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Macroeconomic variables and Dhaka stock exchange returns: An application of autoregressive distributed lag bounds testing approach

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This empirical study attempts to investigate the fundamental connection between selected macroeconomic indicators, such as exchange rate (ER), industrial production index (IPI), broad money supply (M2) & call money rate (CMR) and stock index returns (IR) in Bangladesh. The monthly data from January, 2008 to April, 2017 are considered for this research. The Autoregressive Distributive Lag (ARDL) bounds testing approach has been applied to explore this dynamic relationship. The result confirms the presence of a long-run relationship among the selected variables. The value of the error correction term indicates that around 67% of the disequilibrium in stock returns is adjusted monthly to get back to the long-run equilibrium. IPI and M2 are positively related to index returns whereas ER and CMR affect index returns negatively. The coefficients of M2 and CMR are statistically significant whereas that of ER and IPI are not. The results of Granger causality show that a unidirectional causality runs from ER to IR, CMR to IR, ER to IPI, and CMR to ER whereas a bidirectional causality between IPI and M2 has been found. This research is of great significance for domestic and foreign stakeholders, especially for policy-makers who can incorporate these findings in their effort to formulate and implement policies.

Keywords: Dhaka Stock Exchange, Bangladesh, macroeconomic indicators, ARDL bounds test, causality

JEL classification: N2, E2, O16

1. Introduction

The South Asian capital markets have turned out to be more attractive investment opportunities for both foreign and domestic investors due to

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the robust economic growth in this region. Bangladesh is also getting the benefit of this favorable outlook of investors that has resulted in high return on equity and profit margins for top companies in Bangladesh compared to that in other countries of the South Asian Association for Regional Cooperation (SAARC) (Aiyer, 2016). This pleasing outlook of investors is essential for stock markets in the SAARC countries to be more vibrant and efficient. A well-organized and efficient stock market acts as an economic indicator that portrays overall condition existing in an economy. Being one of the most critical elements of a developing economy, it leads the way of economic development of a country.

Bangladesh has recently been progressed from 'Least Developed Country' to 'Developing Country' status by the United Nations (UN). In addition to that, the government of Bangladesh is trying to gain the status of 'Developed country' by 2041. In order to do so, the government needs to implement various infrastructure and development projects. Since attracting private investments is a must for financing these projects, there is no alternative to a vibrant and well-functioning stock market which Bangladesh is lacking at the moment. Bangladesh's capital market accounted for only 14.5% of its nominal GDP (CEIC Data, 2019) and hence macroeconomic aspect of the capital market needs to be monitored extensively for improving this scenario.

According to Tiwari et al. (2015), stock market return is one of the most important indicators of a country's economic growth. The dynamic relationship between stock prices and economic condition of a country has been explored by several researchers (Maysami et al., 2004; Beltratti and Morana, 2006; Enisan and Olufisayo, 2009; Vähämaa, 2009; Zhao, 2010; Pradhan et al., 2014; Tiwari et al., 2015; Peiró, 2016; Azam et al., 2016). Moreover, there is an ongoing debate in finance regarding the potential of well performing financial markets to boost the economic growth of a country. The findings suggest a positive interaction between the performance of the stock exchanges and the overall economy (Enisan and Olufisayo, 2009; Azam et al., 2016).

Various economic and financial theories, such as arbitrage pricing theory (APT), capital asset pricing model (CAPM), quantity theory of money, and efficient market hypothesis (EMH) have been used to examine these findings (Cooper, 1974; Türsoy et al., 2008; Singhania and Prakash, 2014; Ouma and Muriu, 2014). Many previous studies have converged their attention on identifying the effect of macroeconomic indicators on stock returns (Beltratti and Morana, 2006; Tsouma, 2009; Attari and Safdar, 2013). A long-term interaction between stock indices and corresponding macroeconomic factors has been corroborated by the findings in recent studies (Pradhan et al., 2014; Tiwari et al., 2015; Peiró 2016; Azam et al., 2016).

Abugri (2008) found that emerging stock market returns are likely to show higher volatility than returns in more developed markets. But whether there remains any nexus between the volatility of an emerging market's stock indices and relevant key macroeconomic variables still needs more concrete evidence. Most of the studies dealing with the capital market of Bangladesh have shed light only on the issues, such as the stock market development (Ahmad et al., 2012; Hossain and Kamal, 2010) and the efficiency of the capital market (Hassan and Chowdhury, 2008; Mobarek et al., 2008; Hassan et al., 2000). In addition to this, existing empirical studies (Banerjee and Adhikary, 2009; Rahman and Uddin, 2009; Hasan and Zaman, 2017) regarding the interaction between stock returns and macroeconomic indicators from the perspective of Bangladesh show somewhat mixed results.

Banerjee and Adhikary (2009) found a long-run association between the macroeconomic factors and stock returns in Bangladesh. On the contrary, Rahman and Uddin (2009) showed that there is no long-run interaction between stock prices and exchange rates in India, Bangladesh and Pakistan. These opposing results confirm that there is no consensus regarding the relationship between macroeconomic variables and stock index returns in Bangladesh. Moreover, empirical studies focusing on this dynamic relationship in Bangladesh is relatively scared in the context of developing countries. Given this backdrop, this paper attempts to fill up this research gap from the perspective of a developing country like Bangladesh which has recently gained the status of a developing country and is striving to be a developed country by 2041. This research paper will contribute to its effort of achieving the status by improving the condition of the stock market through proper implementation of the research findings by the policy makers.

More specifically, the objective of this study is to find out the impact of macroeconomic indicators (ER, IPI, M2, and CMR) on the stock returns of the largest stock exchange in Bangladesh namely, the Dhaka Stock

Exchange (DSE) Ltd. over the period of last 10 years (2008-2017). These macroeconomic policy variables are perceived to be linked with index returns as they are the fundamental sources of volatility in a stock market. The Autoregressive Distributed Lag (ARDL) bounds testing approach has been applied in the study. This ARDL model, established by Pesaran et al. (2001), is one of the contemporary models used to analyze time series data. Although the model has proved itself a valuable vehicle for exploring the existence of long-run interactions among various macroeconomic variables with different orders of integration, it hasn't been applied in any of the known existing studies regarding the impact of macroeconomic factors on stock returns in Bangladesh. So, the findings of this paper are of great significance for various entities such as domestic and foreign investors, policy-makers, corporation, government, and other neighbouring financial market players. This study aims to help policy-makers formulate a plan of action in order to strengthen the stock market in one hand and purports to enable both domestic and foreign investors in making appropriate and time demanding investment decisions on the other hand.

The remaining parts of the paper are structured as follows: Section 2 reviews the literature. Section 3 provides a brief overview of the economy of Bangladesh and Dhaka Stock Exchange (DSE) Ltd. Section 4 defines the selected variables along with data sources. Section 5 illustrates the research methodology. The empirical analysis is presented in section 6. The last section provides a synopsis including the policy implications of the findings.

2. Literature Review

The interaction between macroeconomic variables and stock market indices has been explored extensively from the perspective of developed countries in recent years (Beltratti and Morana, 2006; Tsouma, 2009; Peiró, 2016). Some studies are also conducted to investigate this relationship in developing countries (Rahman et al., 2009; Attari and Safdar, 2013; Enisan and Olufisayo, 2009). But a consensus is yet to be reached on this dynamic relationship between stock indices and macroeconomic indicators. A good number of time series models have been used to examine this association. Some studies (Tsouma, 2009; Abugri, 2008; Mukherjee and Naka, 1995; Maysami et al., 2004; Rahman et al., 2009) applied the vector autoregression (VAR) model and the vector error correction model (VECM) while the generalized autoregressive conditional heteroskedasticity (GARCH) model and the ARDL model were also used in other studies (Zhao, 2010; Attari and Safdar, 2013; Enisan and Olufisayo, 2009; Lin, 2012; Azam et al., 2016).

Tsouma (2009) confirmed an interaction between economic activity and stock market returns in emerging and mature markets by applying a bivariate VAR model and Granger causality test although the findings differed between emerging and mature countries. Abugri (2008) also used a VAR model to show the effect of key macroeconomic factors (industrial production, interest rate, money supply, and exchange rates) on market returns at varying degrees in four Latin American countries. A conditional-VAR model and a Granger causality test were applied by Tiwari et al. (2015) to show that there existed a long-run unidirectional causality from stock returns to industrial production indicating stock prices were a leading indicator for economic growth in India. Hondroyiannis and Papapetrou (2001) suggested that changes in the macroeconomic activity and the foreign stock exchanges explained to some extent the changess in the domestic stock market of Greece by using a VAR model.

Pradhan et al. (2014) detected the existence of both unidirectional and bidirectional causality between banking sector development, economic growth, stock market development, and other four macroeconomic factors in ASEAN countries by using a panel VAR model. With the help of a similar model, Pradhan et al. (2015) showed that there was a robust long-run relationship among stock market depth, economic growth, oil prices, exchange rate, interest rate, and inflation rate in the G-20 countries. Maysami et al. (2004) demonstrated that stock index had a cointegrating relationship with industrial production, price levels, interest rate, exchange rate, and money supply in Singapore by applying the VECM. Rahman et al. (2009) also used the VECM to show that the selected macroeconomic variables (IPI, M2, ER, currency reserves, and treasury bills) had a substantial long-run impact on the stock market in Malaysia. Mukherjee and Naka (1995) revealed that the stock market in Japan was cointegrated with macroeconomic indicators by applying a similar model.

Wongbangpo and Sharma (2002) found both long-term and short-term relationships between key macroeconomic factors (interest rate, consumer price index, money supply, gross national product & exchange rate) and stock indices in Thailand, Malaysia, Philippines, Indonesia, and Singapore. Hasan and Zaman (2017) examined the impact of the volatility of macroeconomic factors (oil price, exchange rate, call money rate, and the SENSEX of Bombay stock exchange) on the volatility of stock returns in DSE with the help of a GARCH model. The results revealed that exchange rate and SENSEX returns had a statistically significant effect on the volatility of DSE. Attari and Safdar (2013) applied the EGARCH model to confirm the substantial impact of macroeconomic variables (interest rate, inflation, & GDP) on the stock returns in Pakistan. Zhao (2010) applied VAR and GARCH models to examine the interaction between exchange rate and Chinese stock returns. The study found no stable long-term relationship between these two variables.

Enisan and Olufisayo (2009) explored the long-run and causal interaction between stock indices and economic growth by applying the ARDL model for seven countries (Egypt, South Africa, Morocco, Côte d'Ivoire, Kenya, Zimbabwe, and Nigeria) in sub-Saharan Africa. The findings showed that the development of stock market had a significant positive long-run impact on economic growth. Lin (2012) confirmed the presence of a co-movement between exchange rates and stock indices in Asian emerging markets by using the ARDL model. Azam et al. (2016) also employed the ARDL bounds testing approach to show the existence of a long-run relationship among economic growth, inflation, stock market development, and foreign direct investment (FDI) in Bangladesh, India, China, and Singapore. In Malaysia, the presence of cointegration between the macroeconomic indicators and stock returns is supported by Bekhet and Mugableh (2012) who also used the Pesaran et al. (2001) bounds testing approach.

Beltratti and Morana (2006) showed the presence of a stronger form of causality from macroeconomic variables (federal funds rate, M1, inflation & output) to stock market volatility using S&P 500 data. Peiró (2016) demonstrated that long-term interest rates and industrial production were significant variables causing the movements in stock prices of the three largest European economies (Germany, France, and the United Kingdom). While exploring the quarterly stock returns of 40 economies (21 developed and 19 developing) over the period of 1999-2013, Assefa et al. (2017) found statistically significant negative impact of interest rates on stock returns in the developed countries although there was no impact of interest rates on stock prices in the developing countries. Table 01 presents the summary of the studies dealing with the dynamic interactions between various macroeconomic indicators and stock returns.

Table 01: Synopsis of the studies showing interactions between macroeconomic variables and stock indices

Study	Countries under study	Method	Period
Tsouma (2009)	19 emerging & 22 mature	VAR	1991-2006
Abugri (2008)	04 Latin American	VAR	1986-2001
Tiwari et al. (2015)	India	VAR	1993-2011
Hondroyiannis & Papapetrou (2001)	Greece	VAR	1984-1999
Pradhan et al. (2014)	ASEAN	Panel VAR	1961-2012
Pradhan et al. (2015)	G-20	Panel VAR	1961-2012
Maysami et al. (2004)	Singapore	VECM	1989-2001
Rahman et al. (2009)	Malaysia	VECM	1986-2008
Mukherjee & Naka (1995)	Japan	VECM	1991-1990
Wongbangpo & Sharma (2002)	05 ASEAN	VECM	1985-1996
Hasan & Zaman (2017)	Bangladesh	GARCH	2001-2015
Attari & Safdar (2013)	Pakistan	EGARCH	1991-2012
Zhao (2010)	China	GARCH	1991-2009
Enisan & Olufisayo (2009)	07 sub-Saharan	ARDL	1980-2004
Lin (2012)	06 Asian emerging	ARDL	1986-2010
Azam et al. (2016)	04 Asian	ARDL	1991-2012
Bekhet & Mugableh (2012)	Malaysia	ARDL	1977-2011
Beltratti & Morana (2006)	USA	Fractional cointegration	1970-2001
Peiró (2016)	03 largest European	Regression	1969-2013
Assefa et al. (2017)	21 developed & 19 developing	Dynamic panel data	1999-2013

After reviewing the empirical studies posited above, it is evident that exchange rate, industrial production index, broad money supply, and call money rate have varying degrees of impact on stock indices in many developed and developing countries. But this type of empirical study has not received that much attention in Bangladesh till date. As a result, the policy-makers of Bangladesh are yet to have a straightforward answer to whether the selected four variables have any defining impact on the stock market returns. With a view to providing a conclusive answer, this research paper attempts to investigate the relationship between those macroeconomic variables and DSE returns with the help of an appropriate econometric model. Moreover, these variables are not considered as a whole though they have been used in various research papers individually. This paper also contributes to the burgeoning literature on issues related to industrial production index (IPI) of an emerging economy like Bangladesh which has recently registered the fastest growth rate among the Asia-Pacific economies (Dhaka Tribune, 2019). The research question is about exploring the long run relationship among the selected five macroeconomic variables in order to help policymakers formulate policies that will make DSE more efficient and strengthening DSE is one of the prerequisites for Bangladesh to get included in the list of developed nations.

3. Economy of Bangladesh and Dhaka Stock Exchange Ltd.

Bangladesh is one of the Next Eleven (N-11) countries which have the potential of significant economic growth in the 21st century (O'Neill et al., 2005). According to a report (The World in 2050: How will the global economic order change?) published by PricewaterhouseCoopers (PwC) in February 2017, Bangladesh stands in the 31st position in terms of the size of the economy with a GDP of USD 628 billion at purchasing power parity (PPP) in 2016. The economy of Bangladesh grew by 7.1% in 2016 which is the fastest expansion in 30 years (Asian Development Bank, 2017). The PwC report of 2017 projected that Bangladesh along with Vietnam and India could be the three of the world's fastest growing economy by 2050 with an annual average growth rate of 5%. According to the report, Bangladesh has the potential to move from the 31st to 23rd position by 2050 in terms of GDP (at PPP).

But in order to achieve this goal, improving macroeconomic stability, along with efficient capital investment options, is a must. In addition to this, political stability should be maintained for the economy to flourish at its full capacity. But the recent past of political turmoil in Bangladesh is offering little hope. In 2014 and 2015 combined, political violence cost Bangladesh USD 2.20 billion which is equivalent to 1% of GDP (New Age, 2016). Although political scenario was stable during the last two years, terrorist attacks by the Islamist militias made the situation worse. Despite this political turmoil and terrorist attacks, the economy of Bangladesh managed to put up an outstanding performance.

Monthly industrial production index (IPI) over the period of 2013-2016 indicated an upward trend although there are some ups and downs. On the other hand, the exchange rate of BDT against USD over the same period also showed some mixed pictures. There were some stable periods along with some periods of appreciation and depreciation. The monthly movement of two DSE indices (DGEN and DSEX) over the period of 2008-2016 demonstrated a steady upward trend. However, during earlier 2011 another stock market crash hit DSE in less than two decades that left thousands of ill-fated investors losing their money. The market capitalization also showed an upward trend over the same period. As of September 2017, the number of securities listed with the DSE is 564 and total market capitalization of DSE is around USD 51 billion (Dhaka Stock Exchange Ltd., 2017). It is also evident that after the market collapse in 2011, it took nearly two and a half years for DSE to recuperate and get back the momentum by restoring the investors' fragile confidence. However, during 2015 the market again started to show a bearish trend due to political unrest. In 2016, the market got back its bullish position due to the courtesy of political stability.

This scenario reflects the importance of political stability for a stock market to perform at its optimum level. Moreover, the government also has a capital market master plan (2012-2022) in effect to make DSE more efficient and less vulnerable to share market scams like the one in 2011. The government must try its best to implement the plan and pursue other contemporary strategies so that DSE can become one of the best performing stock markets in South Asia. Moreover, ensuring efficiency of stock markets is crucial for achieving the goal of economic development projected by the government of Bangladesh.

4. Variable Selection and Data Collection

Monthly time series data ranging from January, 2008 to April, 2017 have been used in this study. The data of stock indices have been extracted from the DSE website whereas that of ER, M2, and CMR have been collected from the website of Bangladesh Bank (BB) – the central bank of Bangladesh. The websites of both BB and Bangladesh Bureau of Statistics (BBS) have been used to gather the data of IPI. EViews (version 10) has been used in this research paper for the econometric analysis.

Table 02: List of selected macroeconomic variables

Variable	Definition
Index Returns (IR)	It refers to the monthly return of DSE general/broad index (DGEN and DSEX) which indicates the overall performance of the stock exchange.
Exchange Rate (ER)	ER represents the exchange rate of Bangladeshi Taka (BDT) in terms of US dollar (USD/BDT).
Growth of Industrial Production Index (IPI)	IPI refers to the monthly growth rate of industrial production index. Industrial production index is considered as a proxy to GDP.
Growth of Broad Money Supply (M2)	M2 is the monthly growth rate of broad money available in the economy. Broad money is a monetary aggregate which includes narrow money available in the economy plus time deposits.
Call Money Rate (CMR)	It represents the interest rate at which short term funds are borrowed and lent in the money market. CMR has been used as substitute for interest rate because it is highly correlated with the changes in the monetary base.

As the existing literature suggests, the macroeconomic variables (ER, IPI, M2, and CMR) under consideration affect stock returns extensively. However, most of the studies are based on developed countries. Given this backdrop, these variables are considered as a whole from the perspective of a developing country like Bangladesh which has set the aim of becoming a developed country by 2041. It is assumed that the relationship between ER and IR is negative (Mukherjee and Naka, 1995). When BDT depreciates against USD, Bangladeshi products become cheaper in the United States. This will cause higher BDT-dominated cash flows to Bangladeshi companies given that the demand of Bangladeshi goods are elastic. The opposite would happen when BDT appreciates against USD.

On the other hand, it is presumed that the interaction between IPI and IR is positive, as is evidenced in previous studies (Peiró, 2016; Maysami et al., 2004; Abugri, 2008). A rise in GDP will enhance a firm's ability to generate more cash flow. This will increase the demand of the stock resulting in the upward movement of the stock indices. It is conjectured that there is a positive interaction between M2 and IR due to excess liquidity (Wongbangpo and Sharma, 2002; Maysami et al., 2004).

A negative relationship between CMR and IR is hypothesized (Hasan and Zaman, 2017). There are basically two reasons behind this negative connection. Firstly, the amount of money an investor is willing to pay for a company's share depends on its profitability level. However, interest rates may influence the level of corporate profit as companies finance their plant, property, equipment, raw materials etc. through debts and equity capital (Maysami et al., 2004). A reduction in interest rates indicates lower costs of capital resulting in higher profitability. It ensures that investors are inclined to pay more for the stocks of the company. Secondly, many investors usually buy stocks with borrowed money. As a result, they will require higher returns if interest rates increase. Higher rate of return will result in a depreciation of stock prices.

5. Methodology

The models introduced by Engle and Granger (1987) and Johansen (1991) have been used in several studies (Rahman et al., 2009; Maysami et al., 2004) in order to investigate the interaction between stock returns and relevant macroeconomic indicators. All the variables in the model must be integrated at the same order to run either the VAR or the VECM model. However, ARDL bounds testing approach introduced by Pesaran et al. (2001) does not need this requirement to be satisfied. So, the decision to choose a suitable model relies on the result of stationarity.

As the variables under consideration are integrated at different orders, we have no option but to use the ARDL model instead of other cointegration models. In this paper, the empirical model has been specified in the following way to explore the link between the macroeconomic factors and the stock market indices:

$$\text{IR} = f(\text{ER, IPI, M2, CMR}) \tag{1}$$

Here, equation (2) represents the simple linear regression form of the model:

$$\text{IR}_t = \text{ь}_0 + \text{ь}_1\text{ER}_t + \text{ь}_2\text{IPI}_t + \text{ь}_3\text{M2}_t + \text{ь}_4\text{CMR}_t + \upsilon_t \tag{2}$$

Where,

IR_t = DSE indices return at time t

ER_t = Exchange rate (USD/BDT) at time t

IPI_t = Growth rate of industrial production index at time t

M2_t = Growth rate of broad money supply at time t

CMR_t = Call money rate at time t

ь_0 is constant; ь_1, ь_2, ь_3, and ь_4 are coefficients and υ_t is error term.

The ARDL representation of the equation (2) is given as follows:

$$\begin{aligned}\Delta IR_t = {} & \alpha_0 + \sum_{i=1}^{n_1} \alpha_{1i}\Delta IR_{t-i} + \sum_{i=0}^{n_2} \alpha_{2i}\Delta ER_{t-i} + \sum_{i=0}^{n_3} \alpha_{3i}\Delta IPI_{t-i} \\ & + \sum_{i=0}^{n_4} \alpha_{4i}\Delta M2_{t-i} + \sum_{i=0}^{n_5} \alpha_{5i}\Delta CMR_{t-i} + \beta_1 IR_{t-1} \\ & + \beta_2 ER_{t-1} + \beta_3 IPI_{t-1} + \beta_4 M2_{t-1} + \beta_5 CMR_{t-1} \\ & + e_t \end{aligned} \tag{3}$$

Here, Δ means the 1st difference of the variables, α_0 denotes the drift component, e_t is the white noise error term. White noise error term refers to an uncorrelated random error term having zero mean and constant variance, σ^2 (Gujarati and Porter, 2009, p. 775).

In equation (3), the coefficients from 2nd to 6th (α_{1i} to α_{5i}) imply the short-run relationship whereas the coefficients from 7th to 11th (β_1 to β_5) indicate the long-run relationship. ARDL bounds testing approach is used to explore the long-run relationship among IR, ER, IPI, M2, and CMR. The bounds testing approach uses the F statistic to test the hypotheses. This can be expressed as:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ (there is no co-integration)

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ (there is co-integration)

In the ARDL bounds testing procedure, two critical values have been given by Pesaran et al. (2001) to test the null hypothesis against the alternative one. The null hypothesis is rejected in case of calculated *F* statistic being greater than the upper bound critical value. If the calculated *F* statistic falls below the lower bound critical value, then the null hypothesis cannot be rejected. If the *F* statistic stays between the lower and upper bound critical values, then we cannot reach any conclusion. However, unrestricted error correction model can be introduced based on the assumption drawn by Pesaran et al. (2001). In this model, the long-run elasticities are the negative coefficient of one-lagged regressors divided by the coefficient of the one-lagged dependent variable. The ECM version of ARDL model can be expressed as follows:

$$\Delta IR_t = \alpha_0 + \sum_{i=1}^{n_1} \alpha_{1i}\Delta IR_{t-i} + \sum_{i=0}^{n_2} \alpha_{2i}\Delta ER_{t-i} + \sum_{i=0}^{n_3} \alpha_{3i}\Delta \mathrm{IPI}_{t-i} + \sum_{i=0}^{n_4} \alpha_{4i}\Delta M2_{t-i} + \sum_{i=0}^{n_5} \alpha_{5i}\Delta CMR_{t-i} + \gamma \mathrm{EC}_{t-1} + \mu_t \ldots \quad \ldots (4)$$

Here,

γ = The speed of adjustment
EC = The residuals obtained from equation (3)

However, the underlying assumptions of the ARDL model (Pesaran et al. 2001) are –

- The variables under consideration should be stationary at I(0) or I(1) or both. However, ARDL approach becomes invalid if any of the variables is stationary at I(2).
- There should be no serial correlation among the error terms.
- There should be no heteroscedasticity in the dataset.
- The dataset should exhibit normal distribution.

A unit root test examines whether a variable has a unit root (non-stationary) or not (stationary). There are different unit root tests to choose from. In this study, the augmented Dickey–Fuller (ADF) test, the Phillips-Perron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test are used. ADF test uses various test equations depending on the nature of the time series being considered (Gujarati and Porter, 2009, p. 755). When the time series data do not have any trend (flat) and have a tendency to turn around zero slowly, the following equation can be used:

$$\Delta x_t = \theta x_{t-1} + \alpha_1 \Delta x_{t-1} + \alpha_2 \Delta x_{t-2} + \ldots\ldots + \alpha_p \Delta x_{t-p} + \upsilon_t \qquad (5)$$

In case of time series being flat and having a tendency to turn around non-zero value slowly, the following equation can be used:

$$\Delta x_t = \alpha_0 + \theta x_{t-1} + \alpha_1 \Delta x_{t-1} + \alpha_2 \Delta x_{t-2} + \ldots\ldots + \alpha_p \Delta x_{t-p} + \upsilon_t \qquad (6)$$

In case of time series having a trend and a tendency to turn around the trend line slowly, the following equation may be used:

$$\Delta x_t = \alpha_0 + \theta x_{t-1} + \gamma t + \alpha_1 \Delta x_{t-1} + \alpha_2 \Delta x_{t-2} + \ldots\ldots + \alpha_p \Delta x_{t-p} + \upsilon_t \ldots\ldots \quad .(7)$$

This equation has a time trend (γt) and an intercept term (α_0). The hypotheses of ADF test are as follows:

H_0: $\theta = 0$ (data are not stationary)

H_1: $\theta < 0$ (data are stationary)

PP test has some advantages over ADF test as it corrects serial correlation problem in residuals by making adjustments in the Dickey-Fuller test statistic. Another advantage is that there is no need to add lagged difference terms (Gujarati and Porter, 2009, p. 758). The basic equation for Phillips and Perron (1988) test is as follows:

$x_t = c + \delta_t + a x_{t-1} + e_t$………………………………… ……….(8)

Here,

c = The drift component
δ_t = The deterministic trend
e_t = The error term

Different versions of the PP test can be used by restricting the drift and deterministic components in the equation above. PP test assumes the following hypotheses:

H_0: a = 1 (data are not stationary)
H_1: a ≠ 1 (data are stationary)

Unlike ADF and PP tests, the null hypothesis of KPSS test indicates stationarity in the variables (Greene, 2012, p. 998). The following model is applied to test the stationarity by using KPSS test:

$$x_t = \alpha + \beta t + \xi \sum_{i=1}^{t} z_i + \varepsilon_t \,; \quad t = 1, \dots\dots\dots, T$$

$$= \alpha + \beta t + \xi z_t + \varepsilon_t \dots\dots\dots \quad (9)$$

Here,

ε_t = A stationary series

z_t = An i.i.d. (independent and identically distributed) stationary series having a mean of zero and a variance of one.

If ξ is zero, the X_t is stationary ($\beta = 0$) or, trend stationary ($\beta \neq 0$). X_t is nonstationary if ξ equals to nonzero because z_t is I(1). The hypotheses of KPSS test are as follows:

H_0: $\xi = 0$ (data are stationary)
H_1: $\xi \neq 0$ (data are not stationary)

Granger causality test explores the direction of causality between two time series variables. In this research paper, the interrelationships among the selected macroeconomic indicators are analyzed by the pairwise Granger causality test. The bivariate regression equations below are considered in this analysis:

$y_t = a_0 + a_1 y_{t-1} + \ldots + a_m y_{t-m} + b_1 x_{t-1} + \ldots + b_m x_{t-m} + \mu_t$ ....(10)

$x_t = c_0 + c_1 x_{t-1} + \ldots + c_m x_{t-m} + d_1 y_{t-1} + \ldots + d_m y_{t-m} + \upsilon_t$ ....(11)

Here,

m = Selected lag length

Granger causality test assumes the following hypotheses:

H_0: x_t does not Granger-cause y_t
H_1: y_t does not Granger-cause x_t

However, Granger causality actually expresses precedence. For every pair of variables, one of the four forms of causality is noticed: (i) one-way causality from x_t to y_t, (ii) one-way causality from y_t to x_t, (iii) bidirectional causality, and (iv) absence of any causality.

Diagnostic tests are conducted to look into the assumptions regarding the normal distribution, the serial correlation, and the heteroscedasticity along with the validity of model specification, and the stability of long-run coefficients. Normality test includes Jarque-Bera (JB) statistic for testing the normality of error terms. The null hypothesis of normality test states that the residuals are normally distributed. So, the JB statistic should not be statistically significant for residuals to be normally distributed. Breusch-Godfrey serial correlation Lagrange multiplier (LM) test assumes null hypothesis of no serial correlation up to a specified order of lag. On the other hand, the Breusch-Pagan-Godfrey test is an LM test with the null hypothesis of no heteroscedasticity. So, the LM statistic should not be statistically significant for denying any presence of heteroscedasticity.

Ramsey's RESET test is a general test to identify any misspecifications of the functional form by using higher order terms of fitted values in an auxiliary regression (Brooks, 2014, p. 220). Inadequate modelling of short-run dynamics hampers long-run relationships resulting in some sort of instability in the long-run parameters. CUSUM and CUSUMSQ tests are applied to test the steadiness of long-run coefficients. Cumulative sums (CUSUM) test and cumulative sums of squares (CUSUMSQ) test are based on the recursive residuals which are calculated through iteration from the subsamples of data (MathWorks, Inc., 2017). CUSUM test is based on a normalized version of the cumulative sums of residuals whereas CUSUMSQ test is based on a normalized form of the cumulative sums of squared residuals (Brooks, 2014, p. 234). CUSUM test shows the cumulative sum along with 5% critical lines. If the line of the cumulative sum stays within the two critical lines, the coefficient stability is confirmed. The same procedure is used in case of CUSUMSQ test.

6. Results and Discussions

Table 03 containing the descriptive statistics of the selected variables reveals that IR, IPI, and M2 grew at an average rate of 0.75%, 1.03%, and 1.30% each month respectively whereas the monthly average value of ER and CMR is 0.013 USD/BDT and 7.78% respectively over the period under study.

Table 03: The descriptive statistics of the variables

Statistic(s)	IR	ER	IPI	M2	CMR
Mean	0.007548	0.013352	0.010347	0.012975	0.077840
Median	0.004833	0.012865	0.011300	0.012687	0.073500
Std. Dev.	0.060052	0.000847	0.080775	0.010973	0.043798
Maximum	0.169561	0.014595	0.205427	0.047267	0.335400
Minimum	-0.147536	0.011988	-0.208257	-0.015123	0.007400
Skewness	0.146781	0.380962	-0.328674	0.312141	2.165753
Kurtosis	3.333869	1.540926	3.380804	3.575858	12.55407
Observations	112	112	112	112	112

Source: Authors' own calculation.

The values of the standard deviation indicate that IR and IPI tend to vary more often than other variables. Table 03 also shows that all the variables expect IPI have positive skewness. The kurtosis of IR, IPI & M2 hovers around the benchmark value of 3. However, the kurtosis of ER is below 3 (platykurtic) while that of CMR far exceeds the benchmark value (leptokurtic).

Table 04 reports the results of ADF test, PP test, and KPSS test. Although it is not required to pretest the stationarity of the variables for the ARDL approach, the results will be unreliable if any order of integration of two or higher is detected. As a result, ADF, PP, and KPSS tests are conducted to ensure that not a single variable is integrated at I(2) or above.

Table 04: Results of unit root tests

Variables	ADF				PP				KPSS			
	Intercept		Trend and intercept		Intercept		Trend and intercept		Intercept		Trend and intercept	
	Level	1st difference	Level	1st difference	Level	1st difference	Level	1st difference	Level	1st difference	Level	1st difference
IR	-7.10***	-9.21***	-7.08***	-9.17***	-6.96***	-35.91***	-6.94***	-35.24***	0.13	0.21	0.10	0.20**
ER	-1.25	-6.53***	-1.48	-6.53***	-1.18	-6.53***	-1.33	-6.57***	0.89***	0.15	0.20**	0.11
IPI	-3.86***	-7.55***	-4.98***	-7.52***	-28.94***	-71.16***	-35.60***	-70.76***	0.38*	0.12	0.15**	0.12
M2	-0.69	-11.42***	-2.70	-11.41***	-13.83***	-78.67***	-17.37***	-96.06***	0.61**	0.25	0.11	0.13*
CMR	-4.34***	-10.85***	-4.59***	-10.80***	-4.24***	-18.05***	-4.56***	-17.99***	0.33	0.07	0.16**	0.06

Notes: (*), (**), and (***) indicate the rejection of null hypothesis at 10%, 5% and 1% level of significance respectively.

The result in Table 04 shows that the time series data of all the variables are integrated at level, I(0) or at 1st difference, I(1) and thereby suggests that we can apply the ARDL co-integration model.

Table 05 shows the result of the estimated model based on equation (3). The lag length of both dependent variable and regressors is determined by automatic selection expandable up to 12 lags and Schwartz information criterion (SIC) is used in this study.

Table 05: ARDL model based on bounds testing approach

Dependent Variable: D(IR)
Selected Model: ARDL (1, 5, 0, 1, 1) estimated by conditional error correction regression with restricted constant and no trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.016287	0.081477	0.199901	0.8420
IR(-1)	-0.669373	0.085592	-7.820486	0.0000
ER(-1)	-0.161583	6.206677	-0.026034	0.9793
IPI*	0.076971	0.064320	1.196687	0.2344
M2(-1)	2.296815	0.762926	3.010537	0.0033
CMR(-1)	-0.548918	0.137095	-4.003939	0.0001
D(ER)	11.18650	58.27282	0.191968	0.8482
D(ER(-1))	80.30818	62.33422	1.288348	0.2008
D(ER(-2))	-20.30053	64.03212	-0.317037	0.7519
D(ER(-3))	-304.7070	63.65381	-4.786941	0.0000
D(ER(-4))	138.3969	58.07611	2.383026	0.0192
D(M2)	0.705885	0.495441	1.424762	0.1575
D(CMR)	0.024062	0.158759	0.151563	0.8799

* Variable interpreted as Z = Z(-1) + D(Z).

The best model that has been selected is ARDL (1, 5, 0, 1, 1). It includes both short-run and long-run dynamics.

The result of the ARDL bounds test is presented in Table 06. The *F* statistic value is 14.07596 which is higher than the upper bound critical value of 4.787 at 1% level of significance. It implies that the null hypothesis can be rejected. So, there is a long-run relationship among the variables.

Table 06: ARDL bounds test results

H_0: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	14.07596	4
Critical Value		
Significance	Lower Bound	Upper Bound
10%	2.303	3.220
5%	2.688	3.698
1%	3.602	4.787

The result of the ECM version of the ARDL model is exhibited in Table 07. We see that ECT_{t-1} has a negative sign and is significant at 1% level of significance. Just like the finding of the bounds test, it indicates that stock market returns, exchange rate, industrial production index, money supply, and call money rate have a long-run association.

Table 07: Error correction representation of the selected ARDL model

Dependent Variable: D(IR) **Selected Model: ARDL (1, 5, 0, 1, 1) based on ECM regression with restricted constant and no trend**				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ER)	11.18650	54.27190	0.206120	0.8371
D(ER(-1))	80.30818	60.13857	1.335386	0.1850
D(ER(-2))	-20.30053	60.19855	-0.337226	0.7367
D(ER(-3))	-304.7070	60.76847	-5.014229	0.0000
D(ER(-4))	138.3969	55.33104	2.501252	0.0141
D(M2)	0.705885	0.272917	2.586447	0.0112
D(CMR)	0.024062	0.135589	0.177463	0.8595
ECT(-1)	-0.669373	0.070974	-9.431231	0.0000
R^2	0.580466	Akaike information criterion (AIC)		-3.238347
Adjusted R^2	0.550802	Schwarz information criterion (SIC)		-3.038509
Durbin-Watson (DW) stat	2.009149	Hannan–Quinn information criterion (HQIC)		-3.157335
S.E. of regression	0.046235			

The absolute value of ECT_{t-1} coefficient states that about 67% of the disequilibrium in the stock returns is adjusted monthly to get back to the long-run equilibrium. It suggests that about one and a half months are required, on average, to reach the long-run equilibrium. The result is consistent with that of Lin (2012) for Philippines where about 62.44% of the deviation from the long-run equilibrium level is adjusted every month.

Table 08 demonstrates the long-run coefficients of the indicators at level using the ARDL approach. The result indicates that the relationship of ER with IR is negative. It means that the depreciation of BDT against USD will increase IR returns and this is similar to the findings of Wongbangpo and Sharma (2002) for Malaysia, Indonesia, and Philippines. The sign of CMR affecting IR is also negative. As a result, any increase in CMR will have a bearish impact on stock indices which is consistent with the finding of Hasan and Zaman (2017) for Bangladesh.

On the contrary, positive interaction is observed on IR in case of both IPI and M2. It indicates that growth in industrial production of Bangladesh will increase stock prices by enhancing a firm's ability to generate more cash flow. This finding is akin to that of Wongbangpo and Sharma (2002) for Indonesia, Malaysia, Philippines, Singapore, and Thailand. Growth in broad money supply tends to show a bullish effect on stock prices. This result is consistent with that of Wongbangpo and Sharma (2002) for Malaysia, Singapore, and Thailand. The direction of the empirical relationship is similar to that of our hypothesized relationship. Table 08 also indicates that M2 and CMR are statistically significant whereas ER and IPI are not statistically significant.

Table 08: Estimated long-run coefficients at level using the ARDL bounds testing approach

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ER	-0.241394	9.279122	-0.026015	0.9793
IPI	0.114990	0.097772	1.176104	0.2425
M2	3.431294	1.268720	2.704531	0.0081
CMR	-0.820049	0.214098	-3.830240	0.0002
C	0.024332	0.122305	0.198945	0.8427
EC = IR - (-0.2414*ER + 0.1150*IPI + 3.4313*M2 -0.8200*CMR + 0.0243)				

As M2 significantly affects IR, Bangladesh Bank (BB) should utilize its various monetary policy instruments, such as open market operations (OMO), statutory reserve requirement, and bank rate with a view to maintaining the money supply at a level favorable for making a bullish trend in the stock exchange. On the contrary, because of the significant impact of call money rate on DSE returns, BB and Bangladesh Securities and Exchange Commission (BSEC) should work together in order to harvest synergy between the money market and the stock market of Bangladesh. This type of cooperation among financial regulatory authorities will ensure better performance for both markets by boosting up economic growth through creating a friendly business environment where it is easy to accumulate capital promptly and to offer better investment options.

The summary of the diagnostic tests is demonstrated in Table 09. The findings indicate that there are no problems in the dataset as all the relevant diagnostic tests get accepted in favor of the model.

Table 09: ARDL model diagnostic tests

Diagnostic tests	Statistic(s)	Corresponding value	Corresponding p value
Normality test	Jarque-Bera	3.179587	0.2040
Breusch-Godfrey serial correlation LM test	F-statistic	0.914432	0.4755
Breusch-Pagan-Godfrey heteroscedasticity test	F-statistic	1.036240	0.4230
Ramsey RESET test	F-statistic	0.474311	0.6238

The JB statistic is not statistically significant. It confirms that the residuals are normally distributed. The result of LM test of serial correlation suggests that the null hypothesis of no serial correlation up to the 5th order of lag cannot be rejected. So, there is no autocorrelation in the residuals. The heteroscedasticity test shows that the residuals are homoskedastic. Ramsey RESET test indicates that there are no specification errors in the model.

The graphical representation in Fig. 01 indicates the presence of steadiness in the long-run coefficients as the CUSUM line remains within the 5% critical bands of the parameter stability.

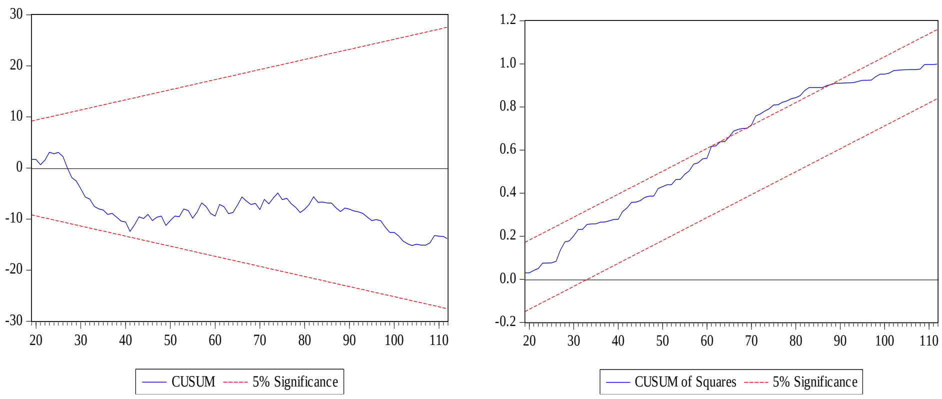

Figure 01: CUSUM and CUSUMSQ test for the stability of long-run coefficients

Although the CUSUMSQ line slightly crosses the upper critical line, most of the time it stays within the critical limits ensuring that the coefficients are stable.

Table 10 exhibits the results of pairwise Granger causality test with 12 lags. There exists a unidirectional causality from ER to IR, CMR to IR, ER to IPI, and CMR to ER. A bidirectional causality between IPI and M2 has been found.

Table 10: The results of pairwise Granger causality tests

Null Hypothesis	F-Statistic	Prob.	Granger Causality
ER ↛ IR	2.18029	0.0211	Unidirectional ER → IR
IR ↛ ER	0.84004	0.6096	
M2 ↛ IR	1.27265	0.2526	No causality
IR ↛ M2	0.35248	0.9755	
IPI ↛ IR	1.26002	0.2603	No causality
IR ↛ IPI	1.23050	0.2789	
CMR ↛ IR	1.79696	0.0639	Unidirectional CMR → IR
IR ↛ CMR	1.46422	0.1571	

M2 ↛ ER	0.51054	0.9017	No causality
ER ↛ M2	0.97785	0.4775	
IPI ↛ ER	0.79394	0.6552	Unidirectional ER → IPI
ER ↛ IPI	1.68923	0.0862	
CMR ↛ ER	1.80652	0.0622	Unidirectional CMR → ER
ER ↛ CMR	0.68149	0.7639	
IPI ↛ M2	2.20260	0.0198	Bidirectional IPI → M2 and M2 → IPI
M2 ↛ IPI	1.77171	0.0686	
CMR ↛ M2	0.41953	0.9513	No causality
M2 ↛ CMR	1.16919	0.3207	
CMR ↛ IPI	0.84503	0.6046	No causality
IPI ↛ CMR	0.97098	0.4838	

The results also suggest that there is no cause-effect between M2 & IR, IPI &IR, M2 & ER, CMR & M2, and CMR & IPI.

7. Conclusion and Policy Implications

This research paper has explored the interaction between selected macroeconomic variables and DSE returns. The ARDL bounds testing approach is applied on monthly data from January, 2008 to April, 2017 regarding DSE indices (DGEN & DSEX) and four macroeconomic indicators (ER, IPI, M2, and CMR). The results show that there exists a long-run relationship among the variables. The statistically significant negative coefficient of error correction term indicates that around 67% of the short-term disequilibrium is adjusted monthly to get back to the long-run equilibrium. CUSUM test shows that the long-run coefficients in the ECM version of the ARDL model are stable. Granger causality test confirms the presence of a unidirectional causality from ER to IR, CMR to IR, ER to IPI, and CMR to ER as well as a bidirectional causality between IPI and M2. Different diagnostic tests affirm that there are no autocorrelation, heteroscedasticity, and specification errors.

With regard to policy implications, the findings of this paper might be of great significance to the policy-making entities, like BB and BSEC for prudent formulation and effective implementation of various policies so that a favorable environment for the stock exchanges can be created. Bangladesh Bank (BB) – the regulator of foreign exchange market –

follows floating exchange rate regime since 2003 (Bangladesh Bank, 2019). Under this regime, market demand and supply forces determine the exchange rate of respective currencies although BB uses monetary policy wisely to stay clear of any adverse impact on the domestic economy caused by abrupt swings in the exchange rate. As a unidirectional causality running from exchange rate to DSE returns is confirmed by the study, BB should remain vigilant in the foreign exchange market and get involved in buying or selling foreign currencies whenever necessary to maintain the foreign exchange market stability that is essential for better stock exchange performance. Due to a positive relationship between money supply and index return, BB should adjust the rates of repo and reverse repo, cash reserve ratio (CRR) and statutory liquidity reserve (SLR) in order to ensure an expansionary monetary policy in favor of a bullish stock market. However, BB cannot afford to increase money supply constantly due to the risk of increasing inflation in the economy. As a result, BB may formulate and implement monetary policy by taking into consideration the trade-off between the better stock market performance and the resulting inflation. Moreover, BB and BSEC should work together to create synergy between the money market and the stock market which will engender prompt capital accumulation and better investment options. Foreign and domestic stakeholders might also find the empirical results of this study helpful in making prudential investment decisions.

However, the present study has considered only four macroeconomic variables. Therefore, the impact of other macroeconomic variables, such as FDI, government spending, and oil prices can be taken into account to make a further extension of the present study. Furthermore, the indices of neighboring foreign stock exchanges, such as Bombay stock exchange, Pakistan stock exchange, and Shanghai stock exchange can also be incorporated in this study to find out whether DSE has any interaction with the foreign stock markets which have strong economic ties and close geographic proximity.

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Appendix

Table A1: Basic representation of the selected ARDL model

Dependent Variable: IR
Selected Model: ARDL (1, 5, 0, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IR(-1)	0.330627	0.085592	3.862813	0.0002
ER	11.18650	58.27282	0.191968	0.8482
ER(-1)	68.96010	100.6308	0.685278	0.4949
ER(-2)	-100.6087	106.4566	-0.945068	0.3470
ER(-3)	-284.4065	106.8400	-2.661986	0.0091
ER(-4)	443.1039	101.5941	4.361511	0.0000
ER(-5)	-138.3969	58.07611	-2.383026	0.0192
IPI	0.076971	0.064320	1.196687	0.2344
M2	0.705885	0.495441	1.424762	0.1575
M2(-1)	1.590930	0.478767	3.322970	0.0013
CMR	0.024062	0.158759	0.151563	0.8799
CMR(-1)	-0.572980	0.157452	-3.639078	0.0004
C	0.016287	0.081477	0.199901	0.8420
R^2		0.469889	AIC	-3.144889
Adjusted R^2		0.402215	SIC	-2.820153
S.E. of regression		0.047448	HQIC	-3.013245
F-statistic		6.943437	DW-statistic	2.009149
Prob (F-statistic)		0.000000		