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Testing Semi-Strong Form Efficiency of Dhaka Stock Exchange

Md Abu Hasan[*]
Md. Abdul Wadud [**]

Abstract

This study investigates semi-strong form of the Efficient Market Hypothesis (EMH) based on macroeconomic variable version of the Arbitrage Pricing Theory (APT) using monthly data of All Share Price Index (DSI) of Dhaka Stock Exchange (DSE) and five macroeconomic variables namely, Industrial Production Index (IPI), Broad Money Supply (M2), Crude Oil Price (OP), Exchange Rate (ER) and Index of Bombay Stock Exchange (SENSEX) from January 2001 to December 2012. The Johansen and Juselius multivariate cointegration tests reveal that IPI and OP have significant negative long run relationship with DSI, while M2, ER and SENSEX have significant positive long run relationship with DSI. The results of VECM indicate that there is long run causality running from the explanatory variables to DSI. The study also reveals that individually IPI and SENSEX are the leading indicators with respect to stock prices in Bangladesh in the short run. Moreover, stock price index of DSE is a leading indicator with respect to IPI and ER in the short run. Therefore, Bangladeshi stock market is motivated by macroeconomic factors, while global stock markets have some influence on it. Hence, it may be concluded that DSE is not efficient in the semi-strong form of EMH.

Keywords: Arbitrage Pricing Theory, Cointegration, Efficient Market Hypothesis, Macroeconomic Variables, Unit Root Tests, Vector Error Correction Model.

[*]Md. Abu Hasan, Lecturer, Department of Economics, Rani Bhawani Govt. Women's College, Natore, Bangladesh. Corresponding author e-mail: hhafij@yahoo.com
[**]Md. Abdul Wadud, Professor, Department of Economics, Rajshahi Unversity, Bangladesh.

1. Introduction

The stock market acts as a bridge between savers and investors in the course of savings mobilization and investment fund allocation. Hossain and Kamal (2010) reveal that the stock market development strongly influences the economic growth in Bangladesh economy. Therefore, the stock market has a crucial role to play to make a strong industrial base of emerging markets like Bangladesh whose economy is progressing rapidly since the last two and half decades. Dhaka Stock Exchange (DSE) is the oldest and largest stock exchange in Bangladesh. Though DSE was established on 28 April, 1954 but its commercial operation started in 1956. DSE has become one of the leading emerging markets in South Asian region owing to the free market policy adopted on or after 1990s. DSE of Bangladesh has grown dramatically and gained second place in South Asia as the growth of the ratio of market capitalization to GNI was 925 percent between 2000 and 2011 (Khan, 2013). As on December, 2014, there are 546 securities listed in DSE with a market capitalization of $41,664 million (DSE, 2015).

Theoretically, the stock market should be closely related to real economic variables of the country. Based on a simple discount model, the fundamental value of a corporate stock is equal to the present value of expected future dividends, thus the future dividends must eventually reflect the real economic activity. So, information on the connection between economic variables and stock prices is decisive to the investors in the equity market as well as to the policy makers. If the connection between stock prices and economic variables exist, the stock market of Bangladesh will lose its informational efficiency and will become more volatile. The role of economic factors and past stock price patterns on the stock prices has been subjected to economic research all over the world. Although, studies like testing semi-strong form efficiency of the stock market in the context of Bangladesh has basically been ignored. Thus, the specific objectives of this study are as follows:

i. To examine the short run dynamics and long run equilibrium links between macroeconomic variables and stock prices

ii. To explore the causal relationships and direction of causality between stock index and macroeconomic variables;

iii. To investigate the semi-strong form efficiency of the stock market in Bangladesh.

This paper should contribute to the literature because a special set of macroeconomic variables is preferred based on reasons rather than randomly selected variables and the way that the variables affect stock market prices has been identified. Moreover, this study would widen the existing literature as local and global macroeconomic variables are used to predict whether the Bangladeshi stock market is motivated mainly by domestic macroeconomic factors, or global stock markets have some influence on it. The study is organized in five sections as follows: section 2 presents the theoretical framework and literature review; and section 3 reports data and methodology; and section 4 reports the empirical findings; section 5 concludes the study.

2. Theoretical Framework & Literature Review

The Efficient Market Hypothesis (EMH) has slowly evaluated from the independent research of several economists, and these contributions succeeded by Fama's (1965) definition of Efficient Market Hypothesis. The EMH states that stock market prices already incorporate and reflect all available information such that none can beat the market by making abnormal profits (Fama, 1965). Fama (1970) mentions that EMH exists in various degrees: weak, semi-strong, strong and successively he accomplishes an important contribution in making the efficient market hypothesis testable. Weak form of EMH assumes that past stock prices are not significant to make an abnormal return. Semi-strong form of EMH presumes that no investor can earn abnormal returns using publicly available information. Finally strong form of EMH assumes that all public and private information are reflected by present stock prices. Fundamental analysis and macroeconomic analysis are employed to test the semi-strong form efficiency of the EMH. Fundamental analysis uses all publicly available firm specific information such as price-earning ratio, share split, and dividend declaration. On the other hand, macroeconomic analysis uses all publicly available global and domestic macroeconomic information such as GDP, interest rate, exchange rate, money supply and foreign stock markets index. Leigh (1997) examines the three forms of EMH in the stock market of Singapore using quarterly data from 1975 Q1 to 1991 Q2. Employing unit root tests, he shows that the stock returns of Singapore stock market follow a random walk model; therefore the market is efficient in weak form. Based on Johansen-Juselius Cointegration model, the study finds that there is no cointegration between stock prices and macroeconomic variables. Thus, he comments that the stock market follows semi strong form of EMH. Moreover, the study operates ECM and finds that stock market of Singapore does not follow the strong form of EMH. The Arbitrage Pricing Theory (APT) is developed by Stephen Ross (1976). APT states that a number of systematic risk factors that are generated by the variations of macroeconomic and financial variables determine the market return. Two versions are used to test and implement APT. Factor loading version uses artificial variables related statistical (i.e., principal component analysis, factor analysis) techniques, while macroeconomic variable version uses economic factors. Chen, Roll and Ross (1986) have tested seven macroeconomic variables, namely, term structure, industrial production, risk premium, inflation, market return, consumption and oil prices in the period of January 1953 to November 1984 to explain the U.S stock return. They reveal that several of these economic variables are significant in explaining expected stock return. Isenmila and Erah (2012) examine the appropriateness of the APT to give reasons for stock returns in Nigeria for the period 2000 Q1-2010 Q4. The study examines the implication of oil prices (OP), money supply (M2), Gross Domestic Product, Exchange rate (ER), inflation and interest rate (IR) in explaining stock returns (All share index) of the Nigerian stock market. The co-integration and error correction methodology reveal that M2 and OP emerge to be negative significant determinants, while ER and IR are observed to be negative insignificant determinants of stock returns both in the long run and the short run. They conclude that the APT macroeconomic variables can explain stock returns in Nigeria.

Ahmed and Imam (2007) explore long-term equilibrium relationships as well as short-run dynamic adjustment between a group of macroeconomic variables and the stock price index of Bangladesh employing cointegration test, vector error correction model and Granger causality test for monthly data of July 1997 to June 2005. Considering industrial production index, money supply and GDP growth in the first model, they find no cointegration among them. When interest rate is added to the previous model, the existence of significant long run relationship is observed with money supply, GDP growth and interest rate change. They comment that changes of interest rate Granger causes stock market returns unidirectionally which implies that the stock market of Bangladesh is informationally inefficient. Afzal and Hossain (2011) examine the relationship between stock prices and four macroeconomic variables from July 2003 to October 2011 using cointegration and Granger causality test. The study recommends that the DSE is not informationally efficient with respect to M1, M2 and inflation rate as the long-run equilibrium relation exists between these variables and stock prices. Moreover, they find a dynamic causal link from the stock price to exchange rate changes. Masuduzzaman (2012) investigates the long-run relationship and the short-run dynamics among macroeconomic variables and the stock returns of Germany and the United Kingdom using consumer price index, interest rates, exchange rates, money supply and industrial productions for the period from February 1999 to January 2011. He applies Johansen co-integration, error correction model, variance decomposition, impulse response functions and finds that all the variables are cointegrated with stock prices in both markets. The study indicates that short and long run causal relationships exist between stock prices and macroeconomic variables for both the UK and the German stock market returns. Hsing (2013) examines the impact of selected macroeconomic variables (industrial production as a proxy of real output, government deficit, domestic real interest rate, money supply, exchange rate, expected inflation rate and US S&P 500 index) on the

Japanese stock market index based on a sample during 1975-2009. The paper finds that the Japanese stock market index is positively influenced by industrial production, is negatively related to the government deficit, domestic real interest rate and expected inflation rate, and displays a nonlinear relationship with the money supply and nominal effective exchange rate. Nisha (2015) investigates the impact of macroeconomic variables on the stock returns of Bombay Stock Exchange (BSE) using monthly data series covering a period of 15 years from January 2000 till December 2015. Employing Vector Autoregression (VAR) model, she finds a significant impact of interest rate, gold price, exchange rate and money supply on the stock returns of BSE. A strong impact of the global macroeconomic factor of the world price index is also detected in this study. Chittedi (2015) explores the nature of the causal relationships between stock prices and the macroeconomic variables in BRIC countries. Applying Autoregressive distributed lag (ARDL) approach and Toda and Yamamoto Granger causality, the study reveals that long-run and short-run relationship exist between macroeconomic variables and stock prices, but this relationship is not consistent for all of the BRIC countries.

Thus, the existing theories and empirical studies do not specify the number of variables that should be included in the multivaraite efficiency model and they are also disappointed to identify a definite guideline for choosing an appropriate set of macroeconomic variables. There are few empirical studies that are based on macroeconomic approach to test semi-strong form efficiency of stock markets (Khan, 2013). Therefore, this study is expected to add several primary contributions to the existing literature.

3. Methodology

3.1 Variable Selection and Justification

Based on the theoretical and empirical literature reviewed in section 2 and 3, this study investigates five macroeconomic variables that might have a significant impact on the most important stock market variable of

Bangladesh named DSE all-share price index (DSI). For the multivariate model of this study, DSE all-share price index (DSI) as a proxy of aggregate stock prices from the stock market is considered as the dependent variable. In contrast, five macroeconomic variables are considered as the explanatory variables from the major markets that coordinate the macroeconomic activities. Industrial Production Index (IPI) as a proxy of GDP from the product market, Broad Money Supply (M2) from the money market, Crude Oil Price (OP) from the natural resources market, Exchange Rate (ER) from the foreign exchange market and one of the Indian (Bombay) stock market index (SENSEX) from the foreign market are used as independent variables. The study uses monthly data of all the variables covering the period from January 2001 to December 2012 (144 monthly observations). All data series are transformed to natural logarithms. The data are collected from secondary sources, such as, the central library and official website of Dhaka Stock Exchange, Monthly Economic Trend issued by Bangladesh Bank (BB) and official website of Bombay Stock Exchange. The analysis is done using the EViews 8.1 econometric software packages.

Dhaka Stock Exchange is the country's leading stock exchange and all share price index (DSI) of DSE covers majority of the stocks in the country. DSI is used as a proxy for stock prices as it allows a more comprehensive analysis. DSI index forms with all shares price of all categories except mutual funds, bonds, and debentures. The GDP is not calculated every month and not even every quarter in Bangladesh. Thus, Industrial Production Index (IPI) is used as a proxy of GDP for this study as monthly data of IPI are available in Bangladesh. Moreover, IPI becomes more vital component of the economy of Bangladesh as the contribution of the industrial sector in GDP is increasing with a decent pace over the last twenty years. Generally, a rise in industrial production signals the economic growth and industrial production affects stock prices through its influence on expected future cash flows. Previous studies such as, Chen et al. (1986), Naik and Padhi (2012) and Hsing (2013) find a positive relationship between IPI and stock prices. According to the portfolio theory, stock prices tend to move higher when the money supply in an economy is high as plenty of money circulating in the economy makes more money available to invest in stocks. Pilinkus and Boguslauskas (2009), Eita (2012), Naik and Padhi (2012), Ray (2012) and Hsing et al. (2012) find positive relationship between money supply and stock prices. Crude oil is the lifeblood of modern economies since it is a very important input for production and so, the price of oil is widely incorporated as an explanatory variable in order to analyse the stock market behavior. An increase in the price of oil in Bangladesh means lower real economic activity in all sectors which will cause stock price to fall. Studies, such as, Isenmila and Erah (2012) and Ray (2012) argue that there is an inverse relationship between share prices and oil price. Foreign Exchange Rate (ER) is a dominant macroeconomic variable that is extensively used to find impact on a domestic stock market. The study uses monthly average Taka (Bangladesh currency) per U.S dollar exchange rate as foreign exchange rate. The flow or traditional approach concentrates on the trade balance and asserts that depreciation improve a country's external competitiveness and thus its trade balance, and ultimately real output. As a result, the profitability and expected cash flows of firms will increase and thus the stock returns. Studies, such as, Hsing et al. (2012) and Aurangzeb (2012) show that there is a positive relationship between exchange rate and stock prices. According to Dekker, Sen and Young (2001) markets with strong economic ties and close geographic proximity are more closely linked than the isolated market. Hence, this study selects the Bombay Stock Exchange (BSE) of Indian stock market as a foreign market. The BSE is the oldest stock exchange in Asia and premier stock exchange in India. SENSEX (BSE-30) of BSE is included which is a widely used index by the researchers of financial economics. Prior research suggests an inverse relationship between geographic distance and financial market linkages.

3.2 Research Methods

3.2.1 Unit Root Test

The cointegration analysis requires the variables that must be integrated in the same order. Two extensively used unit root tests, namely Augmented

Dickey Fuller (ADF) and Phillips-Peron (PP) tests are employed to examine the order of integration of the time series. ADF is the augmented form of Dickey Fuller test. The ADF test is performed using the following equation:

$$\Delta Y_t = \alpha + \beta T + \gamma \Delta Y_{t-1} + \delta_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

where, α is a interecpt (constant), β is the coefficient of time trend T, γ and δ are the parameters where , $\gamma = \rho$-1, ΔY is the first difference of Y series, m is the number of lagged first differenced term, and ε is the error term.

Phillips and Perron (1988) have developed a non-parametric unit root conception. The PP test is performed using the following three equations:

$$\Delta Y_t = \alpha + \beta T + \gamma \Delta Y_{t-1} + \varepsilon_t \quad (2)$$

where, α is a constant, β is the coefficient of time trend T, γ is the parameter and ε is the error term.

3.2.2 The Johnasen Cointegration Analysis

Johansen and Juselius (1990) cointegration approach based the on VAR model is applied to examine the long run relationship that may exist among representative variables. Five different criteria are used to determine the lag lengths used in the VAR. Residual serial correlation LM test is performed to select appropriate lag lengths for the VAR. The Johansen and Juselius approach can be expressed mathematically as:

$$Y_t = \alpha + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + +\varepsilon_t \quad (3)$$

where Y_t is a vector containing n variables of I(1) at time t, α is an (n× 1) vector of constants, A_ρ is an (n× n) matrix of coefficients, ρ is the maximum lag included in the model and ε_t is an (n× 1) vector of error terms.

As in Enders (2004), Equation (3) can be written in the form of the error correction model assuming cointegration of order ρ as:

$$\Delta Y_t = \alpha + (A_1 - I)Y_{t-1} + A_2 Y_{t-2} + \cdots + A_\rho Y_{t-\rho} + +\varepsilon_t \quad (4)$$

or in a final broad form as:

$$\Delta Y_t = \alpha + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{\rho-1}\Delta Y_{t-\rho+1} + \Pi Y_{t-\rho} + \varepsilon_t \quad (5)$$

Where, $\Gamma_i = (A_1 + A_2 + \cdots + A_{\rho-1} - I)$ represent the dynamics of the model in the short run. In Equation 5, $\Pi = (A_1 + A_2 + \cdots + A_\rho - I)$ represents the long run relationship among the variables included in the vector Y_t, and I is the identity vector. The key idea of the Johansen and Juselius approach is to determine the rank of the matrix *Π*, which represent the number of independent cointegration vectors.

Johansen (1988) suggests two test statistics named trace and eigenvalue test statistic for estimating the number of cointegrating vectors or equations. The trace and maximum eigenvalue test are as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \quad (6)$$

and

$$\lambda_{max}(r, r+1) = -T \ln(1 - \widehat{\lambda_{r+1}}) \quad (7)$$

where T is the sample size and $\hat{\lambda}_i$ is the eigenvalues.

3.2.3 Vector Error Correction Model (VECM)

Vector Error Correction Model (VECM) is implemented to investigate the long run causality and short run to long run dynamic adjustment of a system of cointegrated variables. Short run causality between DSI and macroeconomic variables is determined using VECM Granger causality/block exogeneity Wald tests. Equation (4) can be written as a VECM as:

$$\Delta Y_t = \alpha + \sum_{i=1}^{\rho} \Gamma_i \Delta Y_{t-1} + \Pi Y_{t-\rho} + \varepsilon_t \tag{8}$$

where $\Gamma_i = A_1+A_2+A_3+\ldots\ldots\ldots+A_{\rho-1}-I$ represents the dynamics of the model in the short-run and $\Pi = A_1+A_2+A_3+\ldots\ldots\ldots+A_\rho-I$ is the long-run relationship among the variables included in the vector Y_t and I is the identity vector. ΔY_t is an n x 1 vector of variables and α is an (nx1) vector of constants. Π is the error correction mechanism, which has two components: $\Pi=\mu\beta'$ where μ is an (n x 1) column vector representing the speed of the short run adjustment to the long-run equilibrium, and β' is a (1 x n) cointegrating vector with the matrix of long run coefficients. Γ is an (n x n) matrix representing the coefficients of the short run dynamics. Finally, ε_t is an (n x 1) vector of white noise error terms, and ρ is the order of the autoregression.

4. Empirical Results

4.1 Unit Root Test Results

Considering the results of ADF and PP tests (Table 1), it is clearly evident that the null hypothesis of a unit root at the level are accepted in all

Table 1
ADF and PP Unit Root Test Results of the Variables

	ADF			PPP		
Variables	Intercept	Trend & Intercept	None	Intercept	Trend & Intercept	None
DSI	-1.173 [0] (0.6848)	-1.796 [0] (0.7017)	1.554 [0] (0.9703)	-1.198 [3] (0.6742)	-2.120 [4] (0.5296)	1.438 [3] (0.9624)
ΔDSI	-10.69* [0] (0.0000)	-10.69* [0] (0.0000)	-10.53* [0] (0.0000)	-10.68* [2] (0.0000)	-10.67* [2] (0.0000)	-10.54* [3] (0.0000)
IPI	-0.021 [4] (0.9582)	-3.64** [4] (0.0293)	3.843 [4] (1.0000)	-0.126 [25] (0.9434)	-7.71* [25] (0.0000)	6.12 [23] (1.0000)
Δ IPI	-11.00* [5] (0.0000)	-10.97* [4] (0.0000)	-11.46* [3] (0.0000)	-31.79*[23] (0.0001)	-33.8*[23] (0.0001)	-14.7*[27] (0.0000)
M2	1.790 [1] (0.9997)	-2.018 [1] (0.5861)	11.67 [1] (1.0000)	4.99 [61] (1.0000)	-2.045 [15] (0.5711)	24.1 [41] (1.0000)
ΔM2	-15.79* [0] (0.0000)	-9.411* [4] (0.0000)	-2.02**[4] (0.0415)	-16.6* [23] (0.0001)	-33.3* [73] (0.0001)	-9.67* [8] (0.0000)
OP	-1.286 [1] (0.6347)	-3.304 [1] (0.0697)	0.778 [1] (0.8804)	-1.279 [3] (0.6383)	-2.888 [4] (0.1694)	1.018 [3] (0.9185)
ΔOP	-8.125* [0] (0.0000)	-8.096* [0] (0.0000)	-8.069* [0] (0.0000)	-8.125* [4] (0.0000)	-8.096* [4] (0.0000)	-8.113* [3] (0.0000)
ER	-0.535 [0] (0.8795)	-1.694 [0] (0.7490)	3.400 [0] (0.9998)	-0.535 [0] (0.8795)	-1.884 [2] (0.6574)	3.151 [1] (0.9996)
ΔER	-9.946* [0] (0.0000)	-9.907* [0] (0.0000)	-9.344* [0] (0.0000)	-9.906* [3] (0.0000)	-9.866* [3] (0.0000)	-9.345* [2] (0.0000)
SENSEX	-0.662 [0] (0.8515)	-1.742 [0] (0.7273)	1.617 [0] (0.9740)	-0.780 [6] (0.8212)	-2.116 [6] (0.5319)	1.365 [6] (0.9566)
ΔSENSEX	-10.62* [0] (0.0000)	-10.58* [0] (0.0000)	-10.47* [0] (0.0000)	-10.70* [3] (0.0000)	-10.67* [6] (0.0000)	-10.62* [6] (0.0000)

Notes: * and ** indicate stationary at 1% and 5% levels respectively using MacKinnon (1996) critical and p-values. First bracket shows p-values, and third bracket shows optimal lag for ADF and optimal bandwidth for PP.

cases for DSI, M2, OP, ER and SENSEX as test statistics are lower than the critical values. IPI appears to be stationary in the level with trend and intercept as test statistics are lower than the critical values for both ADF and PP tests. Considering the intercept and none term for the IPI series, we can conclude that IPI also has unit root in level. Therefore, we conclude that all series are nonstationary in levels. Results from the ADF and PP show that all series are stationary in first difference with 1 percent significance level, while only M2 is stationary in first differences with 5 percent significance level. So, all the individual series are found to be integrated of order one, i.e., I(1). As a result, the following analysis is conducted under the assumption that all variables are stationary in first differences.

4.2 Selection of Optimal Lag Lengths for the VAR

Banerjee et al. (1993) specify that the number of cointegrating vectors generated by Johansen approach may be sensitive to the number of lags in the VAR model. Henceforth, in this study, we use and check five different criteria namely, Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz Information Criteria (SIC) and Hannan-Quinn Information Criteria (HQ) to determine the optimum lag lengths of the VAR model. Results for each criterion with a maximum of 12 lags exhibit that AIC, sequential modified LR and FPE criteria stand in favor of 12 lags, 10 lags and 2 lags respectively, while SIC and HQ criteria suggest only 1 lag. The presence of residual serial correlation makes the results less efficient. Thus, LM tests are conducted for each suggested lags up to maximum of 12 lags. Results of the Lagrange Multiplier (LM) tests strongly reveal the presence of serial correlation in the estimated residuals generated from VAR (12), VAR (2) and VAR (1) models up to 12 months. Thus, The null hypothesis of no serial correlation in the residuals for the 12 lags and 2 lags suggested by AIC and FPE criteria respectively, and 1 lag suggested by SIC and HQ criteria cannot be rejected based on the p-values of the LM tests. Using 10 lags suggested by sequential modified LR criteria produces no autocorrelation in the VAR model for up to 12 months at 1 percent significance level. So, we accept VAR (10) model for cointegrating analysis.

4.3 Results of Long Run Relationship Based on Johansen Cointegration Test

The Johansen cointegration test is run using the default option of the EViews 8.1 following the suggestions of Agung (2009), which assumes linear trend in the VAR and the cointegrating relationship only has an intercept. Table 2 presents particularized results of cointegration test including the trace test and the maximum eigenvalue test at the 1percent significance level.

Table 2
Johansen-Juselius Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)					Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
CE(s)					CE(s)				
H_0	H_1	Trace Statistic	0.01 Critical Value	P-value**	H_0	H_1	Max-Eigen Statistic	0.01 Critical Value	P-value**
r = 0	r > 0	198.3407*	104.9615	0.0000	r = 0	r = 1	89.26229*	45.86900	0.0000
r ≤ 1	r > 1	109.0784*	77.81884	0.0000	r = 1	r = 2	39.21428	39.37013	0.0105
r ≤ 2	r > 2	69.86413*	54.68150	0.0001	r = 2	r = 3	33.77804	32.71527	0.0070
r ≤ 3	r > 3	36.08609*	35.45817	0.0083	r = 3	r = 4	27.42563	25.86121	0.0057
r ≤ 4	r > 4	8.660466	19.93711	0.3977	r = 4	r = 5	6.958851	18.52001	0.4940
r ≤ 5	r > 5	1.701615	6.634897	0.1921	r = 5	r = 6	1.701615	6.634897	0.1921

Notes: CE(s) represents cointegration equation(s). r indicates the number of cointegrating relationships. *denotes rejection of the null hypothesis at the 1% level. ** indicates MacKinnon-Haug-Michelis (1999) p-values.

A visual inspection in Table 2 reveals that the null hypothesis of there are at most 3 cointegrating vectors can be rejected since the λ_{trace} statistics of 36.08609 is greater than its critical value of 35.45817 at the 1 percent level of significance. Hence, the trace test indicates 4 cointegrating equations at the 1 percent level. In contrast, the null hypothesis of there is no cointegrating vector can be rejected since the λ_{max} statistics of 89.26229 is greater than its critical value of 45.86900 at the 1 percent level of significance. Thus, the maximum eigenvalue test suggests for 1 cointegrating vector at the 1 percent level of significance. We consider one cointegrating relationship based on maximum eigenvalue statistic test following the recommendation of Banerjee et al. (1993) who prefer the maximum eigenvalue statistic test. Moreover, Johansen and Juselius (1990) suggest that maximum eigenvalue test gives better result. Thus, the cointegrating vector based on maximum eigenvalue test is normalized on all share price index (DSI). The normalized cointegrating coefficient gives the long run relationship between DSI and macroeconomic variables. The signs of coefficients are reversed because of the normalization process. The estimation of the equation by cointegration gives the following long run equation:

$$DSI = -32.68 -15.45\ IPI + 8.06\ M2 - 0.94\ OP + 6.75\ ER + 0.86\ SENSEX \quad (9)$$

	(2.13)	(0.92)	(0.37)	(1.61)	(0.26)
	[7.24]	[-8.72]	[2.53]	[-4.17]	[-3.32]

Note: * denotes singnificance of variables, Standard Erros in parentheses and t-statistics in square brackets.

Equation 9 indicates that all the variables included in the model are statistically significant, and long run relationships exist between share prices and macroeconomic variables in Bangladesh. In the long run, industrial production index and crude oil price have negative relationship with all share price index of DSE. On the other hand, money supply, exchange rate and Indian stock prices have significant long run positive relationship with all share price index of DSE. The result is implying that a 1 percent increase in IPI and OP contributes to 15.45 percent and 0.94 percent decrease in stock index at Dhaka Stock Exchange of Bangladesh respectively. Besides, a 1 percent increase in M2, ER and SENSEX contributes to 8.06 percent, 6.75 percent and 0.86 percent increase in stock index at DSE respectively.

4.4 Results of Long Run Causality and Speed of Adjustment based on VECM

The study reduces the lag length by -1 in the lag length for endogenous variables in the model with the shift from the VAR to the VECM. Table 3 presents VEC(9) estimates of the variables. The result shows that the coefficient of error correction term on the regression with first difference DSI is negative and also significant based on t-statistics and P-value. It indicates that there is a long run causality running from the explanatory variables (IPI, M2, OP, ER and SENSEX) to the dependent variable (DSI) at the 1 percent level of significance. The results of the estimated multivariate VECM clearly indicate that the coefficients of error correction terms of the first differenced IPI, ER and OP equations are statistically significant at the 1 percent, 1 percent and 10 percent levels of significance respectively. It suggests that the long run causality is also directing from DSI to IPI, DSI to ER, and DSI to OP. The results confirm that there is bi-directional long run causality between DSI and IPI, DSI and ER, DSI and OP in Bangladesh.

Table 3
Vector Error Correction Estimates

Error Correction	D(DSI)	D(IPI)	D(M2)	D(OP)	D(ER)	D(SENSEX)
Coint. Equation	-0.152184*	-0.070110*	-0.004843	0.067345**	0.015175*	-0.034051
Standard Errors	0.04551	0.02470	0.00535	0.03760	0.00493	0.04379
t-statistics	-3.34406	-2.83899	-0.90494	1.79099	3.07669	-0.77750
P-value	0.0009	0.0047	0.3660	0.0739	0.0022	0.4373

Note: * and ** denote significance at 1% and 10% level respectively

The error correction term of first differenced DSI is -0.152184, which implies that the stock index of Dhaka Stock Exchange requires about six and half months to converge into equilibrium after being shocked. Thus, only 15 percent of the last month's disequilibrium is corrected this month by changes in DSI. The VEC estimates also reveal that the error correction term of first differenced IPI, OP, and ER are significant; however, the coefficients of error correction terms of the first differenced ER and OP equations are not correctly signed. So, adjustment of the disequilibrium of IPI towards a long run equilibrium state takes a long time as the error correction term is too small (0.07). The significant but positive coefficients of error correction terms of ER and OP imply that due to any disturbance in the system, divergence from equilibrium takes place and the system becomes unstable. Above and beyond, the coefficients of error correction terms of M2 and SENSEX equations are correctly signed but not significant. Thus, it can be concluded that DSI and IPI contribute to adjust any disequilibrium, although there is a bi-directional long run causality running between DSI and IPI, DSI and OP, DSI and ER. Moreover, this research finds that all share price index of DSE picks up the disequilibrium quickly and guides the variables of the system back to equilibrium.

4.5 Results of Short Run Causality based on VECM Granger Causality/Block Exogeneity Wald Tests

Short run causality between all share price index of DSE and macroeconomic variables (IPI, M2, OP, ER and SENSEX) is determined with a test on the individual and joint significance of the lagged explanatory variables using VECM Granger causality/block exogeneity Wald tests. Under this system, an endogenous variable can be treated as exogenous. This test detects whether lags of one excluded variable can Granger cause the dependent variable in the VAR system using the Chi-square (Wald) statistics. The results are reported in Table 4.

Table 4
Results of the VECM Granger Causality/Block Exogeneity Wald Tests

Dependent Variable	Excluded	Chi-Square Statistics	Degrees of Freedom	P-value
D(DSI)	D(IPI)	27.13979*	9	0.0013
	D(M2)	11.84370	9	0.2223
	D(OP)	12.59945	9	0.1816
	D(ER)	10.31778	9	0.3254
	D(SENSEX)	17.70702**	9	0.0387
	All	79.79365*	45	0.0011
D(IPI)	D(DSI)	14.72107***	9	0.0989
	All	110.2841*	45	0.0000
D(M2)	D(DSI)	10.47395	9	0.3135
	All	66.68815**	45	0.0195
D(OP)	D(DSI)	6.495771	9	0.6895
	All	78.37936*	45	0.0015
D(ER)	D(DSI)	15.56840***	9	0.0765
	All	86.92780*	45	0.0002
D(SENSEX)	D(DSI)	10.59510	9	0.3045
	All	41.16869	45	0.6350

Note: *, ** and ** denote significance at 1%, 5% and 10 levels respectively.

In the case, where DSI is the dependent variable and IPI, M2, OP, ER, and SENSEX are the joint excluded variables, the Chi-square probability value of the excluded variables is 0.0011 (which is less than 1 percent). This means that there is a short run Granger causality running jointly from IPI, M2, OP, ER and SENSEX to DSI. The result suggests that the five variables namely, DSI, IPI, M2, OP and ER are not significantly exogenous, because the p-values of the joint test for each equation of those variables are 0.0011, 0.0000, 0.0195, 0.0015, and 0.0002 respectively. The test fails to reject the null hypothesis of excluding DSI, IPI, M2, OP and ER from the SENSEX equation. It suggests that DSI, IPI, M2, OP and ER jointly do not Granger cause SENSEX. In DSI equation, the Chi-square probability value of D(IPI) is 0.0013 (which is less than 1 percent), while the Chi-square probability value of D(DSI) in IPI equation is significant at 10 percent level. This means that there is a significant bi-directional short run Granger causality running between DSI and IPI in Bangladesh. There is a unidirectional short run causality running from SENSEX to DSI at 5 percent level of significance. DSI also causes ER in the short run at 10 percent level of significance but the converse is not true. However, the rest of the macroeconomic variables, i.e., M2 and OP individually appear to not have a significant causal relationship with the Bangladesh stock market return in the short run based on the p-values.

Thus, there is a short run Granger causality running jointly from IPI, M2, OP, ER and SENSEX to DSI, while individually IPI and SENSEX are the leading indicators with respect to stock prices in Bangladesh in the short run. Moreover, stock price index of DSE is a leading indicator with respect to IPI and ER in the short run. In order to determine the robustness of the model, diagostic ckecking of the estimated model has been carried out in terms of conventional multivariate residual-based tests for autocorrelation and heteroskedasticity. At 1 percent level of significance, the multivariate Lagrange Multiplier (LM) test for autocorrelation indicates the absence of autocorrelation at all lags, and White's Chi-square test for heteroskedasticity indicates the absence of heteroskedasticity.

5. Conclusion

This study uses publicly available macroeconomic variables information and relates it to stock market activity to test the market efficiency in semi-strong form in DSE based on macrovariable model of APT using monthly data from January 2001 to December 2012. In doing so, the study also gets the long run and short run relationship with causality between DSI and macroeconomic variables. The Johansen cointegration tests reveal that industrial production index and crude oil price have significant negative long run relationship with all share price index of DSE, while money supply, exchange rate and Indian stock prices have significant positive long run relationship with all share price index of DSE. The results of VECM indicate that there is a long run causality running from the explanatory variables to DSI. The error correction term of first differenced DSI implies that the stock index of DSE requires about six and half months to converge into equilibrium after being shocked. Thus, only 15 percent of the last month's disequilibrium is corrected this month. The VECM results also show that only DSI and IPI contribute to adjust any disequilibrium, while all share price index of DSE picks up the disequilibrium quickly and guides the variables of the system back to equilibrium. VECM Granger causality/block exogeneity Wald test results show that there is a significant short run Granger causality running jointly from IPI, M2, OP, ER and SENSEX to DSI. The test also reveals that there is a short run Granger causality running from IPI to DSI at 1 percent level of significance, and SENSEX to DSI at 5 percent level of significance. Thus, individually IPI and SENSEX are the leading indicators with respect to stock prices in Bangladesh in the short run. Moreover, stock price index of DSE is a leading indicator with respect to IPI and ER in the short run. The significant negative long run relationship between DSI and IPI is surprising, while rest of the results are in line with the empirical evidences of several researchers. Taking into consideration the results of Johansen cointegration test, VECM and block exogeneity Wald test, it is obvious that all of the selected macroeconomic variables do significantly explain the stock prices of Bangladesh stock market. Since all the macroeconomic variables do significantly explain the stock prices of Bangladesh stock market either in the short run or long run or both, it can be concluded that the Bangladesh stock market is not efficient in semi-strong form. Consequently, investors can earn abnormal profit from the DSE using publicly available information. Thus we conclde that money supply defined by broad money supply is the largest positive determinant, while GDP proxied by industrial production index is the largest negative determinant of stock prices in Bangladesh in the long run. Investors in the Bangladesh stock market should look at the systematic risks revealed by the industrial production index or GDP, the price of crude oil, broad money supply, exchange rates and the Indian stock market in the long run when they structure portfolios and diversification strategies. They should also focus on the industrial production index or GDP and stock prices of India in the short run when they make a decision to invest in the stock market. Policymakers of Bangladesh should acknowledge stock prices when formulating monetary and fiscal policies as stock price index of DSE is a leading indicator with respect to industrial production index and exchange rate in the short run.

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