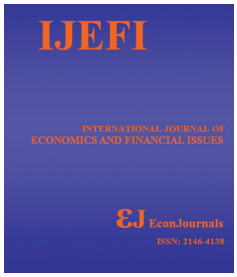

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Dynamic Relations between Stock Price and Exchange Rate: Evidence from South Asia

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ABSTRACT

Our study strives to explore the dynamic association between stock price and foreign exchange rate by taking daily data for a period of January 1, 2009 to June 30, 2015. We employ bivariate vector auto regression model as well as vector error correction model to discover the short run and long run relationship between these two financial variables. We fail to uncover any short run or long run association between these two financial variables for Bangladesh but identify a unilateral causal relationship running from stock price to exchange rate in Pakistan. Moreover, we find a long run negative relation that leads from exchange rate to stock price and a short run unidirectional causal linkage running from stock price to exchange rate in India. Granger causality test results confirmed these findings. The empirical findings of the study do not provide any precise evident in favor of portfolio hypothesis or goods market hypothesis but a mixed interaction of all theories.

Keywords: Dynamic Relations, Stock Price, Exchange Rate, Vector Error Correction Model
JEL Classifications: C32, E44, F31, G15

1. INTRODUCTION

Stock market is the barometer of measuring the economic health of any country. The economic environment is mirrored in the stock market movements. In this globalization era, it is very challenging as well as complex to explain the underlying reasons of the volatility of the stock market as it is influenced by both domestic and international financial and economic activities. Among various international events, international trade and flow of funds are the major cause of volatility in the economic sector, particularly in the stock market. Exchange rate plays dominating role in international trade and flow of funds. The importance of exchange rate has also increased largely in today's globalized world for transfer of capital among and between countries which has influenced on stock price as well.

Because of its sheer importance and role in prompting the advancement of economies, many academicians, economists, professionals, policymakers and researchers pay great attention in determining the association between stock price and exchanger rate. There are two main approaches that explain the relationship between these two variables namely; (i) flow-oriented model (also known as either goods market hypothesis or traditional approach) (ii) portfolio balance approach (also known as stock-oriented model). Flow oriented model suggested by Dornbusch and Fischer (1980) posits that change in the value of domestic currency will change the price of local products which will change the international competitiveness and current account balances and therefore effect on the profitability as well as outputs of the multinational companies and their stock prices. So this model concludes that causality runs from exchange rate to stock price but it should be mentioned here that the sign of this causal direction depends on whether the economy is an import or export dominated one. On the contrary, portfolio balance model (Branson, 1983; Frankel, 1983) proclaims that there is a negative correlation between exchange rate and stock price and stock price leads exchange rate. In this model, volatility in stock price causes variability in exchange rate that forces investors to adjust their portfolios. A boom capital market attracts foreign capital flow by encouraging foreign investors which boost demand for local currency. As a result, increase in stock price is associated to appreciation in foreign exchange rate. The opposite is also true for the bear capital market.

Given the importance and the role of stock market and foreign exchange market, the present study investigates the dynamic relations between stock price and exchange rate in three major South Asian economies (such as Bangladesh, India, and Pakistan) to uncover its dynamic characteristics by employing traditional vector auto regression (VAR) methodologies. Unveiling such dynamic properties of these two markets may provide potential implications for different stakeholders. In addition, such information about dynamic associations between these two markets can help in the understanding of their possible causal relations. Some of the fundamentals characteristics of these three economies are documented in Table 1. These three economies can be significantly distinguished from each other in terms of degree of openness, size of the economy, exchange rate regime, development and maturity of financial markets. The capital market of India and Pakistan is more developed than that of Bangladesh but regarding to the capital restrictions and control, Bangladesh is more favorable than that of India and Pakistan. All of these reasons encourage the authors to reexamine the dynamic relationship between stock price and exchange rate in three major South Asian economies.

Only a few literatures are available for the South Asian countries which report contradictory findings. The divergences of research findings motivate us to investigate the dynamic relationship between stock price and exchange rate in South Asian countries. However, this study can be distinguished from the existing literatures in following ways. First, this is the first study on South Asia after the global financial crisis. We use the most updated daily data covering from January 1, 2009 to June 30, 2015. Second, this paper simultaneously investigates short run and long run dynamic relations between stock price and exchange rate by employing VAR methodology. We pay great attention to choose lag order on which most of the prior researchers did not focus. Finally, we check the robustness of the findings of this study by employing different econometric tools including bivariate VAR, vector error correction model (VECM), Granger causality tests, variance decomposition analysis, and ımpulse response analysis.

The objective of this study is to explore the dynamic relationship between stock price and exchange rate in three major South Asian countries. Our empirical results reveal a negative long run relation that leads from exchange rate to stock price as well as a short run causal relation from stock price to exchange rate in India. Our study also finds a short run unidirectional relation running from exchange rate to stock price in Pakistan. But for Bangladesh, these two markets seem to be independent.

The reminder of the study is arranged as follows: A brief overview of the extant literatures is depicted in second section. The third section describes data and methodology employed in this study. Empirical results and analysis are presented in fourth section and the final section concludes the paper.

2. LITERATURE REVIEW

A plethora of studies has been conducted to examine the relationship between stock price and exchange rate in the context of developed and emerging markets in the globe at different time but there is no consensus and conclusive findings of the directions and their relationship. Several empirical findings of major studies reported in the following paragraphs.

Franck and Young (1972) is the pioneer of investigating the relationship between stock price and exchange rate who failed to detect any correlation between these two financial variables. By using monthly date Aggarwal (1981) found a positive correlation between the US stock price and exchange rate but Solnik (1987) reported a negative relationship for eight industrialized economies. Later Seonen and Aggarwal (1989) re-examined the relationship for the same eight industrial economies by employing the Solnik model and reported positive relations for three economies and negative for the rest of the five economies. By employing cointegaration and multivariate Granger causality to a number of Pacific Basin economies Phylaktis and Ravazzolo (2005) explored a positive linkage between foreign exchange market and stock market and noted that the US capital market acts as an important channel for integration. Diamandis and Drakos (2011) made similar analysis for four emerging Latin American economies and their results also support the findings of Phylaktis and Ravazzolo (2005).

The empirical findings of Ajayi et al. (1998) revealed that stock prices lead exchange rates in developed markets but no significant causal relationship in emerging economies. Nieh and Lee (2001) failed to find significant long-run causal relations but detected short-run (for a single day only) unidirectional relationship in G-7 countries (namely The US, The UK, Canada, Italy, France, Japan and Germany). In certain G-7 counties like German, the UK and Canada, exchange rates cause stock prices but the opposite is true for Japan and Italy. They also found that these two variables were independent in the US financial markets. Yang and Doong (2004) documented a significant relationship in G-7 economies and reported that stock market is more informative than that of foreign exchange market.

By using daily data of Singapore, Tokyo and Hong Kong Yu (1997) identified the feedback relationship in Tokyo's financial market and no significant relationship in Singapore market but a unidirectional causal relation running from stock prices to

Table 1: Size of economy, size of ınternational trade, exchange rate arrangement and capital control

Country	GDP[a,*]	Internationaltrade to GDP[b,*]	Exchange rate arrangement**	Capital control***
Bangladesh	$172.9 billion	0.4452	Stabilized arrangement	Moderate (gate)
India	$2048.5 billion	0.4871	Floating	Strong (wall)
Pakistan	$243.6 billion	0.3102	Other managed	Strong (wall)

[a]GDP is reported here for the year 2014. [b]International trade is measured by the ratio between the sum of import and export and GDP for the year 2014. *Data retrieved from the official website of World Bank. **International monetary fund, annual report on exchange arrangements and exchange restrictions (Washington, October 2014). ***Fernandez et al. (2015). Capital Control Measures: A New Dataset. IMF Working Paper, WP/15/80, Institute for Capacity Development. GDP: Gross domestic product

exchange rates in Hong Kong financial market. Moreover, their study revealed a consistent long run relationship in each of the three financial markets. Abdalla and Murinde (1997) found unidirectional Granger causality running from exchange rate to stock prices for Pakistan, India, and Korea and reverse causality for Philippines. Granger et al. (2000) detect unilateral causality running from exchange rate to stock price in South Korea, reverse causality for Philippines, Malaysia, Singapore, Hong Kong, Taiwan, and Thailand but no causal relationship in Indonesia and Japan. Among nine Asian economics (Japan, Taiwan, Singapore, Malaysia, Philippines, Indonesia, South Korea, Hong Kong and Thailand) Amare and Mohsin (2000) found long run relationship only in Singapore and Philippines markets. Dong et al. (2005) found no cointegrating relations in six emerging Asian countries however they identified feedback causality in Korea, Thailand, Malaysia and Indonesia.

Pan et al. (2007) disclosed a unidirectional causal relation from exchange rate to stock price in Japan, Malaysia, Hong Kong and Thailand but found a reverse relationship for Hong Kong, Singapore and Korea in pre-Asian Crisis. They detected a feedback relation for Hong Kong only. Besides, during the Asian crisis, they found unidirectional causal relations between exchange rate and stock prices for all the sample countries except Malaysia. By appling autoregressive distributional lag model Lin (2012) showed a stronger association during crisis period and causality of spillover running from stock price to exchange rate in the Asian emerging economies. The study also recommended that stimulating activities of government can prevent a currency crisis. Considering 10 Asian countries (of which three are developed and seven are developing) Kuo (2013) detected one long run cointegrating vectors for seven countries and two cointegrating relations for the rest. Moore and Wang (2014) examined the determinants of dynamic linkage in developed and emerging market and found a negative correlation between stock prices and exchange rate. Their empirical results explored that trade balance is the vital factor of dynamic associations in the emerging Asian markets on the other hand; interest rate differential is the contributory force for advanced economies.

Walid et al. (2011) employed Markov-Switching EGARCH approach to examine the dynamic linkage between changes in exchange rate and volatility of stock price for Malaysia, Hong Kong, Mexico and Singapore and stated that both stock market and foreign exchange markets are strongly regime dependent and react asymmetrically to the volatility. By employing MS-VAR model Chkili and Nguyen (2014) noted that stock market has more influence on foreign exchange market during both low volatility and high volatility period in BRICS countries.

Xinling and Peng (2011) documented a bidirectional but low asymmetric spillover effect between Chinese stock market and foreign exchange market. Chi et al. (2012) analyzed the volatility spillover effect through multi-resolution wavelet technique and found no coherence in different trading periods which indicate unidirectional short run volatility spillover from equity market to foreign exchange market. Inci and Lee (2014) found feedback relations in nine major sectors of eight economies. Mouna and Anis (2015) studied the sensitivity of stock return, exchange rate risk and interest rates in industrial and technological sectors in six different European countries, China and the US (a total of eight countries) and explored a significant effect among these variables particularly in industrial sector during the crisis period. Xiong and Han (2015) found bidirectional but asymmetric volatility price spillover effect from foreign exchange market to stock market for both continued RMB appreciation and constant RMB shock stages.

More recently Kollias et al. (2016) investigate the nexus between exchange rate and stock price in eight European economies (four countries with national currencies and four that adopted Euro) by using threshold cointegration methodology and gave evidence in favor of Portfolio Balance Model in financial crisis sub period. Their findings also detected feedback relationship for the UK and Norway. Islami and Welfen (2013) found both short run and long run relationship only in Poland but short run linkage in other three Eastern European economies namely Hungary, Czech Republic and Slovenia.

3. DATA AND METHODOLOGY

3.1. Data

Our study explore the dynamic relationship between exchange rate and stock price of three major South Asian countries[1] (namely Bangladesh, India, and Pakistan) by using daily data covering from January 1, 2009 to June 30, 2015. To examine the relationship, we use stock price indices of major stock exchanges and exchange rate between local currencies to US dollar (Major stock price indices and currencies of the sample countries are presented in Table 2). We use secondary data which were extracted from official websites of central bank and stock exchange of respective countries. To enhance data quality as well as to obtain a one-to-one correspondence of daily data, a number of data mining steps were employed such as excluding data of weekend and public holidays. Moreover, only those daily data (date) were considered which were common in both of the series. All the data series are transformed in natural logarithmic form to avoid the possible heteroscedasticity effect.

3.2. Methodology

3.2.1. Unit root test

Most of the economic and financial time series data are non-stationary at level (Nelson and Plosser, 1982; Hill et al., 2001). If both stock price and exchange rate series are non stationary then spurious (nonsense) regression result may yield which may cause an invalid inference (Granger and Newbold, 1974). We employ here two most popular and powerful unit root tests - Augmented dickey-Fuller (ADF) and Philips-Perron (PP) unit root test - to check the stationary of our data series. Unit root test can also detect the order of integration between the time series data. We denote I(d) for a series, if the series is integrated at "d" order, at that time the series should be made difference at "d" times to gain the stationary of the series. So a series must be difference once if

1 There are eight countries in South Asia among them four countries stock market and exchange rate data is available. But authors can access daily data in three countries only.

Table 2: Stock price ındices and currencies of sample countries

Country	Stock ındex	Currency
Bangladesh	DSE general index	Bangladeshi Taka
India	BSE-100 index	Indian Rupee
Pakistan	KSE all share ındex	Pakistani Rupee

DSE: Dhaka stock exchange

it is at I(1). We will use the akaika ınformation criteria (AIC) to select the optimal lag length.

3.2.2. Cointegration test

If we find the data series at I(d), we will employ Johansen and Juselius (1990) cointegration test to detect the long run association between these two financial variables (for detail, see for example, Johansen and Juselius, 1990). This test offers max-eigen value as well as trace value test statistic to identify the number of cointegrating vector(s).

3.2.3 Granger causality test

Granger causality test is useful to determine whether one variable is forecasted by another variable. It will also helpful to detect the direction of causality running from one variable to another. Application of Granger causality test depends on the results of stationary test and cointegration test of time series data. If there is no cointegrating relation between two variables; one can proceed to apply Granger causality test. Granger causality between stock price indices and exchange rates can be examined by following bivariate VAR models:

$$D(LNSPI)_t = \Pi_0 + \sum_{i=1}^{P} \vartheta_i D(LNSPI)_{t-i} + \sum_{j=1}^{p} \rho_j D(LNEXR)_{t-j} + \omega_{1t} \quad (1)$$

$$D(LNEXR)_t = \Gamma_0 + \sum_{i=1}^{q} \lambda_i D(LNSPI)_{t-i} + \sum_{j=1}^{q} \varsigma_j D(LNEXR)_{t-j} + \omega_{2t} \quad (2)$$

Where D represents the difference operator. LNSPI and LNEXR are the stock price index and exchange rate in logarithmic form respectively. Π_0 and Γ_0 are the constants, ϑ_i, ρ_j, λ_i and ς_j are the parameters. ω_{1t} and ω_{2t} are uncorrelated stationary disturbance term. The null hypothesis of Equation (1) is that exchange rate does not granger cause stock price if we can accept $\sum_{j=1}^{p} \rho_j = 0$. Similarly, stock price granger cause exchange rate (in Equation (2)) if all the coefficients of λ_i are jointly significantly different from zero (i.e., $\sum_{i=1}^{q} \lambda_i \neq 0$). A bidirectional relationship exist if both $\sum_{j=1}^{p} \rho_j \neq 0$ and $\sum_{i=1}^{q} \lambda_i \neq 0$. Exchange rate and stock price are said to be independent if both $\sum_{j=1}^{p} \rho_j = 0$ and $\sum_{i=1}^{q} \lambda_i = 0$.

3.2.4. VECM

If we find the stock price indices and exchange rate are cointegrated (i.e., integrated at I(d) order) then according to the "Granger representation theorem" we have to investigate the dynamic linkage between these two financial variables within the framework of error correction mechanism (ECM). Since ECM can secure both short-run dynamics and long run equilibrium relation between two cointegrated variables, we formulate the ECM as follows:

$$D(LNSPI)_t = \alpha_0 + \sum_{i=1}^{P1} \gamma_i D(LNSPI)_{t-i} + \sum_{j=1}^{p2} \psi_j D(LNEXR)_{t-j} + \omega_1 \tilde{e}_{t-1} + \epsilon_t \quad (3)$$

$$D(LNEXR)_t = \beta_0 + \sum_{i=1}^{P3} \Omega_i D(LNSPI)_{t-i} + \sum_{j=1}^{p4} \varphi_j D(LNEXR)_{t-j} + \omega_2 \tilde{e}_{t-1} + \epsilon_t \quad (4)$$

Where $\tilde{e}_{t-1}$ denotes the error correction term which indicates the speed of short run adjustment toward long-run equilibrium. ω_1 and ω_2 are the adjustment coefficient. γ_i, ψ_j, Ω_i, ϕ_j are the parameters to be estimated. Coefficient ψ_j and Ω_i secure the short-run dynamic relationship between the two financial variables. Change in exchange rate will lead stock market if we can identify at least one ψ_j is significantly different from zero. On the other hand, stock market will have a short run effect, if one or more of the coefficient Ω_i is nonzero and statistically significant. The presence of long-run relationship between exchange rate and stock price indices will be captured from finding one or both statistically significant speed of adjustment coefficients ω_1 and ω_2.

3.2.5. Variance decomposition and ımpulse response

Variance decomposition is an appropriate measure to deal with dynamic stochastic process under VAR environment. It provides the information about the random shocks (innovations) in the system. It decomposes the forecast error variance for each variable into parts to discover the effect of exogeneity of variables involved in the system over different time periods.

The error terms, ω_{1t} and ω_{2t} in Equation (1) and Equation (2) are known as innovation in the VAR terminology. The error terms in Equation (1) and (2) can be formulated in the following way:

$$V_t = \sum_{p=0}^{\infty} \pi_p \omega_{t-p} \quad (5)$$

Where V_t is the 2×1 column vector that hold in the variable LNSPI and LNEXR and ω_t is the 2X1 column vector that take the innovation of ω_{1t} and ω_{2t}. Equation (5) represents a linear combination of recent and past one step ahead innovations, ω_t. So we can rewrite the l step ahead innovations of V_t at time t−l+1 as follows:

$$\sum_{p=0}^{l-1} \pi_p \omega_{t-p}$$

Though forecast errors, ω_{1t} and ω_{2t} in Equation (1) and (2) are not serially correlated, they may be contemporaneously correlated between these two equations. We can restructure the Equation (5) in the following orthogonalization form to avoid the possible contemporaneous correlation between Equations (1) and (2):

$$V_t = \sum_{p=0}^{\infty} \pi_p Z u_{t-p} = \sum_{p=0}^{\infty} \beta_p u_{t-p}$$

Where $\beta p = \pi p\ Z$, Z is a lower triangular matrix. u_t is the orthogonalized forecast error term which is $\omega_t = Zu_t$. The i^{th} and j^{th} component of βp express the impulse response of the i-th variable to one standard deviation shock in the j-th variable in p periods.

4. EMPIRICAL RESULTS AND ANALYSIS

We apply the secondary data of three South Asian emerging economies for a time period of January 1, 2009 to June 30, 2015 to explore the dynamic relationship between stock price and foreign exchange rate. Some sophisticated and powerful econometrics techniques are employed to discover the relationships and their results and interpretations are reported in the following subsections.

4.1. The Results of Unit Root Test

To avoid the spurious correlation which may result ambiguous inference of the time series data we test the stationary property of each series of the variables by implementing the unit root test. We employed ADF test and PP test with an intercept only and an intercept and trend at log level as well as log first difference to check the stationary of the stock price indices and exchange rates series. For ADF test, 24 lags were selected by using the formula $L_{max} = 12 * \sqrt[4]{T/100}$ (where L_{max} is the maximum lag length and T is total number of observations) to minimize AIC. For PP test statistics, bandwidths were selected by taking Newey-West automatic recommendation following Bartlett Kernel. The results of the unit root test are reported in Table 3. The results accept the null hypothesis of having a unit root at log level in two variables for all three countries but it rejects the same at log first difference which clearly evident that the two financial variables become stationary at log first difference. Thus the variables are integrated at order one, I(1).

4.2. The Results of Cointegration Test

After establishment the order of integaration of each of the series, next step is to check the long run relationship by employing Cointegration test. Johansen and Juselius (1990) test of cointegration is employed as it is more sophisticated and powerful approach to determine the long run relationship. Since the result of Johansen and Juselius approach is based on the selected lag length of VAR model, the optimal lag order has to be chosen by appropriate information criterion. We put emphasis on the AIC for determining the optimal lag length as it capture the minimum

Table 3: Results of unit root test

Country	Variable	Intercept			Intercept and trend		
		t value	P value	lag	t value	P value	Lag
ADF test							
Bangladesh	$LnSPI_{BD}$	−2.064940	0.2592	4	−1.930928	0.6377	4
	$LnEXR_{BD}$	−1.397747	0.5848	18	−1.215030	0.9063	18
	D ($LnSPI_{BD}$)	−24.66716*	0.0000	3	−24.69996*	0.0000	3
	D ($LnEXR_{BD}$)	−6.27747*	0.0000	17	−6.32835*	0.0000	17
India	$LnSPI_{IN}$	−2.014455	0.2807	2	−2.408492	0.3749	2
	$LnEXR_{IN}$	−0.522589	0.8843	18	−2.558118	0.2999	18
	D ($LnSPI_{IN}$)	−27.78255*	0.0000	1	−27.78789*	0.0000	1
	D ($LnEXR_{IN}$)	−8.735193*	0.0000	17	−29.71535*	0.0000	1
Pakistan	$LnSPI_{PK}$	−0.689826	0.8473	3	−2.329805	0.4169	3
	$LnEXR_{PK}$	−1.155309	0.6955	9	−1.729570	0.7378	9
	D ($LnSPI_{PK}$)	−27.74784*	0.0000	2	−27.73994*	0.0000	2
	D ($LnEXR_{PK}$)	−11.14173*	0.0000	8	−11.15704*	0.0000	8
Country	**Variable**	**Intercept**			**Intercept and trend**		
		t value	**P value**	**Band width**	**t value**	**P value**	**Bandwidth**
PP test							
Bangladesh	$LnSPI_{BD}$	−2.244924	0.1906	20	−2.142454	0.5210	21
	$LnEXR_{BD}$	−1.265894	0.6473	25	0.786066	0.9645	25
	D ($LnSPI_{BD}$)	−65.83539*	0.0001	17	−66.21137*	0.0001	18
	D ($LnEXR_{BD}$)	−29.11046*	0.0000	21	−29.10546*	0.0000	21
India	$LnSPI_{IN}$	−2.183230	0.2127	3	−2.545977	0.3057	4
	$LnEXR_{IN}$	−0.412458	0.9047	11	−2.383920	0.3878	11
	D ($LnSPI_{IN}$)	−36.50273*	0.0000	1	−36.50404*	0.0000	0
	D ($LnEXR_{IN}$)	−39.61998*	0.0000	11	−39.62429*	0.0000	11
Pakistan	$LnSPI_{PK}$	−0.853945	0.8028	14	−2.922139	0.1556	3
	$LnEXR_{PK}$	−1.261190	0.6495	16	−1.535106	0.8173	16
	D ($LnSPI_{PK}$)	−61.42087*	0.0001	7	−61.40649*	0.0000	7
	D ($LnEXR_{PK}$)	−34.95084*	0.0000	14	−34.94106*	0.0000	14

Ln represents the natural log of the variable. D represents the first difference. SPI and EXR represent the stock price indices and exchange rates respectively. The suitable lag length (for ADF test statistics) was determined by using AIC with maximum lags of 24. For PP test statistics, bandwidths were selected by taking Newey-West automatic recommendation following Bartlett Kernel. *Indicates that test value(s) is significant at 1% level. ADF: Augmented dickey-fuller, PP: Phillips-Perron

Table 4: VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1947.302	NA	0.000275	−2.523089	−2.516162	−2.520512
1	11514.26	11096.69	1.13e-09	−14.52641	−14.90562	−14.91867
2	11830.62	630.6751	7.53e-10	−15.33155	−15.29691	−15.31866
3	11953.53	244.6907	6.54e-10	−15.48577	−15.43728*	−15.46773
4	11967.10	26.98581	6.37e-10	−15.49818	−15.43584	−15.47499
5	11975.36	16.40047	6.34e-10	−15.50371	−15.42751	−15.47536
6	11985.09	19.29595*	6.29e-10*	−15.51114*	−15.42108	−15.47764*
7	11988.80	7.356447	6.29e-10	−15.51077	−15.40686	−15.47211
8	11990.58	3.527734	6.31e-10	−15.50789	−15.39013	−15.46408

*Indicates lag order selected by the criterion. LR: Sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion, VAR: Vector auto regression

Table 5: Results of cointegration test

Country	H_0	H_A	Trace statistics	C.V. at 5%	Prob*
Trace test					
Bangladesh	r=0	r≥1	14.75547	15.49471	0.0644
	r≤1	r≥2	6.097659	3.841466	0.0135
India	r=0	r≥1	16.18062**	15.49471	0.0394
	r≤1	r≥2	0.003757	3.841466	0.9499
Pakistan	r=0	r≥1	12.00434	15.49471	0.1567
	r≤1	r≥2	1.407257	33.841466	0.2355
Country	**H_0**	**H_A**	**Max-eigen statistics**	**C.V. at 5%**	**Prob***
Max-eigen value test					
Bangladesh	r=0	r≥1	8.657808	14.26460	0.3157
	r≤1	r≥2	6.097659	3.841466	0.0135
India	r=0	r≥1	16.17687**	14.26460	0.0246
	r≤1	r≥2	0.003757	3.841466	0.9499
Pakistan	r=0	r≥1	10.59709	14.26460	0.1756
	r≤1	r≥2	1.407257	33.841466	0.2355

**Designates rejection of null hypothesis at 0.05 level of significance. *Represents P values are placed-in from Mackinnon-Haug-Michelis (1999) table. r is the number of cointegrating vector(s). Both trace and max-eigen value indicate one cointegrating vector for India but no cointegrating vector for Bangladesh and Pakistan

sum of residual. The optimal lag order selected for Bangladesh under VAR model is reported in Table 4 (the lag length for India and Pakistan is determined in the same way. They are not reported here to save the space but available upon request).

The lag order selection indicates 6 lags for Bangladesh, 4 lags for India and 7 lags for Pakistan. The result of Johansen and Juselius cointegration test are presented in Table 5. Table 5 shows no evidence of cointegration except for India from trace statistics and maximum eigen-value statistics as the test statistic values are less than those of the critical values. So there is no long run relationship between stock price indices and exchange rate in Bangladesh and Pakistan (similar findings also reported by Ratner, 1993 for the USA; Dong et al., 2005 for six emerging Asian economies; Nieh and Lee, 2001 for G-7 countries among others) but a long run relationship exists in India (a few studies such as Amare and Mohsin, 2000 for Singapore and Philippines markets; Kuo, 2013 for ten Asian countries reported identical findings).

4.3. The Results of Bivariate VAR and Granger causality Test

Since the financial variables of Bangladesh and Pakistan are not cointegrated, we use bivariate VAR model for these two countries to discover the possible short-run linkage between them. Table 6 shows that none of the coefficients of $D(LNSPI_{BD})$ and $D(LNEXR_{BD})$ is statistically significant. So these two financial variables are independent for the case of Bangladesh and we can conclude that there is no short run relation between stock price and Exchange rate. This finding is also confirmed by Granger causality test results exhibited in Table 7. Existing studies such as Yu (1997) for Singapore; Granger et al. (2000) for Indonesia and Japan; Ajayi et al. (1998) for the emerging economies also failed to find significant causal relationship between these two variables. For Pakistan, the coefficient of $D(LNSPI_{PK})$ lag 3, lag 4 and lag 6 are statistically significant at 10%, 5%, and 1% level respectively (Table 8). This result implies that there is a short run causal relation running from stock market to foreign exchange market in Pakistan. Table 7 of Granger causality test results supports this finding. Therefore, we can conclude that there is a short run unidirectional Granger causality running from stock market to foreign exchange market in Pakistan. Consistent with previous empirical studies including Abdalla and Murinde, 1997 for Philippines; Granger et al., 2000 for Philippines, Malaysia, Singapore, Hong Kong, Taiwan and Thailand; Murinde and Poshakwale, 2004 for Hungary (before inception of Euro); Pan et al., 2007 for Hong Kong, Singapore and Korea (pre-Asian crisis of 1997); Kollias et al., 2016 for eight European economies (in financial crisis sub period) among others documented similar findings.

4.4. The Results of VECM

Since ECM serves as a suitable framework for capturing both long-run and short-run interaction between variables, we use Equations (3) and (4) to estimate the relationship between $LNSPI_{IN}$ and $LNEXR_{IN}$.

Table 9 describes the result of VECM for both stock price indices and exchange rates of India. It is mentioned earlier that parameters ω_1 and ω_2 secure the long-run adjustment. The result shows ω_1 has a negative sign and statistically significant while ω_2 is positive and insignificant. This empirical result implies that there is a long run association between the stock market and foreign exchange market where as the stock market adjusts to innovations in the foreign exchange market.

The negative ω_1 means that an increase (decrease) in the exchange rates (i.e., a depreciating [appreciating] the local currency) has a negative (positive) effect on the local stock market in the long run. This means that there is a long run association between

Table 6: Results of VAR estimation for Bangladesh

Dependent variable	D ($LNSPI_{BD}$)		D ($LNEXR_{BD}$)	
Independent variable	Coefficient	t-test (P value)	Coefficient	t-test (P value)
D ($LNSPI_{BD}$(−1))	−0.458454	−17.93566	−0.000241	−0.457833
		(0.0000)		(0.6471)
D ($LNSPI_{BD}$(−2))	−0.209493	−7.451544	−0.000304	−0.525243
		(0.0000)		(0.5995)
D ($LNSPI_{BD}$(−3))	−0.094040	−3.290909	−0.000537	−0.911498
		(0.0010)		(0.3622)
D ($LNSPI_{BD}$(−4))	−0.048971	−1.713945	−0.000825	−1.400119
		(0.0867)		(0.1617)
D ($LNSPI_{BD}$(−5))	−0.011712	−0.416561	−8.28E−05	−0.142774
		(0.6771)		(0.8865)
D ($LNSPI_{BD}$(−6))	−0.002410	−0.094284	0.000149	0.282414
		(0.9249)		(0.7777)
D ($LNEXR_{BD}$(−1))	−1.237107	−1.000595	0.358211	14.05073
		(0.3172)		(0.0000)
D ($LNEXR_{BD}$(−2))	0.943963	0.724504	0.373522	13.90327
		(0.4689)		(0.0000)
D ($LNEXR_{BD}$(−3))	0.705709	0.511420	−0.187949	−6.606342
		(0.6091)		(0.0000)
D ($LNEXR_{BD}$(−4))	−1.061066	−0.768931	0.065750	2.310754
		(0.4421)		(0.0210)
D ($LNEXR_{BD}$(−5))	−0.856004	−0.656835	0.135537	5.048771
		(0.5114)		(0.0000)
D ($LNEXR_{BD}$(−6))	−0.185519	−0.149943	−0.066221	−2.598344
		(0.8808)		(0.0095)
C	0.000715	0.801138	2.59E-05	1.409881
		(0.4232)		(0.1588)
R^2	0.174824		0.355856	
Adjusted R^2	0.168356		0.350811	

*, ** and *** represent the significance of t-statistic at 0.01, 0.05 and 0.10 level respectively and t-statistic is taken from Student's (1908) t-table. VAR: Vector auto regression

Table 7: Results of Granger causality test for Bangladesh, Pakistan and India

Country	Null hypothesis (H_0)	F statistic	Probability	Decision
Bangladesh	D ($LNEXR_{BD}$) does not Granger cause D ($LNSPI_{BD}$)	0.52809	0.7873	Accept H_0
Lag 6				
	D ($LNSPI_{BD}$) does not Granger cause D ($LNEXR_{BD}$)	0.43025	0.8591	Accept H_0
Pakistan	D ($LNEXR_{PK}$) does not Granger cause D ($LNSPI_{PK}$)	0.61241	0.7461	Accept H_0
Lag 7				
	D ($LNSPI_{PK}$) does not Granger cause D ($LNEXR_{PK}$)	3.73793	0.0005	Reject H_0
India	D ($LNEXR_{IN}$) does not Granger cause D ($LNSPI_{IN}$)	0.66987	0.6129	Accept H_0
Lag 4				
	D ($LNSPI_{IN}$) does not Granger cause D ($LNEXR_{IN}$)	26.2172	5.E-21	Reject H_0

these two markets and stock market adjust to innovations in the foreign exchange market. The negative ω_1 implies that an increase (decrease) in exchange rates (i.e., a depreciating [appreciating] the local currency) has a negative (positive) effect on the local stock market in the long run.

We also detect statistically significant short run relationship between the stock market and foreign exchange market in India. When $LNSPI_{IN}$ is a dependent variable, we found all the coefficients of ψ_i are negative and only coefficient ψ_3 is significant at 10% level meaning that if exchange rate in India increases (depreciates) 3 days before has a negative effect on today's stock market. This implies that (though this is a weak evidence) stock market takes 3 days to adjust the disequilibrium of foreign exchange market. In the exchange rate equation, all the coefficients of Ω_i are negative except the coefficient Ω_3. The coefficient Ω_1 is negative and statistically significant at 1% level which implies that immediate increase in the stock market has a negative short run effect (appreciate the local currency) on foreign exchange market. This is also true for the coefficient Ω_3 which is negative and significant at 5% level. So from the results, it is evident that there is a short run unidirectional causal relationship from stock price to exchange rate in India. Granger causality result documented in Table 7 is also analogous and strongly agreed with this finding. This finding is consistent with the Portfolio balance model recommended by Branson, 1983; Frankel, 1983.

4.5. The Results of Variance Decomposition

The results of variance decomposition are documented in Table 10 from day 1 to day 10 ahead. The results exhibit that; variability in

Table 8: Results of VAR estimation for Pakistan

Dependent variable	D ($LNSPI_{PK}$)		D ($LNEXR_{PK}$)	
Independent variable	Coefficient	t test (P value)	Coefficient	t test (P value)
D ($LNSPI_{PK}$(−1))	−0.423212	−16.64066 (0.0000)	−0.003049	−1.199123 (0.2307)
D ($LNSPI_{PK}$(−2))	−0.144137	−5.219725 (0.0000)	−0.003333	−1.207124 (0.2276)
D ($LNSPI_{PK}$(−3))	−0.014466	−0.519328 (0.6036)	−0.004650	−1.669937*** (0.0951)
D ($LNSPI_{PK}$(−4))	0.013005	0.466727 (0.6408)	−0.005761	−2.067681** (0.0388)
D ($LNSPI_{PK}$(−5))	−0.021999	−0.788945 (0.4303)	−0.003406	−1.221565 (0.2221)
D ($LNSPI_{PK}$(−6))	−0.034816	−1.259403 (0.2081)	0.009699	3.509449* (0.0005)
D ($LNSPI_{PK}$(−7))	0.005878	0.229856 (0.8182)	0.002560	1.001295 (0.3168)
D ($LNEXR_{PK}$(−1))	−0.102799	−0.401868 (0.6878)	0.159497	6.235900 (0.0000)
D ($LNEXR_{PK}$(−2))	−0.257218	−0.997775 (0.3185)	0.018454	0.716046 (0.4741)
D ($LNEXR_{PK}$(−3))	−0.268697	−1.052640 (0.2927)	0.013809	0.541284 (0.5884)
D ($LNEXR_{PK}$(−4))	−0.048828	−0.190994 (0.8486)	−0.018058	−0.707564 (0.4793)
D ($LNEXR_{PK}$(−5))	−0.145180	−0.567890 (0.5702)	0.119328	4.668670 (0.0000)
D ($LNEXR_{PK}$(−6))	0.268227	1.041709 (0.2977)	−0.055767	−2.166080 (0.0305)
D ($LNEXR_{PK}$(−7))	−0.034524	−0.135791 (0.8920)	0.046777	1.840697 (0.0659)
C	0.001800	3.497070 (0.0005)	0.000122	2.378722 (0.0175)
R^2	0.157062		0.057849	
Adjusted R^2	0.149409		0.049312	

*.**.***Represents significant at 0.01, 0.05 and 0.10 level respectively. VAR: Vector auto regression

Table 9: Results of the VECM for Indian stock price and exchange rates

Dependent variable	D ($LNSPI_{IN}$)		D ($LNEXR_{IN}$)	
Independent variable	Coefficient	t test (P value)	Coefficient	t test (P value)
CointEq	−0.005849	−3.755479* (0.0002)	1.76E-05	0.017696 (.9859)
D ($LNSPI_{IN}$(−1))	0.070035	2.624518* (0.0088)	−0.116185	−10.03689* (0.0000)
D ($LNSPI_{IN}$(−2))	−0.037209	−1.351793 (0.1766)	0.002881	0.241309 (0.8093)
D ($LNSPI_{IN}$(−3))	−0.007134	−0.259546 (0.7952)	−0.026390	−2.213450** (0.0270)
D ($LNSPI_{IN}$(−4))	−0.016067	−0.584790 (0.5588)	−0.009934	−0.833512 (0.4047)
D ($LNEXR_{IN}$(−1))	−0.071718	−1.147198 (0.2515)	−0.091084	−3.358653* (0.0008)
D ($LNEXR_{IN}$(−2))	−0.022616	−0.360692 (0.7184)	0.081827	−3.008395* (0.0027)
D ($LNEXR_{IN}$(−3))	−0.104266	−1.662586*** (0.0966)	−0.009309	−0.342174 (0.7323)
D ($LNEXR_{IN}$(−4))	−0.046657	−0.765799 (0.4493)	0.029966	1.133811 (0.2570)
C	0.000739	2.259158** (0.0246)	0.000298	2.113382**(0.0347)
F statistic	3.132411*		12.84709*	
P value (F statistic)	0.000953		0.000000	

*.**.***Represents significant at 0.01, 0.05 and 0.10 level respectively. VECM: Vector error correction model

the stock price and exchange rate of Bangladesh is explained by their own shocks. For Pakistan, most of the stock price changes are explained by their own shocks; and about 1.76% variation in the exchange rate can be explained by the stock price. We identify comparatively a stronger relationship between the stock price and exchange rate for the case of India. At day 1, around 12.42% variation in the exchange rate is due to the variation in stock price and over the period of time this shocks increase gradually and reach to 32.49% at day 10.

4.6. The Results of Impulse Response Analysis

We also plot impulse responses to depict the dynamic interaction between the stock price and exchange rate. The results illustrating impulse responses of stock price for one standard deviation shock

Table 10: Results of variance decomposition

Country	Day	D (LNSPI) shock explained by		D (LNEXR) shock explained by	
		D (LNSPI)	D (LNEXR)	D (LNEXR)	D (LNSPI)
Bangladesh	1	100.00	0.00	99.98	0.02
	2	99.95	0.05	99.96	0.04
	3	99.91	0.09	99.94	0.06
	4	99.90	0.10	99.88	0.12
	5	99.89	0.11	99.75	0.25
	6	99.87	0.13	99.74	0.26
	7	99.86	0.14	99.74	0.26
	8	99.86	0.14	99.74	0.26
	9	99.86	0.14	99.74	0.26
	10	99.86	0.14	99.73	0.27
Pakistan	1	100.00	0.00	99.87	0.13
	2	99.99	0.01	99.73	0.27
	3	99.95	0.05	99.65	0.35
	4	99.91	0.09	99.48	0.52
	5	99.91	0.09	99.25	0.75
	6	99.89	0.11	99.21	0.79
	7	99.83	0.17	98.25	1.75
	8	99.81	0.19	98.25	1.75
	9	99.81	0.19	98.24	1.76
	10	99.81	0.19	98.24	1.76
India	1	100.00	0.00	87.58	12.42
	2	99.97	0.03	77.29	22.71
	3	99.95	0.05	74.17	24.83
	4	99.86	0.14	71.89	28.11
	5	99.77	0.23	70.34	29.66
	6	99.73	0.27	69.32	30.68
	7	99.71	0.29	68.65	31.35
	8	99.69	0.31	68.16	31.84
	9	99.69	0.31	67.79	32.21
	10	99.68	0.32	67.51	32.49

Figure is in percentage

to exchange rate and vice versa is demonstrated in Figures 1-3. If we give one S.D. innovation in Bangladesh stock price (Figure 1) a negative response is detected on Bangladesh exchange rate. Their impacts are reduced overtime and finally die out at day 7. A shock of exchange rate to the stock price in Bangladesh is also found negative and its impact is lost after 6th day. For Pakistan (Figure 2), the impacts of stock price shock on the exchange rate is clearly negative for the first 4 day and then fluctuate between day 5 to day 8 but lost its effect after day 9. On the other hand, the response of exchange rate to stock price remains negative until day 6 and becomes positive between day 7 and day 8 after then its impact is die out. In India (Figure 3), a small negative shock of stock price to exchange rate is found for the first 6 days; but its impact is lost after 7th day. On the other hand, a comparatively large negative impact of exchange rate to stock price is found for the first 3 days; then it becomes positive for a few hours, again turns into negative up to day 6. Finally, its impact is lost after 7th day.

Figure 1: Impulse response analysis of Bangladesh

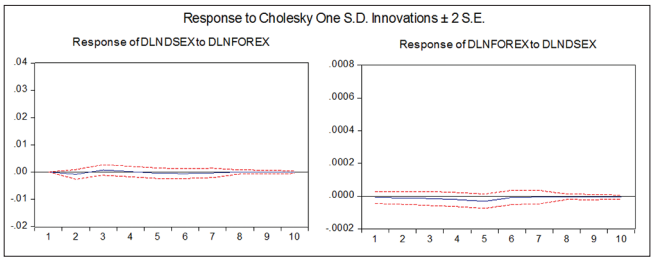
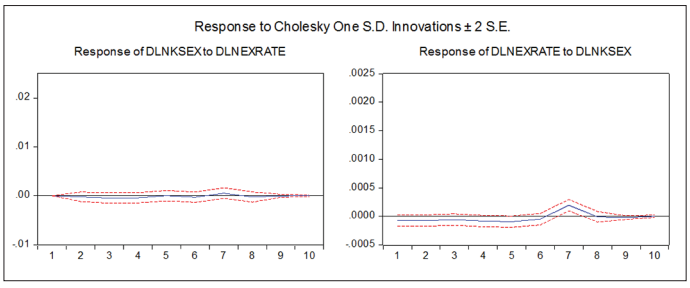


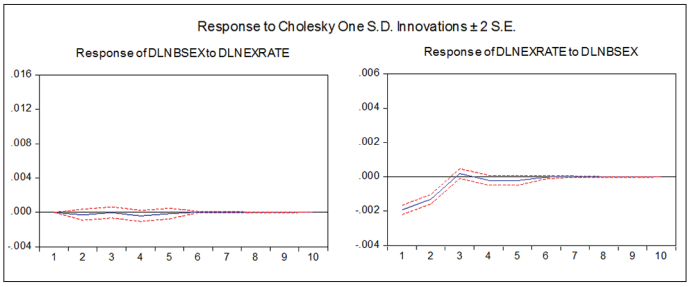
Figure 2: Impulse response analysis of Pakistan



5. SUMMARY AND CONCLUDİNG REMARKS

Increased reform in global financial system, relaxation of government restriction on foreign capital, adoption of more flexible exchange rate system and increased international economic integration have opened the possibility of international investment and portfolio diversification which have also led to the interdependency of the international financial markets particularly foreign exchange markets and stock markets. Therefore, exploring the dynamic relationship between the stock price and exchange rate has gained more attention among the researchers, academicians, professional and policy makers. Although some significant statistical relations between these two financial variables may exhibit by applying VAR methodology, it is often difficult to

Figure 3: Impulse response analysis of India



explain those economic interactions because of the possibility of generating those relations from monetary and fiscal related policies (IS-LM related policies) or uncovered interest rate parity.

This study focuses on the dynamic relationship between stock price index and exchange rate for three South Asian emerging economies by using the daily data covering from January 1, 2009 to June 30, 2015. This paper uses some econometric tools to investigate the short-run and long-run relationship as well as the causality between these two financial variables. ADF and PP unit root test clearly suggest that both the series are non stationary at log level but it becomes stationary at log first difference. Thus these two series are integrated at order one. After confirmation of the order of cointegration; we proceed to conduct cointegration test by employing Johansen and Juselius cointegration procedure. We find no evidence of cointegration for Bangladesh and Pakistan but the existence of cointegration for the case of India. These findings recommend us to use bivariate VAR model for Bangladesh and Pakistan and VECM for India.

The bivariate VAR model suggests that there is no short run relation between stock price indices and exchange rate in Bangladesh but a unidirectional causal relation running from stock market to foreign exchange market in Pakistan. These findings are also supported by Granger causality test results. The results of VECM evident that there is a long-run association between the stock market and foreign exchange market in India and stock market adjust to innovation in the foreign exchange market. This paper also finds a short run unidirectional relation from stock price to exchange rate in India. We check the robustness of our findings by employing different econometrics techniques including bivariate VAR, VECM, Granger causality test, variance decomposition analysis, and impulse response analysis. All of the econometric methods provided the consistent results.

It is mention here that we fail to find any precise evidence in favor of portfolio hypothesis or goods market hypothesis but a mixed interaction of all theories. This study assumes that difference in findings among these three emerging economies in the South Asia is due to differences in institutional set up, size of the economy, exchange rate arrangement and accessibility of foreign capital. Investors should understand the interaction of these two financial markets and take necessary precautionary measure in international portfolio diversification. Finally, empirical results of this study will offer valuable insights to different economic agents including investors, professionals, regulators and policymakers.

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