
	Variance Equation			
C	9.11E-05	3.41E-06	26.73521	0.0000
RESID(-1)^2	0.272322	0.020228	13.46258	0.0000
GARCH(-1)	0.081220	0.019694	4.124000	0.0000
VARIANCESERIES_EXCHANGE	2.714909	0.094950	28.59313	0.0000
R-squared	0.110917	Mean dependent var		4.16E-05
Adjusted R-squared	0.108474	S.D. dependent var		0.004138
S.E. of regression	0.003907	Akaike info criterion		-8.490233
Sum squared resid	0.033325	Schwarz criterion		-8.472041
Log likelihood	9303.805	F-statistic		45.38990
Durbin-Watson stat	2.184128	Prob(F-statistic)		0.000000

Substituted Coefficients

=====================

STOCKPRICE = 0.4122804104*STOCKPRICE(-1) + 0.008910239624*EXCHANGERATE - 3.239177082e-006

GARCH = 9.106310507e-005 + 0.2723223265*RESID(-1)^2 + 0.0812195676*GARCH(-1) +2.714908802 * VARIANCESERIES_EXCHANGE

From these results, we can infer that a positive relationship exists between Stock prices and exchange rates. When exchange rates increase, Stock prices also increase. This is supported by the mild positive correlation we have observed between the variables. Also, the volatility (or conditional variance) of Stock prices is also positive related to the volatility of exchange rates as can be seen from conditional variance equation above. This implies that movements in exchange rates cause movements in Stock prices as well.

CONCLUSION

This study empirically examines the dynamics between the volatility of Stock prices and movement of Rial-Dollar exchange rates, in terms of interdependency and causality and aims to model the relationship.

First, raw values of data were converted to log normal forms and descriptive statistics were obtained. From the Jarque Bera statistics it was affirmed that the distribution is non-normal in case of both the variables. This posed questions on stationarity of the two series. Hence, the next step was to check stationarity of the two series with ADF test and the results showed stationarity at level forms for both the series.

Then, the coefficient of correlation between the two variables was computed and it was found to be slightly positive. This provided a foundation to determination of the direction of influence between the two variables. Granger Causality test was applied for this purpose to the two variables, it appears that Granger causality runs one way, from Exchange Rates to Stock prices , but not the other way. Thus, GARCH (1,1) framework was used to first extract conditional variances of the two series and then to model the Stock prices series on its own lagged values and on exchange rates series. The study ultimately develops a model to successfully capture the said relationship.

Regarding to current study, it is recommended to improve the economic environment of IRAN through following measures:

1. Modifying the taxation system and passing new regulations regarding tax on incidental incomes.
2. Studies show that performing free market operations by central bank through selling bonds for governmental development plans, as a monetary policy, can be effective for attracting a portion of money existing in the society. That can help stabilizing the financial market and increase the contribution of private sector.
3. Strengthening the economy infrastructure cause faster dedication of the resources to industrial sectors and faster presentation of the products to market. In exports sector that activity can leads to earning more foreign currencies.

REFERENCES

Aggarwal, R. (2003). Exchange Rates and Stock Prices: A study of the US Capital Markets under Floating Exchange Rates. *Akron Business and Economic*, 12, pp. 7-12.

Aggarwal, R. and Soenen, L. (1989). Financial Prices as Determinants of Changes in Currency Values. *25th Annual Meetings of Eastern Finance Association. Philadelphia*.

Ajayi, R. A. and Mougoue, M. (1996). On the Dynamic Relation between Stock Prices and Exchange Rates. *Journal of Financial Research,* 19 (2), pp. 193-207.

Ajayi., R. A., Friedman, J. and Mehdian, S. M. (1998). On the Relationship between Stock Returns and Exchange Rates: Test of Granger Causality. *Global Finance Journal*, 9 (2), pp. 241-251.

Azimi, Mahmoud. Momentum Strategy in Tehran StockExchange, Dissertation for Master Degree, Alameh University, 2004.

Bahmani-Oskooee, M. and A.Sohrabian. (1992). Stock Prices and the Effective Exchange Rate of the Dollar. *Applied Economics*, 24 (4), pp. 459 – 464.

C.K.Ma, and Kao, G. W. (1990). On Exchange Rate Changes and Stock Price Reactions. *Journal of Business Finance and Accounting*, 17 (3), pp. 441-449.

Chou, Y. L. (1969). *Statistical Analysts*. London: Holt Rinehart and Winston.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49 (4), pp. 1057-1072.

Doong, S.-C., Yang, S.-Y. and Wang, A. T. (2005). The Emerging Relationship and Pricing of Stocks and Exchange Rates: Empirical Evidence from Asian Emerging Markets. *Journal of American Academy of Business*, Cambridge, 7 (1), pp. 118-123.

Enders, W. (1995). *Applied Economic Time Series*. New York: Wiley.

Engle, R. F. and Granger, C. W. (1987). Co-integration and error-correction: Representation, *estimation and testing. Econometrica*, 55 (2), pp. 251-276.

Fama, E. F. (1981). Stock returns, real activity, inflation and money. *American Economic,* 71 (4), pp. 545-565.

Gordon, J. and Gupta, P. (2003). Portfolio Flows into India: Do Domestic Fundamentals Matter? *IMF Working Paper Number* WP/03/02, pp. 217-229.

Griffin, J. M., Nardari, F. and Stulz, R. M. (2004). Daily cross-border equity flows: Pushed or pulled? *Review of Economics and Statistics*, 86, pp. 641-57.

Gujarati, D. N. (2003). *Basic Econometrics*. McGraw Hill, India.

Ibrahim, M. and Aziz, M. (2003). Macroeconomic Variables and the Malaysian Equity market: A Rolling through Subsamples. *Journal of Economic Studies,* 30 (1), pp. 6-27.

Joseph, N. (2002). Modeling the Impacts of Interest Rate and Exchange Rate Changes on UK Stock Returns. *Derivatives Use, Trading and Regulation*, 7 (4), pp. 306-323.

Kim, K. (2003). Dollar Exchange Rate and Stock Price: Evidence from Multivariate Cointegration and Error Correction model. *Review of Financial Economics*, 12 (3), pp. 301-313.

Kurihara, Y. (2006). The Relationship between Exchange Rate and Stock Prices during the Quantitative Easing policy in Japan. *International Journal of Business*, 11 (4), pp. 375-386.

Maysami, R. and Koh, T. (2000). A Vector Error Correction Model of the Singapore Stock Market. *International Review of Economics and Finance,* 9 (1), pp. 79-96.

Mishra, A. K., Swain, N. and Malhotra, D. (2007). Volatility Spillover between tock and Foreign Exchange Markets: Indian Evidence. *International Journal of Business*,12 (3), pp. 343-359.

Morley, B. and Pentecost, E. (2000). Common Trends and Cycles in G-7 Countries Exchange Rates and Stock Prices. *Applied Economic Letters*, 7 (1), pp. 7-10.

Murinde, V. and Abdalla, I. S. (1997). Exchange Rate and Stock Price Interactions in Emerging Financial Markets: Evidence on India, Korea, Pakistan and the Philippines. *Applied Financial Economics*, 7 (1), pp. 25-35.

Naeem, M. and Abdul, R. (2002). Stock Prices and Exchange Rates: Are they Related? Evidence from South Asian Countries. *The Pakistan Development Review,* 41 (4), pp. 535-550.

Najang, and Seifert, B. (1992). Volatility of Exchange Rates, Interest Rates, and Stock Returns. *Journal of Multinational Financial Management*, 2, pp. 1-19.

Nieh, C-C. and Lee, C-F. (2001). Dynamic Relationship between Stock prices and Exchange Rates for G-7 Countries. *The Quarterly Review of Economics and Finance*, 41 (4), pp. 477-490.

Ozair, A. (2006). Causality Between Stock prices and Exchange Rates: A Case of The United States. Florida Atlantic University, Master of Science Thesis.

Pan, M-S., Fok, R. C-W. and Liu, Y. A. (2007). Dynamic Linkages between Exchange Rates and Stock Prices: Evidence from East Asian markets. *International Review of Economics and Finance*, 16 (4), pp. 503-520.

Parkinson, J. M. (1987). The EMH and the CAPM on the Nairobi Stock Exchange. *East African Economic Review*, 3 (2), pp. 105-110.

Pethe, A. and Karnik, A. (2000). Do Indian Stock Markets matter? Stock Market Indices and Macro Economic Variables. Economic and Political Weekly, 35 (5), pp. 349-356.

Phylaktis, K. and Ravazzolo, F. (2005). Stock Prices and Exchange Rate Dynamics. *Journal of International Money and Finance*, 24 (7), pp. 1031-1053.

Sevuktekin, M. and Nargelecekenler, M. (2007). Turkiye'de IMKB ve Doviz Kuru Arasındaki Dinamik liskinin Belirlenmesi. *Turkiye Ekonometri ve Istatistik Kongresi,Inonu Universitesi, Malatya* **.**

Smyth, R. and Nadha, M. (2003). Bivariate Causality between Exchange Rates and Stock Prices in South Asia. *Applied Economics Letters*, 10 (11), pp. 699-704.

Soenen, L. and Hennigar, E. S. (1988). An Analysis of Exchange Rates and Stock Prices: the U.S. experience U.S. Experience between 1980 and 1986. *Akron Business and Economic Review*, 19, pp. 7-16.

Solnik, B. (1987). Using Financial Prices to Test Exchange Rate Models: A Note. *Journal of Finance*, 42 (1), pp. 141-149.

Stavárek, D. (2005). Stock Prices and Exchange Rates in the EU and the USA: Evidence of their Mutual Interactions. *Finance a úvûr–Czech Journal of Economics and Finance*, 55 (3-4), pp. 141- 161.

Vygodina, A. V. (2006). Effects of Size and International Exposure of the US Firms on the Relationship between Stock prices and Exchange Rates. *Global Finance Journal*, 17 (2), pp. 214-223.

Wu, Y. (2000). Stock Prices and Exchange Rates in a VEC Model-the Case of Singapore in the 1990s. *Journal of Economics and Finance*, 24 (3), pp. 260-274.