

EXCHANGE RATE, INTEREST RATE AND STOCK MARKET: EVIDENCE FROM PAKISTAN STOCK EXCHANGE

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Abstract: *The study analyzes the impact of change in exchange rate and interest rate on the volatility of stock market in Pakistan from January 2000 to December 2015 on weekly basis. The result clearly indicates the existence of ARCH and GRACH effect, and further, change in exchange rate is a source that can enhance the volatility of equity markets in Pakistan. While the effect of interest rate is observed reverse as compare to exchange rate. It has calm effect on the volatility of dependent variables. Finally, study has implication for investor, managers and policy makers in Pakistani equity market.*

Keywords: *Interest Rate, Exchange Rate, Stock Market Volatility*

JEL: C22, F31, G1, E44

1. Introduction

Equity market is central for the flow of funds among several involved parties. It act as intermediary among the investors and corporations. It also props up the reallocation of fund among varying parties (Sohail & Hussain, 2009). There are series of factors which directly or indirectly affecting the stock market of any country (Bilson et al., 2000). This statement is generally based on the well-known theory of investment fiancé, namely, arbitrage pricing theory by Ross in 1976. As per arbitrage pricing theory, return on any security is linearly depending on the K factors. These factors may be international forces, country specific, industry specifics, company specific,

behavioral specific etc. According to the literature these may be economic activity (Fama, 1984), exchange rate (Jones et al.1996), monetary policy (Pearce and Roley 1985), money supply, interest rate, gold prices , inflation, and oil prices. On the basis of theories, different researcher put different variables into econometrics model and

presents their findings. Among these entire macroeconomic variables, this particular study limited only two of the variables that are interest rate and exchange rate against the equity market in Pakistani environment. Exchange rate is the value of currency of one country in term of the value of other country's currency. It directly affect the cash flow of importing and exporting firms in a country. Exchange rate and interest rate both have a significant long run plus short term relation with the equity markets (Hasan and Nasir 2008).

The basic aim of study is to find out the linkages among the interest rate, exchange rate and equity markets. There are various methodologies to explore this relationship. Some of the researcher explore the cointegration between the macro variables and equity markets like Aydemir and Demirhan (2009), Phylaktis and Ravazzolo (2000), Hasan and javed (2009), Mishra (2004) and Akmal (2007). But in most of the financial time series data there exist some periods where the volatility is relatively more. In the existing literature there exist also evidences to model this phenomenon of volatility like Joseph and Vezos (2006), Kanas (2000), Chen et al. (2004), Darby et al. (1999) and Hassan et al. (2000). Present study tries to comment on the impact of exchange rate and interest rate on the volatility and return of equity market. For this study uses the idea of Engle's ARCH (1982) and Bollerslev's GARCH (1986) model. We find that change in exchange rate is a source which can enhance or multiplies the volatility of the equity markets in Pakistan. While the effect of interest rate is observed as reverse as compare to exchange rate. Therefore we recommend to investors, analysts, fund managers, and corporate stakeholder that they should be vigilant about this exciting and clam effect of exchange rate and interest rate on the equity market of Pakistan.

The remaining part of study is planned in such a manner that next section includes the related literature. After this, collection of data and presentation of data is discussed along with a detail methodology. The next is finding of the study and finally there is a brief conclusion.

2. Literature Review

The linkages between the interest rate, exchange rate and stock return are key issue since last couple of decades. Researchers always try to probe the relationship between the interest rate, exchange rate and stock returns. In the presents literature there are number of studies which explore this relation by using various financial econometrics tools like Aydemir and Demirhan (2009), Phylaktis and Ravazzolo (2000), Hasan and javed (2009), Hamao (1988), Hussain and Mahmood (2001), Mishra (2004), Akmal (2007), Muhammad and Rasheed (2003) and Bahmani and Sohrabian (1992). But it is well known fact that in most of the financial time series data there exist some

periods where the volatility is relatively more as compare to other periods i.e. volatility clustering. There are separate model that model this aspect of time series data. In the existing literature there exist also evidences to model this volatility clustering like Joseph and Vezos (2006), Kanas (2000), Chen et al. (2004), Darby et al. (1999), Hassan et al. (2000), Elyasiani and Mansur (2004), Chowdhury, Mollik and Akhter (2006) and Chowdhury and Rahman (2004). So all the existing literature divides into two main categories i.e. some explore the dynamics relationships which may be short term and long term and some tries to analyze the other important aspect of time series data termed as volatility clustering. The existing research which was done by various researchers around the globe are briefly described as follow.

Aydemir and Demirhan (2009) investigated the linkages among exchange rate and equity market. The period of study was approximately 8 years which starts from 2001 to 2008. To check the stationarity of the financial data unit root test was employed. It was declared that the series were stationary at first differences. They also employed the MWALD test for causality and found bidirectional causality between the variables under study. Furthermore it was also empirically reported that there exist negative causality from the foreign exchange rate and equity markets. Phylaktis and Ravazzolo (2000) also analyzed both of the long run and short term relationship among the six Pacific Basin stock markets and exchange rate. Monthly data has been used for relatively long period which starts from 1980 to 1998. It was strongly argued from the cointegration test that was no long run cointegration between the equity markets and exchange rate for six countries except Hong Kong. They further analyzed that the United States market was a key variable for the local markets and equity markets were tightly allied with the exchange rate markets. Hence policy maker should be proper cautious about the association between the countries' stock markets and exchange rate changes.

In Pakistani context, Hasan and javed (2009) explored the relationship between the range of macroeconomic variables and stock market in Pakistan for a period of 11 year which starts from 1998 to 2008. To examined this long nature relationship cointegration test by Johansen and Juselius used. They also applied the granger causality, for the lead or lag relation between the macroeconomic variables and returns of stock markets in Pakistan. Overall it was concluded that there exist evidence that the monetary variables had long run relation with the return of stock markets in Pakistan for the whole period of study. Only unidirectional causality was observed between the variables and stock markets. It was further concluded from the impulse response and variance decomposition test the returns of Karachi stock exchange was explained by himself. Similarly Nishat (2001) and Maysami and Koh (2000)

also analyzed the relationship between some of the monetary variables and returns of the stock markets and approximately found the same results as mention above.

On the other hand there are also many studies that studied and take into account the concept of volatility clustering. Brief reviews of such studies are presented. Joseph and Vezos (2006) empirically assessed effect of changes in exchange rate and changes in interest rate on the return of US banks. To capture the volatility or change in the interest rate and exchange rate ARCH and EGARCH model was used on the daily data from 1990 to 2001. In this study, they also compare the results of simple OLS with the results of ARCH model. They found that EGARCH model was a best option for their data sets as compare to the OLS model. It was found that the sensitivity coefficient for the foreign exchange rate is positive for both of the model whereas the coefficient of interest rate showed a blend of positive and negative values. It was further concluded that the effect of both the changes in exchange rate and changes in interest rate on the US bank was relatively weak. Finally they declared that the return of banks were not able to echo the hedging policies.

In the developing equity market of Bangladesh, Chowdhury, Mollik and Akhter (2006) investigated the effect of the volatility in the macroeconomic variables on the volatility of the return of the stock markets. They used monthly data for their study and it enveloped the study period which starts from 1990 to 2004. Renowned GARCH methodology was adapted to capture the effect of macroeconomic volatility on the Bangladeshi stock returns. Further to understand the nature of the relation between variables as VAR test also used. It is concluded that there exist a relationship between the volatility of macro variables and the volatility of equity markets in Bangladesh under studied periods. They also mentioned that this nature of relationship was not as much strong as there exists in different theories of finance. Yanliang and Lintao (2007) analyzed the impact of exchange rate volatility on the equity markets in china. It was empirically reported that this volatility in the exchange rate had an exciting impact on the stock markets. Adjasi et al. (2008) also investigated the above relationship between the volatility of equity markets and exchange rate and concluded a negative relationship between the variables.

On the basis of all above literature, it is summarized there exists evidence that many of researchers study the volatility aspect of stock market. In other words they studied the impact of changes in interest rate and exchange rate on the volatility of equity markets. Our present study is an attempt to explore the impact of change in macroeconomic variables i.e. exchange rate and interest rate on the volatility of equity markets in Pakistani

perspective. The methodologies that will be exercise for this study are described in the next section.

3. Data and Research Methodology

The study period for this study is 16 year on weekly basis which starts from January 2000 to December 2015. This study uses the weekly data of the variables i.e. stock market index, foreign exchange rate and interest rate. This particular study uses three types of proxies for the above variable. One of the renowned index of the Pakistani stock market i.e. KSE-100 index as the proxy for the stock market in Pakistan. Rupees per United State Dollar rate is use as the proxy for the foreign exchange rate. To measure the interest rate, 6 month government Treasury bill rates are used. The data regarding the stock market index, and foreign exchange rates are collected from the Bloomberg database while interest rate are obtained from the State Bank of Pakistan. Remember these all are well known and reliable sources for the data collection.

Weekly series of the continuously compounded return for the variable are designed by:

$$R_t = \ln \left(\frac{X_t}{X_{t-1}} \right) \dots \dots \dots (1)$$

Here, R_t shows the Returns for current week, X_t & X_{t-1} symbolize the value of variable for current and previous week, respectively

3.1. The ARCH model

If someone observes the generic assumption of the Least Square then we can say that autocorrelation and homoscedasticity in the data are most important among others. If these two assumptions along with others are violated then one cannot apply the least square. Word homoscedasticity mean equal or same spread i.e. the variance remains unchanged or constant and not depend upon the value of the explanatory variable. If there is heteroscedasticity in the data but someone assume homoscedasticity then it may affect the standard error and it is better to use such a model which can capture this heteroscedasticity. The rich idea to capture the heteroscedasticity in a model was based upon the work of Engle (1982). Engle (1982) give the idea of ARCH model and mathematically:

$$Y_t = \rho_1 + \rho_2 X_t + \varepsilon_t \dots \dots \dots (2)$$

$$\varepsilon_t \approx \text{iid } N(0, \sigma^2)$$

$$\sigma_t^2 = \varphi_0 + \varphi_1 \varepsilon_{t-1}^2 \dots \dots \dots (3)$$

The variance equation of ARCH (q) model is given below:

$$\sigma_t^2 = \varphi_0 + \sum_{i=1}^q \varphi_i \varepsilon_{t-i}^2 \dots \dots \dots (4)$$

$$\varphi_i \geq 0 \quad \forall i = 0,1,2,3, \dots, q$$

3.2. GARCH model

Bollerslev (1986) generalizes the work of ARCH model. He says that volatility in the time series or variance is a function of lag values of the innovation and itself.

The GARCH (p, q) model is given below:

$$Y_t = \rho_1 + \rho_2 X_t + \varepsilon_t$$

$$\varepsilon_t \approx \text{iid } N(0, \sigma^2)$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \varphi_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \psi_i \sigma_{t-i}^2 \dots \dots \dots (5)$$

From the last equation (5) of GARCH (p, q), it is notable that it can be reduced to ARCH (q) model. If we add the explanatory variable in the variance equation of GARCH model then it can written as follow:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \varphi_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \psi_i \sigma_{t-i}^2 + \sum_{i=1}^k \beta_i X_i \dots \dots \dots (6)$$

Here in equation 6, the X_i shows the set of k explanatory variables as variance regressor in the variance equation of GARCH model. This study uses the changes in interest rate and changes in exchange rate as variance regressors in equation 6.

4. Empirical Result

Results of descriptive statistics are reported in Table 1. KSE-100 index, on an average offered a 0.38% weekly return with a standard deviation of approximately 4%. The maximum value of weekly return is 17.8% while minimum value of return of KSE-100 per week is 20.1%. Similarly, descriptive statistics for rest of variables can be interpreted from Table 1.

Table 1
Descriptive Statistics

	<i>Return of KSE</i>	<i>Δ in Exchange Rate</i>	<i>Δ in T Bill</i>
Mean	0.0038	0.0010	0.0007
SD	0.0408	0.0069	0.0245
Kurtosis	3.5107	12.1307	4.8759
Skewness	-0.7958	1.6174	-0.7246
Range	0.3791	0.0785	0.1837
Min.	-0.2010	-0.0293	-0.1059
Max.	0.1781	0.0493	0.0778

Correlation matrix is a technique which can be used to measure the strength as well as direction of relationship between all the variables under study. Results of table 2 show that return of KSE-100 index has weak negative relationship with other variables. Whereas relationship between change in exchange rate and change in interest rate is positive and also relatively weak.

Table 2
Results of Correlation Matrix

	Return of KSE	Δ in Exchange Rate	Δ in T Bill
Return of KSE	1.0000		
Δ in Exchange Rate	-0.0793	1.0000	
Δ in T Bill	-0.0752	0.1318	1.0000

This study also uses a set of diagnostic tests which includes Lagrange multiplier test and White's General Test. Results of these are presented at Table 3. The results of LMT and WGT clearly show that there exists autocorrelation and heteroscedasticity in the return of stock market in Pakistan which ultimately leads to the application of Engle's ARCH (1982) and Bollerslev's GARCH (1986) model.

Table 3
Diagnostic Test of our Study

Name	Test	CHSQ(χ^2)	Prob
Serial Correlation	Lagrange multiplier test (LMT)	6.0016	0.014
Heteroscedasticity	White's General Test (WGT)	12.2792	0

Table 4 concludes the result of GARCH (1, 1) model for Pakistani equity market. Table 4 has two part; upper part shows the results of mean equation while lower depicts the results of variance equation in Pakistani equity Market. From the mean equation, researcher wants to find the impact of independent variables on the return of Pakistani stock markets. Here the objective is to comment on the impact of change in exchange rate and interest rate on the return of equity market. From the table, the probability value of exchange rate is 0.0116 means that this explanatory variable has a significant negative impact on return of KSE-100 index in study period while Pakistani equity market remain independent from the changes in interest rate. The results of lower part shows the phenomena of volatility clustering. Here the p-value of coefficient φ_1 and ψ_1 confirms the presence of ARCH and GARCH effect in Pakistani equity market during our study period.

Table 4
A GARCH (1, 1) for Pakistani Equity Market

Variable	C	S.E	Z	P
C	0.0040	0.0019	2.1212	0.0339
KSE(-1)	0.1573	0.0529	2.9721	0.0030
T. BILL	-0.064	0.0587	-1.104	0.2693
Exchange Rate	-0.575	0.2282	-2.523	0.0116

	Variance Equation			
C	0.0003	0.0001	3.4810	0.0005
φ_1	0.1536	0.0519	2.9564	0.0031
ψ_1	0.6292	0.0959	6.5612	0.0000
R^2	0.0271	Schwarz criterion		-3.647
Adj. R^2	0.0210	Durbin-Watson test		2.0810

Table 4 shows the results of following equations of our study i.e. the mean equation and variance equation. The GARCH (p, q) model is given below:

$$\begin{aligned}
 Y_t &= \rho_1 + \rho_2 X_t + \varepsilon_t \\
 \varepsilon_t &\approx \text{iid } N(0, \sigma^2) \\
 \sigma_t^2 &= \alpha_0 + \sum_{i=1}^q \varphi_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \psi_i \sigma_{t-i}^2 \dots \dots \dots (5)
 \end{aligned}$$

This study also adds the explanatory variables in the second proportion of the GARCH model. The result of this model is given in table 5. It is pretty visible that change in exchange rate is a source which can enhance or multiplies the volatility of the equity markets in Pakistan. Simply speaking if there is any increase or any boost in the exchange rate then it is excitingly disturb the stock markets. While the effect of our other variable i.e. the interest rate is observed reverse as compare to exchange rate. It has calm effect on the volatility of dependent variables.

Table 5
GARCH (1, 1) with Exchange Rate and Interest Rate as variance Regressor

Variable	C	S.E	Z	P
C	0.003233	0.001797	1.798376	0.0721
KSE(-1)	0.194664	0.058227	3.343187	0.0008
Variance Equation				
C	0.0004	0.0001	6.9104	0.0000
φ_1	0.2749	0.0695	3.9554	0.0001
ψ_1	0.4535	0.0773	5.8673	0.0000
T. BILL	-0.0029	0.0013	-2.2204	0.0264
Exchange Rate	0.0267	0.0063	4.2549	0.0000
R^2	0.0181	Schwarz criterion		-3.647
Adj. R^2	0.0161	Durbin-Watson test		2.1362

Table 5 shows the results of following equation 6 of our study. If we add the explanatory variable in the variance equation of GARCH model then it can written as follow:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \varphi_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \psi_i \sigma_{t-i}^2 + \sum_{i=1}^k \beta_i X_i \dots \dots \dots (6)$$

Here in equation 6, the X_i shows the set of k explanatory variables as variance regressor in the variance equation of GARCH model. This study uses the changes in interest rate and changes in exchange rate as variance regressors in equation 6. Mathematically,

$$\sigma_t^2 = 0.0004 + 0.2749\varepsilon_{t-1}^2 + 0.4535\sigma_{t-1}^2 - 0.0029(\text{T. BILL}) + 0.0267(\text{Exchange Rate})$$

5. Conclusion

This study analyzed the impact of interest rate, and exchange rate on the stock markets in Pakistan. It also empirically analyzed the volatility aspect of the stock return in Pakistani equity markets and showed that how exchange rate and interest rate is creating a source of disturbance in the equity markets.

The results of Lagrange multiplier and White's General test clearly showed that there exists autocorrelation and heteroscedasticity in the return of stock market in Pakistan which ultimately leads to the application of Engle's ARCH (1982) and Bollerslev's GARCH (1986) model. Results of the correlation matrix showed that return of KSE-100 index had weak negative relationship with interest rate and exchange rate. GARCH (1, 1) showed that this explanatory variable (exchange rate) had a significant impact on return of KSE-100 index in study period. It was pretty visible from GRACH (1, 1) that change in exchange rate was a source which can enhance or multiplies the volatility of the equity markets in Pakistan. While the effect of interest rate is observed as reverse as compare to exchange rate. It has calm effect on the volatility of equity returns in Pakistani stock market. Therefore we recommend to investors, analysts, fund managers, and corporate stakeholder that they should be vigilant about this exciting and clam effect of exchange rate and interest rate on the equity market of Pakistan.

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