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Nexus of Stock Prices and Exchange Rate in Pakistan

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Abstract: The aim of the current paper is to find the association between stock price and exchange rate and to analyze whether it is 'short run' or 'long run'. For this purpose unit root test (ADF), cointegration tests and vector error correction model (VECM), Granger causality test are used on the daily data of stock price (KSE-index) and exchange rate from 1st January, 1995 to 31st October, 2012 in Pakistan. The result of cointegration test shows that between these two variables there exists 'long run' and 'short run' relationship. It is found that there exists a flow relationship from the stock price to the exchange rate. The path of the relationship occurs from the stock price to exchange rate then the monetary policies are required to be tightened and the interest rate must have to be revised.

Key words: Stock Price · Exchange Rate · Monetary policies · Unit root Test · Granger Causality Test

INTRODUCTION

The association between the two variables, the stock price (*SP*) and the exchange rate (*ER*), attracts attention of many researchers from early eras of 1990's. Their work shows that the relationship between the variables is not conclusive. The two theories have been put before us, traditional approach and portfolio approach. The first theory is about the relationship from the *ER* to the *SP*. It explains that it is the *ER* that causes changes in the *SP*. It also indicates that the increase in the worth of currency (overvalued) will show an upward trend in *SP*. For example, in Pakistan scenario, the currency is getting devalued but the *SP* shows an upward trend due to inflation. The second theory is about the relationship from *SP* to *ER*. It explains that upward trend in *SP* causes the currency to appreciate.

From the above we conclude that both the theories not only contradict each other but also change the real scenario. In order to observe the impact of one market on the other one, the researchers have a lot to explore the exact relationship between the two variables i.e. to *SP* and the *ER*. The analysis of the data will help us to find the existence of the association between the variables. And if, relationship exists then flow of relationship between the two variables can be found to predict the position of one market on the basis of other. Moreover, the results can help us to make decisions about monetary policies. If the path of relationship occurs from the *SP* to *ER* then the monetary policies are required to be tightened and the interest rate must have to be revised.

Apart from the theoretical studies, a number of the empirical studies have been conducted and they show varying results for the both, developed and the developing countries. The work of [1-6] show that there is no associationexists between the *SP* and the *ER* in Bangladesh, India and Sri-Lanka respectively. [7] observed mixed results for India, Japan, Hong Kong, Singapore and Korea. [8-13] show that there exist either unidirectional or bi-directional relationship between these two variables in case of Malaysia, Brazil, New Zealand, India, Thailand and Turkey respectively.

The work of different scholars has contradicted the theoretical and empirical backgrounds. It is important to discover the exact association between the *SP* and the *ER* variables. And to reach at a reasonable conclusion that how one market can be used to predict the position of the other one. In the next sections this paper is arranged in such a way that we will be having literature review, methodology, analysis and conclusion.

Literature Review: Usually, the stock price (*SP*) is stated as an existing value of the future cash flow of corporations. It has better to adjust according to the economic perspectives. According to [14], the exchange rate (*ER*) is the worth of the assets and the actual *ER* is

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Table 2.1:

Author	Country	Variables	Time Period	Methodology	Results
[17]	Malaysia	Macro-economic variable, SP and ER	January, 1997-August,1998	Cointegration, VAR	SP +ive money supply. ER –ive SP
[1]	Pakistan, India, Bangladesh and Sri Lanka	SP and ER	January, 1994-December, 2000	Granger causality test	ER ⇔ SP (in long and short run, in case of India and Pakistan) ER ◎ SP (in short run in Bangladesh and Sri Lanka)
[2]	India	SP, ER, foreign ER reserves	1991-2001	Granger causality and unit root test	SP ◎ macro-economic variables i.e. ER rate, ER reserves.
[3]	India	SP, ER	April 1992 to March 2002	Granger causality test and VAR	SP ◎ ER
[14]	Australia, France, USA, Germany, U.K, Poland, Slovakia, Hungary and Czech Republic	SP, ER	1970-1992	Granger causality and VAR	SP ↔ ECH rate (in long run in developed nations) SP → ECH rate (in developing countries)
[15]	Brazil	SP, ER	August 1, 1994 to May 14, 2002	Cointegration test and Granger causality test	SP ↔ ER (but no long run relationship)
[8]	New Zealand	SP, ER	1999-2006	ADF test, Granger causality test and ECM.	SP ↔ ER
[9]	Czech Republic, Greece, Hungary, Ireland, Poland, Portugal, Slovenia and Spain,	SP, ER	December, 1992 to December, 1998	Cointegration and VAR	SP → ER
[4]	Egypt, Kuwait, Oman and Saudi Arabia	SP, ER	Egypt 1994-2006: Kuwait 1992-2006; Oman 1996-2006; and Saudi Arab 1994-2006.	Unit root test, co-integration and VAR	SP ◎ ER
[10]	Turkey	SP, ER	23 February 2001 to 11 January 2008	Causality test	ER ↔ SP
[5]	India, Bangladesh and Pakistan	SP, ER	2003-2008	Granger causality, Unit root and VAR	SP ◎ ER
[11]	Turkey	SP, ER	23 February, 2001 to 4 November, 2009	Granger causality and ADF	SP → ER
[12]	Romania and US	SP, ER	January, 2008 to October, 2010	Granger causality and Cointegration	SP → ER
[13]	India	SP, ER	9th March, 1999 to 9thMarch, 2009	GARCH and Granger causality test	SP ↔ ER
[7]	India, Japan, Hong Kong, Korea and Singapore	SP, ER	2002-2010	Unit root test and granger causality test	SP → ER (long run in Hong Kong, Japan and Singapore, butshort run in India and Korea)
[18]	Iran	SP, ER	1384-1389 H (1964-1969)	GARCH	ER +ive cemet, food and automotive industry SP ER –ive pharmacy, machinery and chemical industries SP ER ◎ metal industry SP
[6]	Bangladesh	SP, ER	January 1983 to August 2003	Granger causality and unit root test	SP ◎ ER
[19]	Thailand	SP, ER	July 1997 to June 2010	GARCH, Cointegration, causality test.	SP → ER

estimated by the expected *ER*, i.e. prices of other assets. [3] is of the view that the association between *SP* and the *ER* is estimated through three different approaches: flow oriented model, stock oriented model and portfolio balance approach.

The flow oriented model describes a positive (+ve) association between the *SP* and the *ER* with a positive flow of causality moving from the *ER* variable to the *SP* variable, which arose from the hypothesis of employing the direct *ER* quotation. The stock oriented model approach puts much emphasis on the function of the financial (formerly capital) account in the *ER* estimation. The portfolio balance model indicates a either positive or negative association between the *SP* and the *ER* and resulted in that the *SP* throws an impact on the *ER*.

These approaches explain the existence of the relationship between the two variables and force the investors to perceive that these variables are correlated. So, this turn out is an important topic for the researchers. According to [15], there are two different theories about the financial market: traditional approach and portfolio adjustment. The traditional approach suggests that the *ER* causes the change in the *SP*. The portfolio adjustment suggests that a change in the *SP* directs either positive or negative correlation to the *ER*.

Many studies have been conducted during different time period to measure the association between the *SP* and the *ER* variables, so that the position of one market can be perceived on the basis of the other one. [16] was the first scholar who determined that there was no association between the *ER* and the *SP* of US multinational firm. [6] suggested that there exists no relationship between these two variables in case of Bangladesh. [3] stated that there is no causality between the two variables in India. Ray (2012) is of the view that the short term unidirectional relationship has been found in Korea and long run equilibrium relationship occurs in Hong Kong, Singapore and Japan.

So, from theoretical literature put forward by the scholars it has been observed that a 'long run' association occurs in the developed countries where it is possible to forecast the position of one market can be perceived on the foundation of the other one. But in the developing countries there is either non association between *SP* and *ER* or unidirectional association, which flow from *SP* to *ER*. Table 2.1 shows the relationship between the variables studied by different researchers for different countries.

MATERIALS AND METHODS

Unit Root Test: In order to work on time series data, the data is required to be stationary. Many studies show that major time series variables data is not stationary. And if non-stationary data is used in regression analysis then the analysis results appear to be spurious. When further tests are applied on time series data, it is required to make time series data stationary. For this, unit root test proposed by Augmented Dickey Fuller (ADF) is used. ADF is obtained by,

$$Y_t = \beta_1 + \beta_2 + Y_{t-1} + E_t \tag{3.1}$$

Y_t is the variable at time t, Y_{t-1} is Y variable with 1 lag period data, E_t is error term included and β_1 and β_2 are the coefficients. In order to make data stationary, it is required that mean and variance of the variable required to be non-variant.

Cointegration and VECM: The cointegration test is applied to determine the long term equilibrium relationship between the variables i.e. *SP* and *ER* and both variables need to be integrated at order 1. [20, 21] methods are applied to determine the cointegration between two or more variables and number of cointegrating vectors for variables of the same order. The purpose of cointegration test is to see whether the variables are cointegrating or not. The Johansen method uses to find the existence of cointegrating vectors in non-stationary time series as a vector autoregressive (VAR):

$$\Delta Z_t = C + \sum_{i=1}^{K} \Gamma_i \Delta Z_{t-1} + \Pi Z_{t-1} + \eta_t \tag{3.2}$$

where Z_t a vector of non-stationary variable, C is constant. The information on the coefficient PP matrix between the level of Π is separated as $\Pi = \alpha\beta$, where α is relatedcomponent of the matrix and modified coefficients b and β matrix comprises the number of cointegrating vectors. The Johansen cointegration test specifies two test statistics: first, the likelihood ratio statistics, the H_o is exactly (r) cointegrating vectors and the H_A is (r + 1) vector is the maximum eigen value statistic. The second statistics for the H_o at most (r) cointegrating vectors and the H_A is the trace statistics. The critical values for both test statistics are calculated. By considering the eigenvalue, hypotheses can be generated as:

H_0 : The number of +ve eigenvalues are exactly none.
H_1 : There are exactly r positive eigenvalues.

The orders of tests begin with ($r = 0$) and finish when the H_0 cannot be denied any more. The cointegration rank is then same to the value at which the H_0 could not be denied [22]. The H_0 will be rejected if the test statistics value is greater than the corresponding critical value. If cointegration exists between *SP* and *ER*, then Vector Error Correction Model (VECM) is applied at the next step to find the short term association among the variables.

$$\Delta SP_t = \beta_0 + \sum_{i=1}^{q} \beta_{1t} \Delta SP_{t-i} + \sum_{i=1}^{q} \beta_{2t} \Delta ER_{t-i} + \alpha_1 Z_{t-1} + \varepsilon_{1t} \quad (3.3)$$

$$\Delta ER_t = {}_0 + \sum_{i=1}^{r} {}_{1t} \Delta ER_{t-i} + \sum_{t=1}^{r} {}_{2t} \Delta SP_{t-i} + \lambda_1 Z_{t-1} + \varepsilon_{2t} \quad (3.4)$$

where, Z_{t-1} is considered at the "error correction term" that is attained from the cointegrating equation so that the deviations in the variables are relatively determined by the previous values of Z_t. Δ is used as the first difference operator with the variables. The error correction terms (α_1 & $\_\__1$) of eq. 3.3 and 3.4 are estimated to determine the speed of the adjustments of ΔSP_t and ΔER_t towards the long-term equilibrium relationship, while the coefficients of ΔSP_{t-1} and ΔER_{t-1} are estimated to determine the short-run dynamic nature of the model.

Granger Causality Test: Causality, as name suggests, is used to find cause and effect relationship of variables. For two variables, if it is not sure about dependent and independent variables then granger causality test is applied to find causality flow from one variable to other. [23] had introduced about causality model and its application. It is used to find either one variable is significant enough to forecast another. It helps to determine from the past values of variable that either this variable can forecast another variable or not. The lagged values of both variables are considered to check that either one variable is forecasting the change in another variable. The null hypotheses for this test are:

H_{01} : The *SP* doesn't granger cause the *ER*
H_{02} : The *ER* doesn't granger cause the *SP*

The p-value is considered to reject the null hypotheses. According to [24], if the two variables are $I(1)$ and residuals are integrated at zero order then, it means, two variables are cointegrated. So, the variables data is required to be stationary in order to find good results of Granger causality, otherwise the results get spurious. The equations of the granger causality for *SP* and *ER* are:

$$SP_t = \gamma_0 + \sum_{i=1}^{n} \alpha_i ER_{t-i} + \sum_{j=1}^{n} \beta_j SP_{t-j} + u_{1t} \quad (3.5)$$

$$ER_t = \gamma_1 + \sum_{i=1}^{m} \lambda_0 ER_{t-i} + \sum_{j=1}^{m} \delta_j SP_{t-j} + u_{2t} \quad (3.6)$$

where, SP_t and ER_t are the stock price and exchange rate at time t and u_{1t} and u_{2t} are both uncorrelated error terms for t time period. Eq. (3.5) shows that the present value of stock price (SP_t) is correlated with the past value of stock price(SP_{t-1}) and as well as the lag value of exchange rate (ER_{t-1}). Likewise, eq. (3.6) shows that the present value of exchange rate (Er_t) is correlated to the lag value of exchange rate (ER_{t-1}) and the lag value of stock price (S_{t-1}).

Data Collection: In the analysis, data of stock market and exchange market of Pakistan is taken. The data of KSE-100 index and *ER* of domestic currency i.e. Pak Rupee per US Dollar is collected from Karachi Stock Exchange data base and FOREX website respectively. The period of data collection is from 02 January, 1995 to 31 October, 2012. The daily data of both variables is taken that comprise of 4341 observations of each variable. The log transformation of data of both variables is necessary to do. The graph shows the trend of both variables i.e. *ER* and *SP* which helps in analysis. The graph shows upward trend in both variables. Figure 3.1 show that the graph of the *SP* seems to be more volatile other than *ER*.

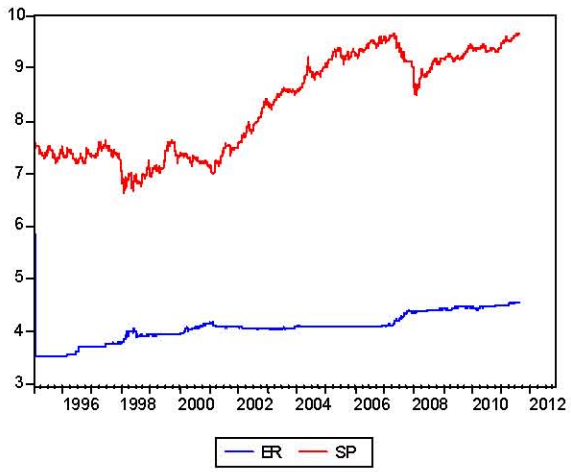

Fig. 3.1: Graph showing trend in SP and ER

RESULTS AND DISCUSSION

In order to find the nature of distribution of the variables, the normality test is used. The results of descriptive statistics and Jarque Bera statistics are shown in table below:

If median is greater than mean, then it shows negative skewness in both variables as tail appears in negative direction. If the value of kurtosis is less than 3, then, it shows it is platykurtic (negative skewness). The negative skewness shows that graph of both variables i.e. *ER* and *SP* has tail in negative direction. This shows that at the beginning period data was at low rates and as the time passes, the data approaches to its peak. But the value of skewness appears towards negative direction as well. If the value of skewness is zero (0) and the value of kurtosis is three (3), it indicates that the variables are normally distributed. The value of skewness for *SP* and *ER* are -0.19 and -0.03 respectively. The value of kurtosis for *SP* and *ER* are 2.91 and 1.34 respectively. Table 4.1 results show that the both of variables are non-normally distributed and kurtosis also shows negative skewness.

In order to determine the stationarity of each variable, ADF unit root test is used in Table 4.2 below:

ADF is used to find either that data is stationary or not. The above results of ADF test shows that the data of *SP* and *ER* is stationary. Both variables are integrated at 0 order *I(0)*. Now, the data can be used and further tests are applied to find short run, long run and causal relationship between the two variables i.e. *SP* and *ER*.

To determine the presence of long-run relationship between the variables, the Johansen cointegration test is used. The estimated trace (λ trace) and maximal eigen value test (λ max) statistics and their relevant 1% critical values are shown in Table 4.3:

The null hypotheses of the λ statistics indicates that the number of cointegrating vectors is less than or equal to (r) against the H_A and it comes out to be 1. However, the maximal eigenvalue test also recommends the number of cointegrating vector is 1. So, there is long term equilibrium relationship between the *SP* and *ER* at 1% significant level. At the next step, the short run relationship between variables has been found, by using VECM. The VECM statistics are shown in Table 4.4 below:

Table 4.1: Descriptive Statistics

Variables	SP	ER
Mean	4.08	8.29
Median	4.09	8.45
Standard deviation	0.28	0.95
Skewness	-0.19	-0.03
Kurtosis	2.91	1.34
Jarque-Bera	28.66 (0.00)	502.26 (0.00)

Table 4.2: Unit Root Test Results

	Level I(0) with Intercept and Trend		
Variables	t-stats	*k*	Conclusion
SP	-59.16*	0	Stationary *I*(0)
ER	-20.89*	1	Stationary *I*(0)

Note: 5% critical value is taken with constant at trend and intercept.

Table 4.3: Cointegration Results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistics λtrace	Critical value	p-value
None* r ≤ 0	0.14	679.70	15.49	0.00
At most 1* r ≤ 1	0.00	11.58	3.84	0.00
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic λmax	Critical value	p-value
None* r ≤ 0	0.14	668.12	14.26	0.00
At most* r ≤ 1	0.00	11.58	3.84	0.00

Note: *denotes rejection at the 1% level. ** [25] p-values.

Table 4.4: VECM Results

Error Correction Variables	ΔSP	ΔER
SP(-1)	0.11*	0.09*
	(0.02)	(0.04)
ER(-1)	0.01	-0.33*
	(0.01)	(0.01)

Note: ( ) represents standard error. * level of significance at 1%.

Table 4.5: Granger Causality Test Results

Null hypothesis	F-statistics	p-value
ER does not granger cause *SP*	0.43	0.99
SP does not granger cause *ER*	1.42	0.07*

Note: * Level of significance at 10%.

The VECM result in Table 4.4 shows, in short run there is positive relationship of *SP* causing the *ER*. In order to ascertain the flow of any long run correlation between the *SP* and the *ER*, the Granger causality test is performed. Table 4.5 shows the results:

The statistics given in the Table 5, there is rejection of H_0, i.e. *SP* does not cause *ER* as the f-statistics is 1.42 at 10% level. It means that there is unidirectional causality occurs between the two variables, from *SP* to *ER* of Pakistan.

CONCLUSION

This study analyses the association between the *SP* in Karachi Stock Exchange (KSE) and the *ER* (with respect to US$). The ADF unit root test was used for both variables in order to compute the stationarity of time series data and the results show that the variables are stationary, *I*(0) order. The Johansen cointegration method was applied and there is a long run equilibrium relationship between the variables. The VECM was applied to measure the short run relationship, which shows that the *SP* is causing *ER* in short run. The Granger causality test was applied to determine the causality and the result shows that there exists unidirectional relationship, which flow from the *SP* to the *ER* means the *SP* causes the *ER*. The test results support the portfolio adjustment model of *ER* determination that suggests there is a unidirectional causation that runs from *SP* to *ER*.

On the basis of the different theories on the relationship of *SP* and *ER*, this is a mutual conviction among the different investors that there exists a strong association between the *SP* and *ER*. And it is predicted on the basis of other variables. The result of the current study evaluates this conviction and state that these variables are anticipated on the basis of previous values of other variables. The results of stationarity of time series evaluates that there is a possibility of increase of profitability of stock market on the basis of foreign *ER*. So, both markets are correlated, as there is a unidirectional causal short run relationship between the two variables from *SP* to *ER*. There exists also cointegrating long run equilibrium relationship, so, the investors can use the facts of one market to forecast the other. It is also advocated in the literature that if the path of the relationship occurs from the *SP* to *ER* then the monetary policies are required to be tightened and the interest rate must have to be revised. Therefore, the policy makers need to revise the monetary policy and interest rate of the country for the betterment of market participants who use information of one market to improve the forecast of other market.

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