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CAUSALITY ANALYSIS OF VOLATILITY IN EXCHANGE RATE AND STOCK MARKET PRICES: A CASE STUDY OF PAKISTAN

Rana Ejaz Ali Khan[1†] --- Rafaquat Ali[2]

[1]*Associate Professor and Chairman, Department of Economics the Islamia University of Bahawalpur, Bahawalpur. Pakistan*

[2]*M. Phil Scholar, Department of Economics the Islamia University of Bahawalpur, Bahawalpur, Pakistan*

ABSTRACT

This study attempted to investigate the direction of causation between the volatilities of exchange rate and stock market prices in Pakistan. Monthly time series data of Karachi Stock Exchange prices (KSE-100 Index) and exchange rate of Pakistan (Rupee against US Dollar) is used for the period of January 1992 to February 2013. Philips Perron (PP) unit root test is applied to check the stationarity. PP test results show that all variables were stationary at first difference. GARCH model is applied on each variable to measure the volatility. Then the series of each variable are used for Granger causality analysis. The results of Granger causality test show a bidirectional relationship between the exchange rate volatility and the variability of stock market prices in Pakistan.

Keywords: Financial market, Stock market prices, Exchange rate, Karachi stock exchange.

JEL Classification: E32, O14, O40.

Contribution of the Study

This study is one of very few studies which have investigated the relationship of the variability of stock prices and exchange rate in Pakistan. In this study, we use conditional standard deviation of each variable as a measure of volatility and then use causality analysis.

1. INTRODUCTION

The stock exchange markets play a central role in the economies because they provide long-term funding to the firms and businesses. The stock market prices are affected by a number of

† Corresponding author
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internal and external factors. Exchange rate is one of them[1]. The global investors are investing in stock markets of the world so international investment is flourishing rapidly and capital is traveling across all over the world. Profitability of foreign investors is determined by foreign exchange rates when they invest in international stock markets. In this way exchange rate and its volatility may create uncertainty or may build confidence, on the other hand. So exchange rate becomes important for making stock market price volatile.

Stock market prices are incentives for the investors in their decision making to invest in the stock market. The fluctuations in stock market prices are generally irregular and unpredictable. Variability in stock market prices creates uncertainty among the international investors and to avoid risks the investors decrease then investments in the stock exchanges. The variation in exchange rate may change the stock market prices.

In the literature mixed evidences are found about the causal relationship between exchange rate volatility and variability of stock market prices. Some of the studies have found unidirectional and others bidirectional relationship between these two variables. Empirical evidences have shown causation from exchange rate to stock market prices (Abdalla and Murinde (1997) for Pakistan; Erbaykal and Okuyan (2007) for eight countries out of thirteen countries; Yusuf and Rahman (2012) for Malaysia; Olugbenga (2012) for Nigeria) as well as causation from stock market prices to exchange rate (Erbaykal and Okuyan (2007) for five countries out of thirteen countries; Yusuf and Rahman (2012) for Thailand). The studies have also found bidirectional causality (Erbaykal and Okuyan (2007) for three countries; Yusuf and Rahman (2012) for Malaysia). However, there are some evidences of no causation between exchange rate and stock market prices (Asaolu and Ogunmuyiwa, 2011; Zia and Rahman, 2011). The negative relationship has also been explored between stock market prices and exchange rate (Gan *et al.*, 2006; Pilinkus and Boguslauskas, 2009; Akbar *et al.*, 2012; Raza *et al.*, 2012).

A positive cointegration between stock market prices and foreign exchange rate has also been found by Singh *et al.* (2011). It makes the relationship between exchange rate and stock market prices varying depending upon the economies, size of economies and stock market bulk as well as the technique of analysis. The current study will attempt to see the causation volatilities in exchange rate and stock market prices in Pakistan. Karachi Stock Exchange (KSE) established in 1947 is Pakistan's oldest and largest stock exchange and an emerging stock market in South Asia. The two other stock exchanges are Lahore Stock Exchange and Islamabad Stock Exchange which were established in 1974 and 1989 respectively.

All the big companies are trading their shares at KSE. In the first week of May 2012 KSE had daily turnover of 255 million shares with US$ 41 billion market capitalization. A net inflow of US$ 227.67 million was done by foreign investors during July 2012 to March 2013. KSE has witnessed

[1] The other factors may be political instability, budget deficit, devaluation of local currency, interest rate, money growth, foreign direct investment, market capitalization and international oil prices, etc. (Abdullah and Hayworth (1993). Mukherjee and Naka (1995). Ali (2011). Akbar, Ali and Khan (2012). Raimony and El-Nader (2012). Raza, Nasir, Zeshan, Mohammad and Tanvir (2012).

a series of fluctuations and a range of factors are responsible for the phenomenon. In the last three decades there occurred a number of changes in political and economic scenario of the country and they affected the stock exchange market in Pakistan. Since financial reforms[2] in 1991, foreign investors invested in Pakistani stock exchange and listed companies at KSE reached to 591 in 2012. During 2012 there was a rise in inward remittances by overseas Pakistanis. Repayment of foreign debt to IMF put pressure in devaluation of Pakistani rupee. On the other hand, improvement in economic and political stability kept the local and foreign investors hopeful for safety of their investment. We have included the KSE index in the analysis as it represents the stock market of the country in a better way.

A variety of measures of variability has been used in literature, like percentage change (Schwert, 1989), log of first difference (Castanias, 1978), relative change (Grossman and Shiller, 1981), conditional variances and standard deviation (Gujarati and Porter, 2009). We will use autoregressive conditional heteroskedasticity (ARCH) technique and generate a conditional variance and standard deviation series. Conditional standard deviation series is used as a measure of variability. Finally we will employ Granger causality test to find causation between the volatilities in stock market prices and exchange rate.

2. LITERATURE REVIEW

In the literature the analysis of stock market prices and exchange rate has remained the focus of the studies. They provide theoretical and empirical support on fluctuations in stock market prices and variability of exchange rate. The relationship between exchange rate and stock prices in Turkey has been investigated by Kasman (2003). The study used four stock price indices of financial, services and industrial sector, and composite index. Time series analysis of Johnson cointegration found a long-run relationship between stock market price and exchange rate. The causality analysis provided a conformational relation between composite index and exchange rate, service sector index and exchange rate and financial sector index and exchange rate. The study also found that causality runs from exchange rate to industrial sector index.

For Ghana, Adam and Tweneboah (2008) analyzed the long and short-run relationships between the stock market price and the exchange rate. Empirical results found long-run relation between exchange rate and stock prices. Erbaykal and Okuyan (2007) analyzed thirteen developing countries and established a relationship between stock prices and exchanges rates. Empirical findings showed a significant causal relationship between exchange rate and stock prices in eight out of thirteen economies. The causality from stock prices to exchange rate was found in five countries. In three countries the study found bidirectional causality between stock prices and exchange rate.

[2] Financial reforms in Pakistan were started in 1991 under structural adjustment program of IMF.

For Lithuania, Pilinkus and Boguslauskas (2009) found that exchange rate is one of the significant determinants of the variability in stock prices. Results of impulse response function explained that exchange rate negatively affects stock market index.

For Nigeria, Asaolu and Ogunmuyiwa (2011) analyzed the relationship between macroeconomic variables including exchange rate and stock prices. They used annual time series data and applied Johansen Co-integration test and Error Correction Model (ECM) for long and short-run analysis. Cointegration results confirmed the existence of long-run relationship, but the Granger causality did not show affiliation between stock prices and macroeconomic variables.

The study concluded that only exchange rate had Granger cause to stock prices. For the same country, Olugbenga (2012) probed the short and long-run impact of exchange rate on stock market development. The study used quarterly time series data and used Johansen cointegration and Granger causality technique. The results show study found a positive relationship between stock market prices and exchange rate in short-run and a negative relationship in the long-run. The Granger causality test explained that causation runs from exchange rate to stock market prices. Finally it was concluded that in Nigeria variability in stock market prices is due to the volatility in exchange rate.

For five countries of the ASEAN Yusuf and Rahman (2012) attempted to find out the causality between the stock price index and exchange rate volatility by using multivariate vector autoregressive (VAR). They found a bi-directional causality for Malaysia and a unidirectional causality from stock prices to volatility of exchange rate in Thailand. No causality effect was found in Indonesia, Philippines and Singapore.

For Pakistan a number of studies have attempted to see the relationship between exchange rate and stock market prices. In the earlier studies Abdalla and Murinde (1997) probed the interaction between real effective exchange rate and stock market prices for Pakistan along with India, Korea and Philippine by using vector autoregressive model on monthly time series data. They found unidirectional causality from exchange rate to stock market prices for all the economies except Philippine.

Hasan and Nasir (2008) attempted to explore the relationship between stock market prices and macroeconomic variables like broad money, industrial production index, interest rate, oil price, inflation and foreign exchange rate by using monthly time series data for the years 1998-2008. The results of cointegration and error correction model have shown a significant relationship between exchange rate and stock prices in Pakistan. Rahman and Uddin (2009) explored the relationship between exchange rate and stock price in Pakistan, India, and Bangladesh. The study applied cointegration and Granger causality test to examine causal relationship between stock prices and exchange rates. They found no long-run and causality relationship between stock price and exchange rate in these countries.

Sohail and Hussain (2009) investigated the relationship between macroeconomic indicators and stock prices by using monthly time series data for the years 1998-2008. They applied cointegration test for long-run relationship. Industrial production index, real effective exchange rate

and money supply were found positively cointegrated with stock prices. A dynamic relationship between exchange rate and stock price index has been analyzed by Zia and Rahman (2011). The study used monthly time series data from 1995 to 2010 and employed Engle-Granger causality and Co-integration technique. The results explained that there existed no long-run relationship between exchange rate and stock prices. No causal relationship was found between the variables. The analysis pointed out that political instability was the reason for such type of conflicting results to the literature.

Akbar *et al.* (2012) examined the relationship between stock market prices and macroeconomic variables by using monthly time series data for the years 1999-2008. They transformed variables into natural log and used the vector error correction model and Johnson's co-integration. Co-integration results showed that there is a long-run relationship between the stock market prices and macroeconomic variables. A positive relationship was found between stock market prices and money supply and a negative relationship between inflation and foreign exchange rate. Raza *et al.* (2012) have also analyzed the effect of exchange rate, inflation and foreign direct investment on stock market prices in Pakistan by using annual time series data. They found that exchange rate and inflation had a negative effect on stock prices. The current study is an addition to the concerned literature with analysis of volatility in Karachi stock market prices and exchange rate of Pakistan with fresh data and particularly the monthly time series data.

3. DATA DESCRIPTION AND METHODOLOGY

To see the relationship between stock market price and exchange rate monthly time series data for the time period January 1992 to March 2013 has been used. The closing values of Karachi stock exchange index (KSE-100 index) at the end of the month and exchange rate (Rupees against the US Dollar) have been used for analysis. Data has been taken from State Bank of Pakistan and Karachi Stock Exchange. The stationarity of data has been checked by Phillips and Perron test and volatility is measured by GARCH model. Finally Granger causality test is applied to measure the unidirectional or bidirectional causality between exchange rate volatility and stock price variability.

3.1. Estimation Techniques

3.1.1. Phillips and Perron (PP) Unit Root Test

All the time series data are generally found in non-stationary form so stationarity checks are essential to avoid the spurious regression results. We have used PP test (Phillips and Perron, 1988) for stationarity of data.

It is more realistic than Augmented Dickey Fuller (ADF) test by Dickey and Fuller (1981) and is non-parametric in nature. It corrects serial correlation and heteroskedasticty in error terms. Mathematically PP test is approximately same as ADF test that is with and without constant and trend. It is represented as:

$\Delta X_t = \beta_1 + \beta_{2t} + \gamma M_{t-1} + \varepsilon_t$ …….. (i)

$\Delta X_t = \beta_1 + \gamma M_{t-1} + \varepsilon_t$ …… (ii)

In above equations, β_1 is constant and β_{2t} is trend. The second equation consists of only constant term (β_1). Here the null hypothesis (H_0) is $\gamma = 0$ (the variable has a unit root) that is less restricted than ADF. Normally ADF and PP tests provide the same results regarding order of integration. If H_o is rejected, then the variable is said to be stationary or independent of time. Otherwise (H_o is not rejected) it is said to be non-stationary or have time effect.

3.1.2. Autoregressive Conditional Heteroskedasticity [ARCH (q)] Model

Autoregressive conditional heteroskedasticity (ARCH) technique given by Engle (1982) focuses on the modeling of conditional variance and more appropriately conditional Heteroskedasticity. It is used to measure the conditional variability or volatility that includes the lagged value and gives higher weights to recent past observations than others. For example the model gives unequal weights formation that changes towards autoregressive method.

3.1.3. Generalized Autoregressive Conditional Heteroskedasticity [GARCH p q] Model:

The generalized ARCH model (Bollerslev, 1986) includes the lagged conditional variance terms as autoregressive.

The general form of GARCH (p q) model is as

$Z_t = \alpha + \beta Y_t + \mu$ …….. (iii)

$h_t = £ + ¥ \mu^2_{t-1} + € h_{t-1}$ ……(iv)

Equation (iii) is the mean equation and equation (iv) is the conditional variance equation which has the variance scaling parameter ht that depends both on past values of the shocks which are captured by previous period squared residual terms (μ^2_{t-1}) and previous period error variance (h_{t-1}). The simplest form of GARCH (p q) is the GARCH (1 1). 1st number in parenthesis represents ARCH term and 2nd number represents GARCH term. We generate conditional variance series and then standard deviation series that represent the volatility in concerned variable.

3.1.4. Granger Causality Test

Granger causality test (Granger, 1969) has been employed to determine the causality between exchange rate and stock price indices. The Granger causality test is used to observe the relationship between two variables in terms of whether they are related or not and which one causes the other one or no one cause each other. For example we have two variables Y and Z. Four reasonable outcomes may emerge from the test. Firstly Y can Granger cause Z, secondly Z can Granger cause Y, thirdly there can be no causality between Y and Z and finally there can exist bi-directional causality from Y to Z and Z to Y.

The model utilizes Granger causality test to determine the direction of causality between the volatility of exchange rate and stock price in Pakistan. The generalized method is expressed as:

$Zt = \gamma_0 + \gamma_1 Z_{t-1} + \ldots\ldots\ldots + \gamma_m Z_{t-m} + \lambda Y_{t-1} + \ldots\ldots\ldots\ldots \lambda Y_{t-n} + \dot{\varepsilon}$ …….. (v)

$Yt = \gamma_0 + \gamma_1 Y_{t-1} + \ldots\ldots\ldots + \gamma_n Y_{t-n} + \lambda Z_{t-1} + \ldots\ldots\ldots\ldots \lambda Z_{t-n} + \dot{\varepsilon}$ …….. (vi)

Where γ_0 is constant, γ_i and λi are coefficients of lagged values of variables Z and Y. $\dot{\varepsilon}$ is white noise residual. We can replace above equations to the variables of volatility of stock prices and exchange rate volatility as:

$VSPt = \gamma_0 + \gamma_1 VSP_{t-1} + \ldots\ldots + \gamma_m VSP_{t-m} + \lambda VEXR_{t-1} + \ldots\ldots \lambda VEXR_{t-n} + \dot{\varepsilon}$ …….. (vii)

$VEXRt = \gamma_0 + \gamma_1 VEXR_{t-1} + \ldots\ldots + \gamma_n VEXR_{t-n} + \lambda VSP_{t-1} + \ldots\ldots \lambda VSP_{t-n} + \dot{\varepsilon}$ ……. (viii)

Where VSP = Volatility in stock market prices (KSE-100 Index)

VEXP = Volatility in exchange rate (Pakistani rupee against US Dollar)

4. EMPIRICAL RESULTS

Table-1. Unit Root Test: Phillips and Perron (PP) Test

Variables		Constant and Intercept			Trend and Intercept			Conclus
		Null Hypothesis: the variable has a unit root or non- stationary						
		Coefficient	Standard Error	Test statistics (t-value)	Coefficient	Standard Errors	Test -statistics (t-value)	
SP (Stock market price)	Level	0.0068	0.00685	0.992	-0.0157	0.0135	-1.161	I(1)
	1st Difference	-0.8748	0.063	-13.86	-0.8853	0.0632	-14.001	
EXR (Exchange rate)	Level	0.0030	0.002	1.280	-0.005	0.009	-0.5457	I(1)
	1st Difference	-0.601	0.057	-10.37	-0.606	0.058	-10.41	

The table 1 represents the results of unit root test, under the null hypothesis the variable has a unit root. We test each variable at level with intercept, level with trend and intercept and then at first difference. We use coefficient value and standard error to find that at what level the variable has order of integration. In order of stationarity of data is shown in last column of the table. The results revealed that null hypothesis is rejected at 1% and 5 % level of significance at first difference and all variables are integrated at order one I(1).

4.1. Measurement of Volatility in Each Variable

To check the existence of ARCH effect we have measured the volatility in stock prices. The results of the volatility in stock prices are shown in table 2.

In the above ARCH model the mean equation is summarized through autoregressive moving average (ARMA) method. The results show that the value of lagged coefficient is 1.01 that is greater than zero.

It means that variability was high in previous period and it will continue to be high in current period and it is highly significant with p-value = 0.000. In the second part of table variance equation is summarized. In variance equation RESID $(-1)^{\wedge 2}$ to RESID $(-7)^{\wedge 2}$ which are actually representing ARCH terms and GARCH(-1) represents GARCH term. We use the conditional variance series and then standard deviation series as a measure of variability of stock prices. The graph of conditional standard deviation has been shown in figure 1.

Table-2. Summary of ARCH in Mean Model

Dependent variable: SP (KSE-100 index) Method: ML - ARCH (Marquardt) - Normal distribution				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-2)^2 + C(6)*RESID(-3)^2 + C(7)*RESID(-4)^2 + C(8)*RESID(-5)^2 + C(9)*RESID(-6)^2 + C(10) + C(7)*RESID(-4)^2 + C(8)*RESID(-5)^2 + C(9)*RESID(-6)^2 + C(10)				
Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Probability
C	31.42292	111.6185	0.281521	0.7783
KSE(-1)	1.010016	0.010541	95.81903	0.0000
Variance Equation				
C	212501.4	64533.42	3.292890	0.0010
RESID(-1)^2	-0.023976	0.004237	-5.659216	0.0000
RESID(-2)^2	0.056952	0.042654	1.335208	0.1818
RESID(-3)^2	0.143319	0.099245	1.444091	0.1487
RESID(-4)^2	-0.023866	0.051094	-0.467109	0.6404
RESID(-5)^2	-0.023480	0.005974	-3.930647	0.0001
RESID(-6)^2	0.079374	0.080526	0.985695	0.3243
RESID(-7)^2	0.096965	0.032712	2.964164	0.0030
GARCH(-1)	0.043663	0.237889	0.183544	0.8544

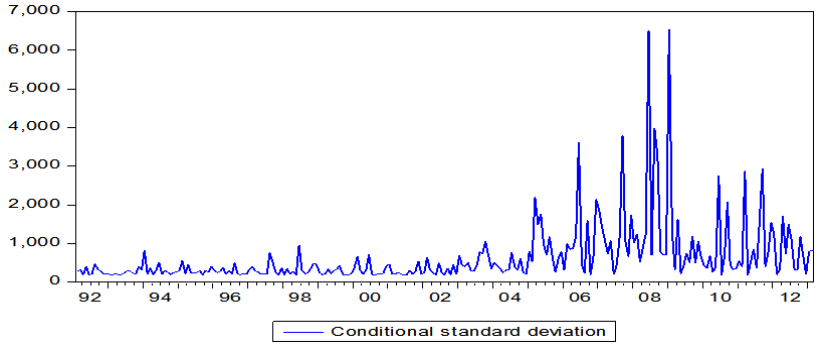

Figure-1. Conditional Standard Deviation of Series of Stock Market Prices (KSE-100 Index)

Figure 1 shows the conditional standard deviation of series of KSE-100 index that shows the volatility of stock prices in Pakistan.

Similarly, volatility of exchange rate has been estimated and then conditional variance series has been obtained and Granger causality test has been applied.

Table-3. Summary of ARCH Model (Exchange Rate)

Dependent variable: EXR (Exchange rate-Pakistani rupee against $US) Method: ML - ARCH (Marquardt) - Normal distribution				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-2)^2 + C(6)*GARCH(-1)				
Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Probability
C	0.028718	0.059585	0.481962	0.6298
EXR(-1)	1.002178	0.000753	1330.978	0.0000
Variance Equation				
C	0.208922	0.034024	6.140376	0.0000
RESID(-1)^2	1.553599	0.216635	7.171508	0.0000
RESID(-2)^2	0.681340	0.366344	1.859835	0.0629
GARCH(-1)	-0.403069	0.227349	-1.772910	0.0762

Table 3 shows that the lagged period effect coefficient is 1.002 which shows that variability was high in previous period and it will continue to be high in current period it is highly significant

with p-value 0.000. In variance equation the sum of ARCH and GARCH terms are greater than one showing volatility in residual. We use the conditional standard deviation series data as a measure of exchange rate volatility in Pakistan. The graph of conditional standard deviation of exchange rate of Pakistan has been plotted in figure 2.

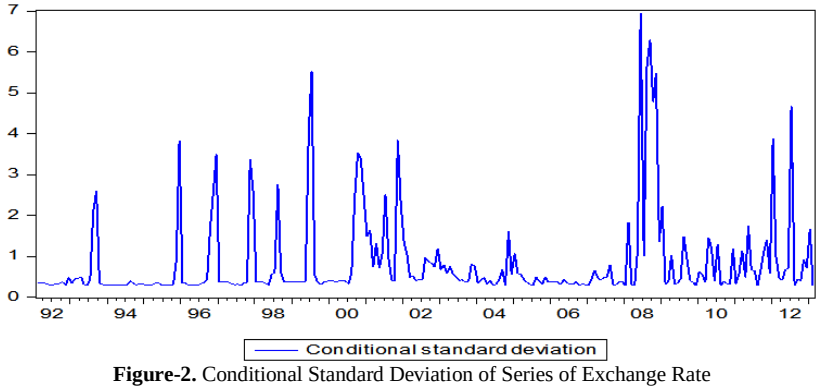

Figure-2. Conditional Standard Deviation of Series of Exchange Rate

Figure 2 represents the graph of the series of conditional standard deviation of exchange rate of Pakistani rupee against US Dollar that measures the variability of exchange rate.

We have done the causality analysis to find the granger causality between the volatilities of both variables, i.e. stock prices and exchange rate. The results of granger causality are shown in table-4.

Table-4. Granger Causality Tests

Pairwise Granger Causality Tests			
Lags: 2			
Null Hypothesis	Observations	F-Statistic	Probability
SP does not Granger Cause VEXR	251	3.43618	0.0337
VEXR does not Granger Cause SP	251	18.3035	0.0000

The results of Granger causality between the volatilities of exchange rate and stock prices show a bi-directional causality. Null hypothesis: exchange rate volatility does not granger cause stock price volatility and variability of stock prices does not granger cause exchange rate volatility is rejected. This bi-directional relationship is not surprising because when stock market is optimistic or bullish, overseas investors come and invest in Pakistani stock market and in return value of domestic currency is appreciated and vice versa. On the other hand when the value of domestic rupee becomes volatile the foreign investors hesitate to hold domestic stocks. Due to the foreign exchange risk there emerged an effect on the stock market in Pakistan.

5. CONCLUSION

The paper empirically investigated the relationship between the volatilities of exchange rate and stock market prices by using granger causality test to find the direction of causation. The

exchange rate as Rupee against US dollar and KSE-100 index are used for analysis. Monthly data for the period of January 1992 to February 2013 has been used. Philips Perron test of unit root is conducted for stationary purpose. GARCH model is applied on each variable to measure the volatility. The series of conditional standard deviation represents the variability of the variables. The series of data for each variable is used for Granger causality analysis. The results of Granger causality test show a bidirectional relationship between the exchange rate volatility and the variability of stock prices.

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