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Efficiency and Volatility of the Stock Market in Bangladesh: A Macroeconometric Analysis

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Abstract. This study investigates the weak form efficiency of Efficient Market Hypothesis (EMH) employing Autocorrelation test, Runs test and Unit Root tests, and the nature of volatility characteristics of stock returns applying GARCH family models in Bangladesh stock market using daily all share price index return data of Dhaka Stock Exchange (DSE) from 02 January 1993 to 27 January 2013. This study also examines the semi-strong form of the EMH of DSE based on macroeconomic variable version of the Arbitrage Pricing Theory (APT) applying Cointegration tests, Vector Error Correction Model (VECM) and Granger causality tests, and the volatility of the DSE returns in response to the volatility of the macroeconomic variables employing GARCH family models using monthly data from January 2001 to December 2012. In addition, the short run and long run relationships between macroeconomic variables and aggregate stock prices in Bangladesh have also been determined. Employing both nonparametric tests (Runs test and Phillips-Perron test) and parametric tests (Autocorrelation test and Augmented Dickey-fuller test), this study finds that the DSE of Bangladesh is not weak form efficient. Taking the outcome of VAR models into account, it is found that all selected macroeconomic variables do significantly explain the stock prices of the Bangladesh stock market. As a consequence, it may be concluded that the Bangladesh stock market is not efficient in the semi-strong form of EMH. Results of the estimated MA(1)-GARCH(1,1) and MA(1)-EGARCH(1,1) models reveal that stock market returns of Bangladesh exhibit leptokurtosis, volatility clustering and leverage effect. Results of six GARCH-S models indicate that the volatility of DSE return is significantly influenced by the volatility of macroeconomic variables, such as, exchange rate, broad money supply and stock returns of India.
Keywords. Efficient market hypothesis, Stock prices, Vector error correction model, GARCH family models, Volatility.
JEL. C58, E44, F36, G10, G14.

Highlights

* 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, study like efficiency and volatility of the stock market in Bangladesh in response of macroeconomic variables has basically been ignored.
* This study takes an attempt to uncover the issue of efficiency and volatility of the stock market in Bangladesh by employing both univariate models using daily past share prices data and multivariate models employing monthly data of macroeconomic variables and stock index.
* This research concludes that the stock market of Bangladesh is not efficient in weak and semi-strong form of EMH . Stock market returns of Bangladesh exhibit well-known stylized facts. The volatility of DSE return is significantly influenced by the volatility of macroeconomic variables.

† This summary depends on the PhD thesis which was submitted to Institute of Bangladesh Studies (IBS) on November 2015, under the supervision of Professor Dr. Md. Abdul Wadud, Department of Economics, University of Rajshahi, Bangladesh. The original language is English and the thesis is consisted of 245 pages.

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Summary

Efficiency and volatility have been the most active and successful area of research in time series econometrics and finance in past three decades. The efficient markets theory assumes that stock prices reflect all available information like past stock price patterns , company and economy fundamentals. Therefore, prediction on future stock prices should be a worthless task in an efficient stock market by looking at past price patterns, company and economy fundamentals.Theoretically, the stock market should be closely related to real economic variables of the country. If the connection between stock prices and micro-macroeconomic variables exists, the stock market of Bangladesh loses its informational efficiency and becomes more volatile. Bangladesh has two stock exchanges: Dhaka Stock Exchange (DSE) and Chittagong Stock Exchange (CSE). DSE is the oldest and largest stock exchange in Bangladesh.The stock market of Bangladesh has progressed accompanied by the overall economy after the process of liberalization in early 1990s. Stock markets of Bangladesh are relatively new compared to other emerging countries; however it obtains an immense focus by policymakers, investors, academicians, and even general citizens. Taking into consideration the facts, the study aims to explore the behavior of the Bangladesh stock market.

The rising importance of stock markets globalization has increased the interest in emerging markets. Consequently, researchers have focused research on whether or not these markets are efficient. The stock market of Bangladesh has been growing notably for the past two and half decades. Thus, measuring the efficiency of stock market is an important research topic as this contains various implications for investors. Moreover, the stock market crashes enlighten that it is important to protect the stock market from drastic fluctuations. Thus, analyzing the volatility of stock returns is an informative examination as it bears several indications for investors and policymakers. Hence, this research is designed to macroeconomically investigate the efficiency and volatility of stock market in Bangladesh. In this contex, this study deals with the following specific objectives: i) To investigate the efficiency of the stock market in Bangladesh; ii) To examine the short run dynamics and long run equilibrium links between economic variables and stock prices; iii) To explore the causal relationships and direction of the causality between stock index and macro economic variables; iv) To assess the volatility characteristics of stock returns; v) To investigate the volatility of stockmarket returns in response tothe volatility of the macroeconomic variables.

In view of the facts that this study involves in studying the efficiency and volatility in the Bangladesh stock market, it is essential as well as meaningful to present some relevant aspects about the Bangladesh economy, her stock markets and changes that have taken place within it since the country became independent. For that reason, we state some facts on the performance of the Bangladesh economy, and thereafter the overview of the financial system of Bangladesh. Subsequently, it presents a historical review of the development stages of the Bangladesh stock market since its inception in 1954. A statistical review of the performance of the stock market and the status of DSE in the world stock market perspective are also provided. With an inherited fragile economy after independence in 1971, Bangladesh has categorized as a poor economy and branded as a natural disaster inflated, famine, and devastating economy in the world. Bangladesh has taken more than twenty years to disprove the statement as she witnessed decades of slow economic growth until 1990s. The performance of Bangladesh economy over the last one and half decades has been quite impressive. The country has posted an average annual GDP growth rate of about 4% in the 1970-80s, which improved to 5% in the 1990s. During the first decade of the 21st century, the average economic growth rate has been approached 6% per annum. That is why, The World Bank has signpostedon its website that: ‘ Bangladesh has sustained an impressive track record for growth and development. In the past decade, the economy has grown at nearly 6 % per year despite frequent natural

disasters and fuel, food price and global financial crises. In the past two decades, poverty was reduced by nearly one-third whereas life expectancy, literacy and per capita food production have increased significantly' (World Bank, 2013, para. 1). Currently, Bangladesh is the 31th largest economy in the world in terms of purchasing power parity (Sohel, 2015). Banglades his practically self-sufficient in foodand is a major exporter of garments, leather, ceramics and pharmaceuticals. Bangladesh is now recognized as an emerging economy and frequently captured by reputed international organizations and media. The major findings from the overview of the DSE may be summarized as follows. The total number of enlisted securities is increasing at a handsome rate, although there is a shortage of healthy fundamental companies in terms of the greater demand over supply of companies share as BO accounts is increased from 3 lacs in 1996 to 35 lacs in 2010. The DSE is not succeeding to become a capital market as it is still an equity based market. The stock market indicators like market size is increasing impressively since more than last two decades; however the market size of Bangladesh stands at only around 30%. Market concentration is extreme as Grameenphone holds 16.58% of total market capitalization of the DSE as of December 2009. Foreign portfolio investment makes only around 2% of total investment at DSE, which is the lowest in South Asia region. From the commencement, Dhaka Stock Exchange has faced two major market crashes in November1996 and December 2010. During the crash of 1996, paper shares used to be sold in front of DSE and it was not easy for amateur investors to classify which one is profitable share and which one is fake printed share. In spite of automated share trading , strong surveillance and circuit breakers contrasting formerly in 1996, DSE is strongly affected by the 2nd market crash in 2010-11 . Based on the contemporary investigations of the capital market crashes, various malfunctions and drawbacks are observed like , misuse of book building methods, placement shares, direct listing, problems in audit reports, split shares, margin loans, serial trading, issue of right shares, over exposures of banks, omnibus accounts, insider trading, anomalies in BO account, and hampering nexus of big players like the SEC, DSE, CSE and political leaders.

We also provide a theoretical overview of asset pricing theory. We start with EMH and find evidences in the literature in favor of weak form of EMH and semi-strong form of EMH particularly in developed markets . Then we review the Markowitz portfolio theory and find some strong evidences that the Markowitz optimal portfolio does provide the basis of a useful trading rule strategy. We also outline the Capital Asset Pricing model and Arbitrage Pricing Theory. APT has been tested intensively since its introduction in 1976. Although empirical studies have suggested that APT macroeconomic variables can explain stock returns, it does not specify the number of variables that should be included in the multivaraite efficiency and volatility models, and they are also disappointed to identify a definite guideline for choosing an appropriate set of macroeconomic variables. Finally, the present value model has been explained. Although, the extended version of PVM allows to identify macroeconomic variables that should impact corporate cash flows and discount rates, the linear PVM mainly focuses on the relationship between real stock prices and dividends. Since this research is aimed to macroeconomically investigate the efficiency and volatility of stock market in Bangladesh, we have come to a decision to follow the EMH and APT. We have reviewed the studies that satisfy the following three conditions: i) the issue of stock market efficiency; ii) the relationship between stock prices and macroeconomic variables; and iii) the issue of stock market volatility. Few studies around the world have been conducted to test both the efficiency and volatility of the stock market. Most of scholars have used only historical data of stock index to test efficiency and volatility. The efficiency and volatility test using a top down approach has basically been overlooked. This study tries to fill the gap in the literature as it attempts to explore the efficiency and volatility of DSE by using both univariate and multivariate time series models.

This research tests the weak form efficiency of EMH in the framework of the random walk model using daily all share price index (DSI) return data of Dhaka Stock Exchange from 02 January 1993 to 27 January 2013. Results suggest that DSE of Bangladesh is not efficient in weak form for the whole period. Different tests have been employed to investigate whether past returns of stock indice predict future returns. The following results are obtained:

- The statistical features of the daily DSI return data indicate that the daily distribution of stock market returns is not normally distributed and thus it deviates from the prior condition of the random walk model.
- The serial autocorrelation tests for level and first differences show that the DSE is not weak form efficient as there is highly significant autocorrelation for all lags at the 1% level for the returns of DSI.
- The results of the runs test for DSI return series report that the Z-statistics of the runs test of serial independence is significant at the 1% level. So, the significant positive serial correlation in the return series shows that the Dhaka Stock Exchange does not follow random walk.
- The results of ADF and PP unit root tests reveal that the null hypothesis of unit root is strongly rejected at 1% significant level. Thus the unit root tests suggest that the market is not weak form efficient.

Efficiency tests for the semi-strong form of the EMH have been performed jointly with an equilibrium asset pricing model named ' macroeconomic variable version APT' using monthly data from January 2001 to December 2012. In the avenue of exploring semi-strong form of EMH, the research reveals the long run and short run relationship with causality between stock prices and macroeconomic variables. Wide ranges of VAR models including the Johansen and Juselius multivariate cointegration test, vector error correction model, Granger causality tests are applied. Summary obtained from the above models are given as follows:

- On the basis of the graphical depictions and results of unit root tests, we conclude that the null hypothesis of unit root at the level are accepted for the variables. ADF and PP tests provide that all series are stationary in first differences at 1% level of significance, while only M2 is stationary in first differences at 5% level of significance.
- We operate five different criteria to find out the optimum lag lengths of the VAR model. Results for each criterion with a maximum of 12 lags reveal that AIC, sequential modified LR and FPE criteria propose for 12 lags, 10 lags and 2 lags respectively, while SIC and HQ criteria suggest for only 1 lag. Residual serial correlation Lagrange Multiplier test shows that 10 lags suggested by sequential modified LR criteria produces no autocorrelation in the VAR model for up to 12 months. Hence, we take on VAR (10) model for cointegrating analysis.
- Johansen and Juselius (1990) multivariate cointegration test is applied to investigate the long run relationship between macroeconomic variables and the stock prices of Bangladesh. Results reveal that industrial production index (IPI) and crude oil price (OP) have significant negative long run relationship with all share price index (DSI) of DSE, while money supply (MS), exchange rate (ER), and Indian stock prices (SENSEX) have significant positive long run relationship with all share price index of DSE. Provided that the call money rate (CMR) does not significantly contribute to the long run relationship, we drop CMR from the model and the cointegration test is reestimated. Result implies that a 1% increase in IPI and OP contributes 15.45% and 0.94% decrease in DSI respectively, while a 1% increase in M2, ER and SENSEX contributes 8.06%, 6.75% and 0.86% increase in DSI respectively.
- We apply Vector Error Correction Model (VECM) to investigate the long run causality and short run to long run dynamic adjustment of a system of the six cointegrated variables. Result shows that there is a long run causality running from the explanatory variables (IPI, M2, OP, ER, and SENSEX) to the

dependent variable (DSI). Results of the estimated multivariate VECM also show that there is bi-directional long run causality between DSI and IPI, DSI and ER, DSI and OP in Bangladesh . The negative and significant error correction term of first differenced DSI implies that the stock index of Dhaka Stock Exchange requires about six and half months to converge into equilibrium after being shocked. Thus, about 15% of the last month's disequilibrium is corrected this month. The VECM results also show that DSI and IPI contribute to adjust any disequilibrium, while DSI picks up the disequilibrium quickly and guides the variables of the system back to equilibrium.

- Short run causality between all share price index of DSE and macroeconomic variables (IPI, M2, OP, ER and SENSEX) is revealed with a test on the individual and joint significance of the lagged explanatory variables employing VECM Granger causality/block exogeneity Wald tests. VECM Granger causality/block exogeneity Wald tests 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 individually IPI and SENSEX are the leading indicators with respect to stock prices in Bangladesh in the short run. Furthermore, stock price index of DSE is a leading indicator with respect to IPI and ER in the short run.
- We operate pairwise Granger (1969) causality test between DSI and CMR, since they are not cointegrated based on Johansen cointegration test. The Granger causality test results reveal that there is a unidirectional short run Granger causality running from CMR to stock prices of DSE at 1% level of significance.

Considering the results of Johansen cointegration test, VECM, block exogeneity Wald test and Granger causality test, it is apparent that all of the selected macroeconomic variables do significantly explain the stock prices of Bangladesh stock market either in the short run or long run or both. Since macroeconomic variables information are not inherent in current share prices in the stock market of Bangladesh, it can be concluded that the Bangladesh stock market is not efficient in semi-strong form.

This research assesses the volatility characteristics of stock returns using daily closing stock price returns named DSI returns over a span of 20 years from 02 January 1993 to 27 January 2013 with a total of 4823 daily return observations. A symmetric MA(1)-GARCH(1,1) model and an asymmetric MA(1)-EGARCH(1,1) model suggest the following results.

- The ADF and PP test results expose that the null hypothesis of unit root is strongly rejected at 1% significance level. It specifies that the return series is stationary in level. Positive excess kurtosis of 257.593 of DSI return series indicates that distribution is leptokurtic that is a well-known stylized fact in the finance literature. The p-value associated with Jarque-Bera statistics show that the daily distribution of stock market returns is not normally distributed.
- Volatility clustering is another well-known stylized fact that is also viewed in DSI return series. This volatility clustering nature of DSI returns is confirmed employing the autocorrelation test that shows that there is highly significant autocorrelation for all lags from lag 1 up to lags 30 at the 1% level of significance on the basis of the Ljung -Box Q statistics. This is seen as evidence for the presence of ARCH effect or volatility clustering. Given that the DSI returns are correlated and not normally distributed, we go along with GARCH process to model our time series.
- An appropriate mean equation sets up as MA(1) from 36 combinations of Autoregressive Moving Average (ARMA) using Box Jenkins methodology. Additionally, MA (1) model produces residuals and squared residuals that are free from serial correlation. The ARCH-LM test presents that the estimated residuals exhibit autoresgressive heterskedasticity (ARCH effect). Thus, we proceed a symmetric MA(1)-GARCH(1,1) model and an asymmetric MA(1)-

EGARCH(1,1) model to estimate the level of volatility prevailing in the Bangladesh stock market.

- Results of the estimated MA(1)-GARCH(1,1) model reveal that coefficient of MA(1) in the mean equation is significant at 1% significance level and more importantly, the parameters in the variance equation (ω, α and β) hold the expected positive signs and are significant at 1% level. Results also uncover that the stock market of Bangladesh captures volatility clustering. The sum of the ARCH and GARCH coefficients is less than one, i.e., $\alpha + \beta = 0.60$, and not very close to one means that the volatility of Bangladesh stock market is moderately persistent. Results of the model show that α is lower than β, which implies that the volatility of the stock market is affected by past volatility more than by related news from the past period.
- Results of the estimated MA(1)-EGARCH(1,1) model show that all the parameters of the mean and variance equations are highly significant at 1% level that is a strong indication for leverage effect. The model also explores that the asymmetry term γ is negative and highly significant meaning that negative shock has a greater impact on volatility rather than the positive shocks of the same magnitude. This implies that the volatility spillover mechanism is asymmetric in Bangladesh stock market.

We conduct six GARCH-S(1,1) models with the purpose of estimating the volatility of the macroeconomic variables on stock returns volatility in Bangladesh using monthly data of the variables from January 2001 to December 2012. The extended version of GARCH-M model named, GARCH-S model has the ability to examine the impact of individual macroeconomic variable on the stock market returns volatility. Six GARCH-S (1,1) models suggest the following results.

- The results of six GARCH-S models indicate that including one exogenous macroeconomic variable such as , ΔIPI or ΔOP or ΔSENSEX in the variance equation produces significant ARCH and GARCH parameters, while including ΔER produces only significant GARCH parameter. Although, the sum of α and β is less than one in all of the models, the time-varying volatility of the DSE returns is highly persistent including ΔIPI or ΔOP in the variance equation.
- Regarding the impact of economic news, the λ associated with ΔIPI or ΔCMR or ΔOP does not explain the volatility of the Bangladesh stock market. Hence, the growth of industrial production index (ΔIPI), changes in the interest rate (ΔCMR) and crude oil price (ΔOP) have no significant impact on the volatility of the stock market returns.
- There is a significant positive relationship between changes in exchange rate (ΔER) and the volatility of DSE returns. This result indicates that the volatility of the Bangladesh stock market returns is expected to increase by 21% with an increase in the exchange rate of 1%.
- Results also reveal that there is a significant negative relationship between the growth of the broad money supply (ΔM2) and the volatility of Dhaka stock exchange returns. This implies that the volatility of the Bangladesh stock market returns is expected to decrease by 20% with an increase in the broad money supply of 1%.
- Finally, we find that there is significant negative relationship between the volatility of Indian stock market (ΔSENSEX) and the volatility of Dhaka stock exchange returns indicating that the volatility of the Bangladesh stock market returns is expected to dampen down by 3% by an increase in the volatility of Indian stock market of 1%. Thus, the volatility spillover effect appears between Indian and Bangladesh stock market.

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