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An Empirical Analysis of the Relationship between Macroeconomic Variables and Stock Prices in Bangladesh

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Establishing the relationship between stock prices and macroeconomic variables is very important for formulating current economic stabilisation policies. This paper investigates the causal relationship between four macroeconomic variables and Dhaka Stock Exchange (DSE) stock prices using cointegration and Granger causality test. The results suggest that cointegration exists between stock prices with each of the variables: M1, M2 and inflation rate, indicating a long-run relationship exists between them. We find evidence that unidirectional causality exists from stock market to exchange rate and M1 in the short run. From bivariate Error-Correction models we also find that long run causality exists from M1, M2 to stock market and from stock market to inflation rate. These results are further strengthened when we expand the analysis for multivariate settings. Here, we also note some evidence that M2 Granger-cause stock price and the three macroeconomic variables. These results strongly suggest informational inefficiency in DSE market.

I. INTRODUCTION

We are interested in investigating the relationship between stock prices and macroeconomic variables because individual investors can earn abnormal profits by exploiting this relationship and the existence of this utilizable opportunity would then dangerously distort the market's ability to proficiently allocate scarce resources. In other word, the stock market will lose its informational efficiency. Informational efficiency is defined as at any given time, stock prices fully reflect all available information of the market. Thus, no investor has an advantage in predicting a return on a stock price because no one has access to information not already available to everyone else. Identifying the relationship or informational

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efficiency thus can be used to correct the current economic stabilisation policies. Therefore, the issue of whether stock prices and macroeconomic variables are related or not has received considerable attention. This paper provides empirical evidence of the relationship between DSE stock prices with each of the macroeconomic variables: exchange rate, inflation rate and two money supply variables namely M1 and M2 using Cointegration, Granger-Causality test and Error Correction Model.

The paper is organised as follows: section II provides available literature on similar studies while section III discusses empirical methodology and data. Empirical results are presented in section IV. Finally, in section V concluding remarks are made.

II. LITERATURE REVIEW

Many studies are done around the world to investigate the causal relationship between stock market and different macroeconomic variables. Bahmani-Oskooee and Sohrabian (1992) used monthly values of S&P 500 index and US dollar effective exchange rate for the period of 1973-88 and used cointegration and the Granger causality test to detect the relationship between the variables. They found bidirectional causality in the short run but no long-run relationship between the variables. Habibullah and Baharumshah (1996a) applied residual-based cointegration tests for the Malaysian market and found no evidence for cointegration between various stock indices, the money supply and output using money supply and output using monthly data that span from January 1978 to September 1992. Based on these findings, they conclude that the Malaysian stock market is informationally efficient with respect to output and money supply. In another study, however, they found evidence of informational inefficiency in the Property Index with respect to money supply when an alternative test based on a restricted error-correction model is used (Habibullah and Baharumshah 1996b). Similarly, examining the relationship between money supply changes and stock prices in emerging markets using bivariate Granger causality tests, Cornelius (1993) documents evidence against the informational-efficiency hypothesis in the Malaysian market.

A few studies are done in Bangladesh so far to explore the causal link between stock prices and macroeconomic variables. Rahman and Uddin (2009) considered exchange rates of US dollar in terms of Bangladeshi Taka, Indian Rupee and Pakistani Rupee and monthly values of Dhaka Stock Exchange General Index, Bombay Stock Exchange Index and Karachi Stock Exchange for the period January 2003 to June 2008. Result showed that there is no cointegrating relationship between stock prices and exchange rates. Moreover, Granger causality showed there is no way causal relationship between stock prices and exchange rates in the countries. Later, Ali (2011a) investigated the long-run equilibrium relationship as well as causal relationships between the DSE all share price index (DSI) and the four microeconomic variables (i.e. market dividend yield, market price-earnings multiples, monthly average market capitalisation and monthly average trading volume) using monthly data from January 2000 to December 2010. Important findings include long-run equilibrium relationship among the variables under study. DSI has bi-directional causal relation with market price earnings multiples and the first leg of the monthly average trading volume and unidirectional causality to the first lag of monthly average market capitalisation. In the same year, he investigates the impact of changes in selected microeconomic and macroeconomic variables on stock returns at Dhaka Stock Exchange using data from July 2002 to December, 2009 (Ali 2011b). A Multivariate Regression Model computed on Standard OLS Formula has been used to estimate the relationship. They found that inflation and foreign remittance have negative influence and industrial production index, market P/Es and monthly percent average growth in market capitalisation have positive influence on stock returns. No unidirectional Granger Causality was found between stock prices and all the predictor variables under study except one unidirectional causal relation from stock price to market P/Es.

In our study, we use four macroeconomic variables: the exchange rates, M1, M2, and inflation rates. These variables are normally included in the analysis of a small open economy. We examined both long-run equilibrium and short-run dynamics using cointegration and Granger causality tests. The analysis, thus, provides broader perspectives on the dynamic interactions between the stock market and the macroeconomic variables. It enables us to evaluate the reactions of stock returns to changes in macroeconomic variables (i.e. short-run dynamics) and, additionally, to deviations from the long-run equilibrium relationship when the variables are cointegrated (i.e. long-run adjustments). Moreover, in cointegration tests, we apply good econometric practice by using both a residual-based test of Engle and Granger (1987) and a VAR-based test of Johansen (1988) and Johansen and Juselius (1990). We also extended these analyses to the multivariate setting to check the robustness of the bivariate outcomes.

III. DATA AND METHODOLOGY

This analysis is conducted using monthly data series for the period July 2003 to October 2011. To measure stock prices (SP), we use end-of-the-month values of the DSE general index. We considered the exchange rate (EXC) of Bangladeshi Taka against per US Dollar. The money supply variables are M1 and M2 where M1 comprises total notes and coin in circulation and Deposit Money Banks (DMBs) demand deposits and M2 is defined as total money supply (M1) and Time Deposits with DMBs. We have used the point to point inflation rate (INF) in our study measured by Consumer Price Index (CPI), base 1995-96. Stock prices and exchange rate are collected from the DSE Monthly Reviews. Other variables are collected from the Economic Trend published by Bangladesh Bank, the central bank of Bangladesh. All data are expressed in logarithmic forms.

The methodology employed in this study is based on Granger causality tests. As standard Granger tests are improper when the variables are non-stationary and cointegrated, a priori test of integration and cointegration is assigned. These tests will direct us for proper specification of Granger causality models. If all variables under concern are *I(1)* and not cointegrated, we apply the Granger tests using the first differences of the variables. On the other hand, if these variables are cointegrated, an error-correction model (ECM) should be used. The ECM handily combines the short-run dynamics and long-run equilibrium adjustments of the variables.

The abovementioned succinct discussion suggests some essential steps in our analysis. Firstly, we need to establish the order of integration of the variables. A variable is said to be integrated of order *d*, written *I*(*d*), if it is stationary after differencing *d* times. Namely, variable that is integrated of order greater than or equal to *1* is non-stationary. In our analysis, we use standard augmented Dickey-Fuller (ADF) (1979, 1981) and Phillips-Perron (PP) (1988) unit root tests for testing the order of integration. The ADF test is based on the following regression:

$$\Delta x_t = \alpha + \beta t + \rho x_{t-1} + \sum_{i=1}^{k} \varphi_i \Delta x_{t-i} + \varepsilon_t \tag{1}$$

where x is the variable under consideration and t is a trend term. Testing for unit roots examines whether the estimated value for ρ is significantly less than 0. If the result rejects the null hypothesis that $\rho = 0$, then the series is stationary. The PP test for unit roots is carried in an analogous style using regression (1) without the lagged first differenced terms.

Establishing the order of integration, we progress to the next step to appraise the cointegration properties of the data. The cointegration of the time series suggests the presence of a long-run relationship that constrains their movements. So as to say, being non-stationary individually, the variables cannot flow farther away from each other at random. But there is a requirement for cointegration, the variables are needed to be integrated of the same order and thus their linear combination becomes stationary. For testing the cointegration, we make use of two of the mainly used tests–the residual-based test of Engle and Granger (1987) and the maximum likelihood approach of Johansen (1988) and Johansen and Juselius (1990).

The Engle–Granger (EG) test is a two-step procedure: an OLS estimation of a specified cointegrating regression to get the residuals and a unit root test of the residuals. The null hypothesis is no cointegration, which is rejected if the unit root statistics falls below some critical values. The Johansen–Juselius (JJ) approach to cointegration is a VAR-based test. In particular, Johansen (1988) and Johansen and Juselius (1990) developed two test statistics–the trace test and the maximal eigen value test–to find out the number of cointegrating vectors. These statistics are based on a canonical correlation analysis of residuals from two vector auto regressions: (i) Δx_t on $\Delta x_{t-1}, \ldots, \Delta x_{t-p+1}$ and (ii) x_t on $\Delta x_{t-1}, \ldots, \Delta x_{t-p+1}$. *X* is a vector of the variables considered and *p* is the order of autoregression. According to Cheung and Lai (1993), the JJ test also has a significant power advantage over the EG test.

Lastly, we specify the dynamic interactions of the variables based on the Granger causality models. Specifically, according to Granger's representation theorem, the relations between cointegrated series should be modeled using an error-correction model (ECM). Thus, the dynamic causal link from a macroeconomic variable (*m*) to the stock prices (*p*) can be modeled as:

$$\Delta p_t = \alpha_1 + \sum_{i=1}^{r} \beta_{1i} \Delta p_{t-i} + \sum_{i=1}^{s} \varphi_{1i} \Delta m_{t-i} + \gamma_1 EC_{t-1} + v_{1t} \tag{2}$$

where *EC* is the error correction term obtained from the cointegrating regression or the linear long-run relationship of the variables.

With this arrangement, the changes in the stock prices will not only depend on the changes in the macroeconomic variable but also on the long-run relationship between them. The later measures any previous disequilibrium by the error correction term *EC*, to apply possible influences on the movement of the stock prices. According to Toda and Phillips (1994), the former and the later may be termed as 'short run causality' and 'long-run causality'. Therefore, the stock prices can be informationally inefficient in either the short run or the long run or both.

We can also get the reverse causation from the stock prices to the macroeconomic variables of interest by reversing the roles of the two variables in Equation (2). From these tests, one of the following four patterns of causality can be noted: (1) unidirectional causality from *m* to *p*; (2) unidirectional causality from *p* to *m*; (3) bidirectional causality; and (4) no causality.

IV. RESULTS AND DISCUSSION

Properties of the Data

Table I reports the results of the ADF and PP tests. Panel A of the table presents the results for the log levels of the data series, while panel B reports the results for their first differences.

The results from panel A constantly suggest that all time series considered contain unit roots. We fail to reject the null hypothesis of a unit root even at the 10% significance level in all cases except two. The exceptions are for M1 and inflation rate using the PP test. From panel B, the null hypothesis for a second unit root is rejected in all cases. In particular, the evidence from the tests strongly supports the stationarity of the variables when they are first differenced. Thus, the evidence seems consistent to suggest the stationarity of the first-differenced series. In other words, these variables can be characterised as *I(1)* variables.

TABLE I
INTEGRATION TESTS

Variables	Test Value	P-value	Test value	P-value
A. Log levels				
SP	-2.372	0.42	-8.932	0.60
EXC	-1.508	0.78	-5.043	0.82
M1	-2.347	0.43	-36.728***	0.01
M2	-2.076	0.55	-13.725	0.32
INF	-2.387	0.42	-17.850*	0.09
B. First differences				
SP	-3.413*	0.06	-98.04***	0.01
EXC	-3.790**	0.02	-98.441***	0.01
M1	-6.086***	0.01	-128.329***	0.01
M2	-7.208***	0.01	-114.778***	0.01
INF	-4.776***	0.01	-94.308***	0.01

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

Bivariate Analysis

Concluding that each of the series is non-stationary, we advance to examine whether there exists a long-run equilibrium relationship between stock prices with each of the macroeconomic variable of interest.

Table II presents the results of both the EG and JJ tests for cointegration. As Hall (1991) cautions that the JJ test results may be sensitive to the order of autoregressions (i.e. *p*), we conducted the tests using alternative lag lengths 4, 6 and 8. For the cases where the results are identical across lag lengths, we report only those that set *p* = 6. The EG test indicates cointegration between stock prices with each of the money supply variable M1 and M2 at lag length 6 and 8. When we apply the JJ tests, we also find evidence of cointegration between SP and inflation rate at lag length 4. To be exact, we find evidence that a long run relationship runs between the stock market with M1, M2 and inflation rate. For these three cases, the results suggest a unique cointegrating vector. For the remaining variable--exchange rate, no evidence of a long-run relationship between exchange rate and stock prices is found. The presence of cointegration between the stock market on the one hand and M1, M2, inflation rate on the other hand rejects non-causality between them. In other words, at least one of the variables reacts to deviations from the long-run relationship.

After conducting the integration and cointegration tests, now we can correctly state a framework for assessing the relations between the stock prices and the macroeconomic variables. That is, for cointegrated cases, we implement regression (2). For non-cointegrated cases, the error correction term in Equation (2), *EC*, is omitted from the regression. We report the results for arbitrarily chosen lag lengths of 4 and 8 and for the lag lengths determined by the FPE criterion.

TABLE II
BIVARIATE COINTEGRATION TESTS

Variables	lag	EG test	Trace test r = 0	JJ Tests	
				Max Eigen test	
				r <=1	r =0
SP & EXC	6	-2.406	8.11	1.80	6.31
SP & M1	4	-2.356	6.98	0.05	6.93
	6	-3.282*	7.72	0.12	7.60
	8	-3.149*	10.42	0.02	10.40
SP &M2	4	-2.458	9.93	1.00	8.93
	6	-3.166*	15.37	3.15	12.21
	8	-3.375*	13.57	1.34	12.23
SP & INF	4	-1.894	15.95*	3.03	12.92*
	6	-1.866	12.99	2.31	10.69
	8	-2.026	13.34	2.59	10.75

Note: * denote significance at 10% level.

Table III reports the results of these bivariate causality tests. We identify some important points from the regressions. First, Unidirectional causality runs from stock market to exchange rate and M1. That is, stock price movements expect variations in exchange rate and M1. Again, the results indicate that changing the lags in macroeconomic variables have significant projecting ability on the movements in stock prices in one case where setting the leg length at 4 exhibits no causality between stock market and M1 but at leg length 8 it does. This is further strengthen when we select the leg length using FPE-based specification.

Furthermore, the coefficients of the error correction terms reinforce our findings of cointegration between stock prices and M1, M2 and inflation rate. They are significant in at least one equation. The results indicate evidence of long run causality from M1, M2 to the stock market and from stock market to inflation rate. The results suggest that deviations from the equilibrium path are adjusted by about 40% the next month through the movements in stock prices. Additionally, the error correction estimation for the INF equation also indicates gradual adjustments of this variable to disequilibrium.

TABLE III
CAUSALITY TEST

Null Hypothesis	Lag specification			
	4	8	FPE Criterion	ECM
Non cointegrated Series				
SP dnc EXC	3.533***	1.552	9.128***[1]	_
EXC dnc SP	1.162	0.886	0.408[1]	_
Cointegrated Series				
SP dnc M1	0.646	2.052**	1.837**[12]	-0.322***(-4.189)
M1 dnc SP	0.180	0.794	1.082[12]	-0.004(0.882)
SP dnc M2	0.698	1.602	1.204[12]	-0.404***(-5.361)
M2 dnc SP	0.389	1.074	1.093[12]	-0.010(-1.047)
SP dnc INF	1.140	1.151	1.347[1]	0.005(0.777)
INF dnc SP	1.313	0.905	0.602 [1]	0.032**(0.002)

Notes: 1. Entries under 'Lag Specification' are *F*-statistics for testing the null hypothesis that the coefficients' sums of causal variables are zero.

2. The numbers in squared brackets are the optimal lag lengths determined by the FPE criterion. The numbers in parentheses are *t*-ratios. dnc = does not Granger cause.

3. **, and *** denote significance at 5% and 1% levels respectively.

Multivariate Analysis

The bivariate results may be counterfeit due to the possibility that relevant variables are being omitted from the regressions (Lutkepohl 1982). Therefore, to appraise the robustness of our previous bivariate results, this section extends the analysis to multivariate settings. The analysis proceeds in a similar manner to the bivariate analysis.

For cointegration tests, we conduct only the JJ procedure. The results are reported in Table IV for the multivariate model. Again, we conduct the tests using alternative lag lengths as suggested by Hall (1991). We only report the results for $p = 8$. As the table indicates, the null hypothesis of non-cointegration between the variables is rejected in at conventional significance levels. The null hypothesis of at most three cointegrating vectors cannot be rejected. Thus, the tests suggest three cointegrating vectors that constrain the long-run movements of the variables considered.

TABLE IV
MULTIVARIATE COINTEGRATION TESTS

Statistics	$r = 0$	$r <= 1$	$r <= 2$	$r <=3$	r<=4
SP,EXC,M1,M2,INF					
Trace	77.31**	52.67**	28.95*	15.47	4.70
Max. Eigen.	24.63	23.72	13.47	10.78	4.70

Notes: 1. The lag length is set to 8.
2. ** and * denote significance at 5% and 10% respectively.

To assess the informational efficiency of the DSE market in multivariate settings, we test the causality using error-correction modelling for all the variables. Like the bivariate cases, we employ the FPE criterion to determine the optimum lag length where the maximum lag length is set to 12. The suggested lag length by FPE criterion is 1.

TABLE V
MULTIVARIATE CAUSALITY TEST

		ECT1	*ECT*	
			ECT2	*ECT3*
SP dnc EXC,INF,M1,M2	3.81***	-0.09(-1.585)	-0.37(-1.340)	0.04(-1.585)
EXC dnc SP, INF,M1,M2	0.34	-0.01(-1.231)	-0.05(-1.265)	0.01(0.720)
INF dnc SP, EXC,M1,M2	1.03	0.11(0.235)	0.60(1.285)	-0.31***(-3.96)
M1 dnc SP, EXC, INF,M2	1.75	0.05**(2.748)	0.29**(2.963)	0.02(0.255)
M2 dnc SP, EXC, INF,M1	1.99*	0.02*(2.038)	0.08*(2.115)	0.01(0.857)

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

The results for multivariate Granger causality test are reported in Table V. This analysis is done as a robustness check of our previous bivariate evidence against market efficiency. The results strengthen our previous findings from bivariate analyses. Consistently with bivariate cases, the changes in stock prices Granger-cause changes in the EXC, INF, M1 and M2. The multivariate analysis offers additional evidence indicating that the changes in M2 also Granger-cause changes in the SP, EXC, INF and M1 in the short run. Two of the three error correction terms are significant in most of the cases, indicating the presence of two cointegrating vectors that constraint the movement of the response variable. That is, the proportion by which the response variable was responding to the short-term deviations from its long term equilibrium relationship is significant.

V. CONCLUSION

The paper investigates the relationship between stock prices and four macroeconomic variables for Bangladesh. The analysis has important implications for the economic policymakers of the country. The results suggest that the DSE stock market of Bangladesh is not informationally efficient with respect to M1, M2 and inflation rate. Specifically, it indicates that the stock prices respond to deviations from the long-run equilibrium path traced between the stock market and the three macroeconomic variables. Additionally, there seems to be a dynamic causal link from the stock price to exchange rate changes. From the analysis, we also note that stock prices can act as an informational variable for the movements of exchange rate. Extending the analysis to multivariate settings further supports the findings of the adjustment of the stock market toward the long-run equilibrium level. The multivariate analysis also shows significant causal role of M2 in the short run. Thus, the hypothesis of informational efficiency in the case of the DSE market of Bangladesh is not supported in our analysis.

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