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Evaluating the effectiveness of macroeconomic determinants on the performance of the Dhaka Stock Exchange: A time series approach

[a,] * Fairuz Anjum Binte Habib

[a,] Department of Finance and Banking, Faculty of Business Studies, Bangladesh University of Professionals, Mirpur Cantonment, Dhaka-1216, Bangladesh

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ABSTRACT

The study examines the causal relationships between selected macroeconomic variables and the Dhaka Stock Exchange Broad Index (DSEX) from 2013 to 2023. The researcher employed time series economic approaches such as the Augmented Dickey-Fuller (ADF) test for stationarity, the Vector Autoregression (VAR) and Granger causality tests for short-term dynamics, and Johansen's co-integration test for long-term relationships. The findings demonstrate no co-integration between the variables, implying that there is no substantial long-term relationship between how they change over time. However, the VAR analysis shows short-term association between the chosen macroeconomic factors and the DSEX index performance. This implies that changes in any of these macroeconomic variables may have a short-term impact on the DSEX index. Additionally, causality testing reveals unidirectional relationships, indicating that the DSEX index has a considerable impact on numerous economic indicators, including GDP growth, money supply growth, unemployment, inflation and interest rates. Overall, the DSEX index plays an important role in Bangladesh's macroeconomic landscape by accurately forecasting changes in these variables. This study provides important insights into the operation of the Bangladeshi stock market and fills a gap in the literature on developing economies. The results have implications for Bangladeshi investors and policymakers aiming to increase profits, make informed decisions, and support economic stability. Future research should take into account other macroeconomic variables and market indexes to have a better understanding of stock market dynamics.

I. Introduction

Bangladesh's financial sector has traditionally struggled with bank stability, financial products, and capital raising. Historical crises, such as those in 1996 and 2010, revealed considerable discrepancies, with major investors and insiders gaining from asymmetric information while small investors suffered considerable losses (Islam and Ahmed, 2015). The pandemic has worsened pre-existing issues, lowering stock performance in global markets, particularly in Asian nations like as Bangladesh (Mazur et al., 2021; Al-Awadhi et al., 2020; Liu et al., 2020; Topcu and Gulal, 2020). Haque and Chowdhury (2020) found that the pandemic had a substantial influence on the Dhaka and Chittagong stock markets, causing them to fall to their lowest levels in 41 months since the onset of the pandemic. Furthermore, Mishra and Mishra (2020) claim that the epidemic has strained Bangladesh's economy, which was already struggling with a high poverty rate. Additionally, it interrupted economic activity, exposing market vulnerabilities—a trend observed in several countries (Alzyadat and Asfoura, 2021; Chaudhary et al., 2020). Bora and Basistha (2021) discovered that stock index returns were considerably greater before the outbreak than after it. Since the capital market accounts for a major part of a nation's wealth and is heavily influenced by macroeconomic conditions (Aldin et al., 2012), it is essential to examine the specific factors that affect its performance. This research is especially important in developing countries like Bangladesh, where the dynamics of this relationship remain poorly understood. This study examines the DSEX broad index and macroeconomic variables from 2013 to 2023 to address gaps in understanding how COVID-19 affects the Bangladesh stock market. Despite the significance of macroeconomic determinants in stock market performance, few studies have looked at their impact on the DSEX broad index, particularly before, during, and after the COVID-19 outbreak. This research looks at the DSEX broad index performance and variables such as inflation, GDP growth, money supply growth, unemployment rates, and interest rates to see how they impact market stability during times of global economic uncertainty. It

* Corresponding author. E-mail address: *fairuzanjum30@gmail.com* (F.A.B.. Habib).
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highlights DSEX broad index performance, which is an important indication of Bangladesh's stock market performance (Rezina, Jahan, and Mustafi, 2017; Mahzabeen, 2016; Nisha, 2016; Miah and Banik, 2013; Pal and Mittal, 2011).

Numerous studies have examined the relationship between macroeconomic variables and stock market performance, repeatedly highlighting the critical roles that the money supply, GDP growth, interest rates, inflation, and unemployment play in determining market dynamics. As acknowledged by several scholars (Algieri, Brancaccio, and Buonaguidi, 2020; Olokoyo et al., 2020; Tiryaki, Erdoğan, and Ceylan, 2017; Asekome and Agbonkhese, 2015; Pradhan et al., 2015a; Ibrahim and Musah, 2014; Hussain et al, 2013). GDP growth rate is an important indicator for analysing economic swings and stock market movements (Işık, Ongan and Islam, 2024; Işık et al., 2024f; Ho, 2019; Asekome and Agbonkhese, 2015). Interest rates, which represent the cost of borrowing or the return on savings, have frequently been proved to have a detrimental impact on both Islamic and conventional indices (Almansour and Almansour, 2016; Barakat et al., 2016; Winful, Sarpong and Sarfo, 2016; Hussain et al., 2013). Inflation often has a negative influence on stock market indices by raising borrowing costs (Mohnot et al., 2024; Olokoyo et al., 2020; Almansour and Almansour, 2016; Abu-Libdeh and Harasheh, 2011). According to Hasan et al. (2022), Ibrahim and Musah (2014), and Mohnot et al. (2024), the money supply is a key macroeconomic component that determines stock market indices. Lastly, unemployment is an important macroeconomic variable that influences consumer spending, company investment, and total economic development (Dogru et al., 2024, 2023, 2019; Işık et al., 2024a; 2024b; 2024c; 2024d, 2024e, 2024f, 2024g, 2024h, 2024i, 2021, 2019, 2016, 2015, 2014; Han et al., 2024, 2023; Jabeen et al., 2024a, 2024b, 2024c; Li et al., 2024; Song et al., 2024; Sun et al., 2024; Yan et al., 2024a, 2024b; Ahmad et al., 2023a, 2023b; Alvarado et al., 2023, 2023a, 2022b; Anas et al., 2023; Bulut et al., 2023; Cetin et al., 2023; Das et al., 2023; Jo et al., 2023; Ongan et al., 2023, 2022).

There is a dearth of studies on how macroeconomic issues explicitly affect the DSE Broad Index, despite the well-established association between macroeconomics and conventional stock markets. There isn't much research that compares these impacts with Bangladesh as the focus. This research is noteworthy because it investigates the causal impacts of certain macroeconomic variables on the DSEX Broad Index during a timeframe not previously examined in the literature. By focusing on understudied macroeconomic variables and the performance of the DSEX broad index, the research fills in gaps in the literature. This study intends to address the research question of examining the causal relationship between selected macroeconomic variables and Dhaka stock exchange broad index performance in Bangladesh. The researcher primarily provides in-depth insights into how stock market index (Dhaka stock exchange broad index) performance responds to changes in chosen macroeconomic variables such as GDP growth rate, money supply growth rate, interest rate, unemployment rate, and inflation rate. This will help policymakers, investors, and market players to navigate economic uncertainty and improve market resilience with the help of this technique. Furthermore, it will help them to understand economic dynamics and how they influence the stock market in the long and short run. The research continues as follows: Section 2 provides a detailed assessment of the literature including conceptual framework and assumptions. The methodology is discussed in Section 3. Section 4 presents empirical findings and discussion, while Section 5 concludes the paper.

2. Literature Review

Capital markets reflect economic confidence and respond to indicators of macroeconomic stability. It channels funds into investments and provides a window into the country's economy. A well-developed capital market encourages long-term development via efficient savings accumulation, appropriate investment allocation, and portfolio diversification (Olokoyo et al., 2020). According to previous studies, macroeconomic uncertainty has an influence on stock markets in both developed and developing countries (Gunay and Can, Karanasos, 2022; Yfanti, and Hunter, 2022; Ma, Wang, and He, 2022). Many researchers have investigated the impact of macroeconomic conditions on stock market performance, such as inflation, GDP, national income, per capita income, exchange rates, interest rates, unemployment, and financial crises (Al-Kandari and Abul, 2019; Ho, 2019 Bahloul et al., 2017; Pradhan et al., 2015a; Asekome and Agbonkhese, 2015). Typically, in a case of causality, certain variables (causal variables) are controlled while an observable variable (dependent or impact variable) is changed methodically (Wold, 1954). The researcher needs to understand Granger's (1969) concept—that is, that X Granger causes Y if previous values of X enhance forecasts of Y—is essential to comprehending dynamic time series interactions. Additionally, Keele, Stevenson, and Elwert (2020) state that an identification approach tries to establish that D is independent of Y's potential values to understand relationships as causal effects. Furthermore, the researcher takes into consideration such long-term relationships, the cointegration technique—created by Granger (1986), Hendry (1986), and Engle and Granger (1987)—improves Granger causality testing. The paper investigates the causal relationship between major macroeconomic indicators—unemployment rate, interest rates, inflation, money supply growth rate, GDP growth rate and stock market performance.

2.1 Dependent variable

DSE Broad Index (DSEX): Stock market performances are influenced by economic fundamentals, enabling stock market values to predict future economic activity. The Dhaka Stock Exchange (DSE) computes three indices, namely DSEX, DS30, and DSES, which do not include bonds, debentures, or mutual funds. Within this group, the DSEX stands out as the primary benchmark index, including 97% of the total value of the stock market. This study examines the performance of the DSES Broad Index as the only dependent variable. Its main objective is to measure the causal relationship between the DSES Broad Index and specific macroeconomic variables, as shown in various studies (Rezina, Jahan, and Mustafi, 2017; Mahzabeen, 2016; Pal and Mittal, 2011; Miah and Banik, 2013; Nisha, 2016).

2.2. Independent/explanatory variables

Unemployment Rate (UN): Economic performance, especially unemployment rates, is crucial for a country's capacity to address environmental problems, promote social fairness, and maintain governance standards (Işık, Ongan and Islam, 2024a; Işık et al., 2024b; Işık et al., 2024c; Jo et al., 2023). For instance, Pan (2018) discovered that unemployment rates and stock market prices are cointegrated across nation groups. Sibande et al. (2019) revealed that stock market returns have a considerable impact on unemployment, while unemployment has no significant influence on stock market returns (Algieri, Brancaccio and Buonaguidi, 2020). Nonetheless, research conducted in Turkey between 2003:1 and 2016:12 revealed that unemployment had no impact on stock returns (Tiryaki, Erdoğan, and Ceylan, 2017).

$H1_0$: Unemployment Rate does not Granger cause DSEX Index Performance
$H2_0$: DSEX Index Performance does not Granger cause Unemployment Rate

Interest Rate (INT): As interest rates increase, investors prefer to shift their money from the stock market to interest-bearing securities, resulting in lower stock prices and less demand for shares (Barakat et al., 2016; Winful, Sarpong and Sarfo, 2016; Cook, 1989). For instance, interest rates have been demonstrated to have a substantial adverse and causal effect on stock market performance in Pakistan (Almansour and Almansour, 2016; Hussain et al., 2013). Previous studies have confirmed noteworthy long-term relationships between interest rates and the stock market index (Lee, 2020; Demir, 2019; Barakat et al., 2016; Jareño and Negrut, 2016; Pradhan et al., 2015a; Forson, 2014; Ibrahim and Musah, 2014). On the other hand, Sukmawati and Haryono (2021), aligning with Mukhlis et al. (2018), contend that external factors influencing these variables prevent the Composite Stock Price Index and interest rates from cointegrating. Unidirectional causal relationship was found between interest rates and stock market indices (Wickramasinghe, 2023; Hasan et al., 2022; Bahloul et al., 2017; Barakat et al., 2016; Mahzabeen, 2016). Nonetheless, Ibrahim and Musah (2014) discovered no causal relationship between interest rates and stock market index performance.

$H3_0$: Interest Rate does not Granger cause DSEX Index Performance.
$H4_0$: DSEX Index Performance does not Granger cause Interest Rate.

Inflation Rate (INF): Inflation, defined as an ongoing rise in prices throughout an economy, profoundly affects various sectors (Islam et al., 2024a; Işık et al., 2024e). According to Barakat et al. (2016), rising inflation in Egypt enhances corporate profitability and attracts investors, raising stock prices, whereas, in Tunisia, inflation shifts money to consumption, reducing stock demand and prices. Therefore, inflation can have both positive effects on stock indices through demand-push and negative effects through cost-push, as evidenced by studies (Mishra and Debasish, 2018; Miah and Banik, 2013; bu-Libdeh and Harasheh, 2011). The relationship between inflation and stock markets has been thoroughly studied, highlighting its significance, noting its adverse impacts, and confirming its role as a key economic indicator at natural levels (Keswani and Wadhwa, 2022; Camilleri et al., 2019; Kwofie and Ansah, 2018; Megaravalli and Sampagnaro, 2018). Sukmawati and Haryono (2021) found a long-term relationship between the Stock Index and inflation, which is supported by many researchers (Mohnot et al., 2024; Ligocká, 2023; Olokoyo, et al. 2020; Demir, 2019; Mukhlis et al., 2018; Barakat et al., 2016; Jareño and Negrut, 2016; Peiró, 2016; Pradhan et al., 2015a; Pal and Mittal, 2011). Granger's causality test showed that inflation has a minor influence on the All-Share Price Index (Wickramasinghe, 2023), however Hasan et al. (2022) discovered that inflation has a short-term, unidirectional impact on the Islamic stock index. Furthermore, although some research revealed no causal association between inflation and stock returns, cointegration analysis indicates a long-run relationship with inflation (Almansour and Almansour, 2016; Ibrahim and Musah, 2014).

$H5_0$: Inflation does not Granger cause DSEX Index Performance
$H6_0$: DSEX Index Performance does not Granger cause Inflation

Money Supply Growth Rate (MGR): The money supply has a considerable influence on macroeconomic indicators, namely stock market indexes. According to Barakat et al. (2016), increasing the money supply stimulates more stock market investment since consumers have more discretionary income and purchasing power. Bahloul et al. (2017) indicate that changes in money supply have an apparent impact on index returns under different instability conditions in developing and emerging markets, highlighting a strong long-term relationship with market indexes as supported by various studies (Mohnot et al., 2024;Ligocká, 2023; Hasan et al., 2022; Bhuiyan and Chowdhury, 2020; Demir, 2019; Barakat et al., 2016; Peiró, 2016; Pradhan et al., 2015b; Forson, 2014; Ibrahim and Musah, 2014; Tripathi and Seth, 2014). Meanwhile, Granger's causality test demonstrates that money supply has a negligible influence on the All-Share Price Index (Wickramasinghe, 2023), although Plihal (2016) finds bidirectional causality between money supply and the stock market. On the contrary, both Almansour and Almansour (2016) and Ibrahim and Musah (2014) found no causal relationship between money supply and stock market returns.

$H7_0$: Money Supply Growth Rate does not Granger cause DSEX Index Performance
$H8_0$: DSEX Index Performance does not Granger cause Money Supply Growth Rate

Gross Domestic Product Growth Rate (GR): Asia-Pacific countries are experiencing tremendous economic expansion, with emerging nations attracting foreign investments due to relaxed environmental constraints (Işık et al., 2024c; Işık et al., 2024d). Bangladesh ranks as the 35th strongest economy in the world with a GDP of $460.8 billion. This position enhances foreign direct investment by drawing in worldwide investors (Islam et al., 2024; Islam et al., 2023a; Islam as al., 2023b; Bintara, 2020). This expansion leads to greater employee earnings and better living conditions (Gazi et al., 2024; Işık et al., 2024e). Economic performance, particularly GDP growth, is essential for addressing environmental issues and has a major influence on the all-share index (Işık, Ongan and Islam, 2024a; Işık et al., 2024f; Ho, 2019; Asekome and Agbonkhese, 2015). Previous studies show that changes in GDP have a long-term impact on stock indexes (Olokoyo et al., 2020; Demir, 2019; Barakat et al., 2016; Jareño and Negrut, 2016; Peiró, 2016; Pradhan et al., 2015a; Tripathi and Seth, 2014). In the short run, researchers discover a complex network of causal relationships, but this provides limited insight into how stock market depth may contribute to economic growth (Ligocká, 2023; Pradhan et al., 2015b). However, Mostafa (2020) discovered a two-way causal relationship between traded stocks and economic growth.

$H9_0$: GDP Growth Rate does not Granger cause DSEX Index Performance

$H10_0$: DSEX Index Performance does not Granger cause GDP Growth Rate

data were collected

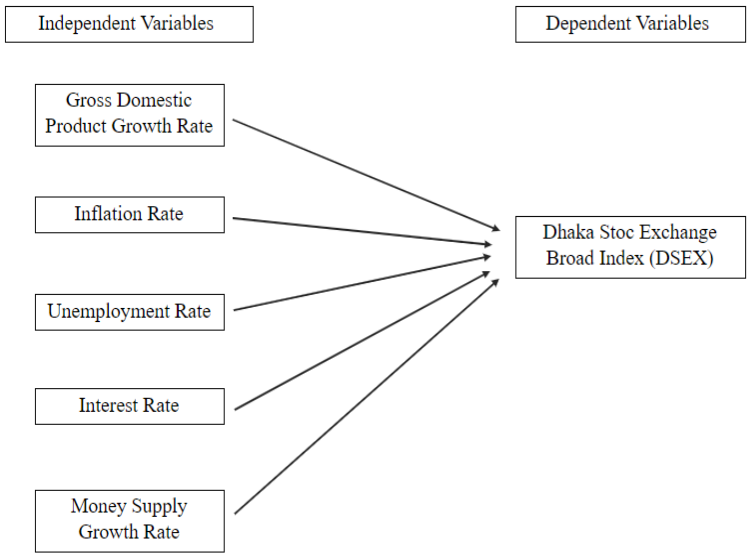
2.3. Conceptual framework

The conceptual framework is derived from a comprehensive review of the existing literature.

3. Methodology

The study employs time series econometric methodologies to examine the influence of macroeconomic variables on the performance of the Dhaka Stock Exchange Broad Index (DSEX) from 2013 to 2023, spanning the periods before, during, and after the COVID-19 pandemic. Data for the DSEX index were collected from Investing.com, which represents overall market performance. Macroeconomic variables

Figure 1: Conceptual Framework



from the World Bank Group's databases, including yearly datasets for GDP growth rates, money supply growth rates, inflation rates (measured in annual percentages by the GDP deflator), and interest rates. The unemployment rate data was gathered from Macrotrends, which gives yearly figures. To effectively analyze stock performance, monthly data was selected to capture real-time dynamics and volatility, which are critical for timely decision-making. In contrast, annual data for macroeconomic variables was chosen to highlight longer-term trends and minimize the effects of short-term fluctuations. To align the different data frequencies, monthly stock market data—including high and low-volume figures—was averaged to generate annual values, thus smoothing out short-term volatility. Normality issues in the inflation data were addressed through an inverse transformation, while GDP growth rates were transformed using a Box-Cox method to achieve normality. Other independent variables remained unchanged, as they met normality assumptions. The quantitative data were analysed using Stata, a statistical program that specialises in econometric and time series analysis. First, the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981, 1979), has been used to assess the data series' stationarity. If the variables are stationary at the initial difference, they are deemed to be of the same order, which is required for co-integration testing. Next, Johansen's (1988, 1991) co-integration test has been used to determine if there are any long-run relationships between the stock market index and macroeconomic data. This approach will provide standardized co-integrating coefficients,

allowing for the estimate of macroeconomic variables' long-term influence on the stock market. Following that, pairwise Granger causality tests have been used to investigate the short-term causal relationships between macroeconomic factors and the stock index. Granger causality (Engle and Granger, 1986; Granger, 1969) states that previous values of one variable may predict future values. In addition, several diagnostic tests have been performed to evaluate the models' adaptability. The Breusch-Godfrey LM and Durbin-Watson d-statistic tests have been employed for assessing autocorrelation, the Breusch-Pagan test to check heteroskedasticity, and the Ramsey RESET test to specify the model.

$$DSEX_t = \alpha + \sum_{i=1}^{n} \gamma i GR_{t-i} + \sum_{i=1}^{n} \delta i INF_{t-i} + \sum_{i=1}^{n} \lambda i MGR_{t-i} + \sum_{i=1}^{n} \mu i UN_{t-i} + \sum_{i=1}^{n} \nu i INT_{t-i} + \epsilon_t$$

Where:

$DSEX_t$: Performance of the DSEX index at time t (dependent variable)

α: intercept term, initial value of the DSEX index

γ_i : measures the impact of lagged GDP growth rates (GR_{t-i})

δ_i : measures the impact of lagged inflation rates (INF_{t-i})

λ_i : measures the impact of lagged money supply growth (MGR_{t-i})

μ_i: measures the impact of lagged unemployment rates (UN_{t-i})

ν_i: measures the impact of lagged interest rate (INT_{t-i})

ϵ_t: error term capturing unexplainable changes in the DSEX index.

4. Findings and Discussion

4.1. Descriptive statistics

Descriptive statistics describe key data properties such as central tendency, dispersion, and distribution shape. The researcher estimates the mean, standard deviation, minimum, maximum, skewness, kurtosis, and Jarque-Bera (J-B) tests for each variable. These statistics are critical for understanding the dataset's underlying patterns and fluctuations, which will guide further analysis.

The DSEX index has a mean of 0.0005 and a low standard deviation of 0.0001, suggesting that it fluctuates between 0.0003 and 0.0006. INF averages 18.31 with a standard deviation of 6.613, with considerable variance ranging from 3.584 to 27.027. GDP has a mean of -0.997 and an insignificant standard deviation of 0.0007, indicating persistently negative growth. Interest rates (INT) average 0.0269 with a standard

Table 1: Descriptive statistics summary

Variable	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	Prob>chi2
DSEX	.0005	.0001	.0003	.0006	0.8676	0.4795	0.7602
INF	18.31	6.613	3.584	27.027	0.2071	0.2293	0.1690
GR	-.997	.0007	-.9994	-.9968	0.0769	0.0797	0.067
INT	.0269	.0097	.0110	.0420	0.9723	0.5413	0.8302
UN	.0459	.0039	.0427	.0532	0.0633	0.8918	0.1442
MGR	.1235	.0327	.0700	.167	0.4153	0.4595	0.5029

deviation of 0.0097 and range from 0.0110 to 0.0420, showing stability. The unemployment rate (UNP) averages 0.0459 with a standard deviation of 0.0039, ranging slightly from 0.0427 to 0.0532, indicating minimal fluctuation. Finally, the money supply growth rate (MSG) averages 0.1235 with a standard deviation of 0.0327, ranging from 0.0700 to 0.167, showing modest growth dynamics. The Jarque-Bera (J-B) test demonstrates that the probability values for inflation and GDP growth rates in their level forms are less than 5%, thereby rejecting the null hypothesis of normality. However, after performing the inverse and Box-Cox transformations, the J-B test probabilities exceed 5%, indicating that the distributions have become normal. Overall, most variables have followed a normal distribution, with the GDP growth rate on the borderline of normality.

4.2. Correlation matrix

The correlation matrix below shows the correlations between dependent and independent variables, including the DSEX index, inflation (INF), GDP growth rate (GR), money supply growth rate (MGR), unemployment rate (UN), and interest rates (INT). Each variable describes the strength and direction of the linear relationships. This approach provides insights into how changes in one variable affect others.

The DSEX index has a high negative relationship with money supply growth (−0.84) and interest rates (−0.61), implying that index improvements lead to declines in both variables. It has a positive relationship with inflation, GDP growth, and unemployment, indicating that

better index performance may lead to higher commodity price, economy growth and unemployment. INF has a minor negative association with GR (-0.11), but moderate negative correlations with MGR and INT (-0.38 and -0.30). This shows that decreasing the growth of the money supply, interest rates, and GDP might lead to higher inflation. The relationship between GDP growth and unemployment is moderately negative (−0.59), meaning that greater unemployment generally corresponds with slower GDP growth. Furthermore, MGR has a significant positive correlation with interest rates (0.76) and a negative correlation (-0.39) with unemployment, indicating that there is a relationship between reduced unemployment and a rise in money supply. Finally, unemployment and interest rates have a negative correlation (−0.48), suggesting that growing unemployment may lead to lower interest rates.

Table 2: Correlation matrix output

	DSEX	INF	GR	MGR	UN	INT
DSEX	1.00					
INF	0.1647	1.00				
GR	0.3019	-0.1128	1.00			
MGR	-0.8375	-0.3808	-0.1453	1.00		
UN	0.2848	0.3874	-0.5890	-0.3876	1.00	
INT	-0.6110	-0.3048	0.2804	0.7553	-0.4784	1.00

4.3. Multicollinearity, serial correlation and heteroscedasticity tests

This section summarizes the findings of several statistical tests performed to evaluate the model's adequacy and dependability.

Table 3: Results of multicollinearity, serial correlation and heteroscedasticity tests

Breusch-Godfrey LM test		Breusch-Pagan for heteroskedasticity		Ramsey RESET test		DW d-statistic
chi2	0.866	chi2(1)	1.60	F (3, 1)	1.22	2
Prob > chi2	0.3521	Prob > chi2	0.2054	Prob > F	0.4797	

The Breusch-Godfrey LM test reveals no significant autocorrelation in the residuals, with a chi-squared statistic of 0.866 and a p-value of 0.3521, indicating that the residuals are independent. Then Breusch-Pagan test for heteroskedasticity provides a chi-squared score of 1.60 and a p-value of 0.2054, showing constant variance with no significant heteroskedasticity. Moreover, the Ramsey RESET test, with an F-statistic of 1.22 and a p-value of 0.4797, indicates that the model is accurately characterized and there is no indication of misspecification. Lastly, the Durbin-Watson d-statistic is 2, confirming the absence of autocorrelation in the residual data. Overall, these findings confirm the model's estimates, an effective and well-defined framework for analysis.

4.4. Test of stationary

Stationarity is critical for econometric models since it ensures that statistical parameters like mean and variance stay constant across time. Additionally nonstationary time series, including those with mean-reverting behaviour, may reduce the efficacy and generalizability of predictions, making them untrustworthy (Pokou, Sadefo Kamdem, and Benhmad, 2024; Subrata, 2020; Jalil and Rao, 2019; Herranz, 2017). The Dickey-Fuller (DF) test, developed by Dickey and Fuller in (1979), is a fundamental technique for determining the existence of a unit root in a time series, with the null hypothesis showing non-stationarity. To allow for higher-order autocorrelation, the test was modified into the Augmented Dickey-Fuller (ADF) test, which contains additional lagged components to address autocorrelation concerns. The Augmented Dickey-Fuller test results showed that all studied variables—DSEX, INF, GR, MGR, UN, and INT—are nonstationary at levels, as demonstrated by strong p-values and t-statistics.

Nonstationary series may provide biased or misleading findings during hypothesis testing (Dinh, 2020b). It may not show true economic trends, possibly leading to poor investment decisions and unproductive governmental responses. Misinterpreting inflation rates, for example, might lead to central banks setting improper interest rates, aggravating inflation in the face of deflationary forces. Similarly, non-stationary GDP growth rates may give an illusion of economic strength, encouraging unnecessary fiscal intervention. Furthermore, nonstationary in the unemployment rate may lead to policies that ignore genuine labour market challenges, such as structural unemployment. Therefore, differentiation can effectively eliminate both trend and seasonal components from a time series, allowing for a better examination of underlying patterns (Pokou, Sadefo Kamdem, and Benhmad, 2024). It is critical to check that macroeconomic time series variables are stable, with constant means and variances throughout time, and covariances determined exclusively by the distance between periods (Subrata, 2020). After the first differencing, all variables become stationary, as shown by significant t-statistics and low p-values, indicating that their statistical data have stabilised (Jalil and Rao, 2019; Herranz, 2017). The 5% critical value for the test is 1.950, indicating that although none of the variables are stationary at levels, they all became stationarity after initial differencing, emphasizing the significance of this process in time series analysis.

Table 4: Stationary (Unit-Root) tests

Augmented Dickey-Fuller test			
		At Level	First Difference
DSEX	t-Statistic	0.401	4.274
	Prob	0.698	0.003
INF	t-Statistic	0.591	4.455
	Prob	0.569	0.002
GR	t-Statistic	0.005	4.912
	Prob	0.996	0.001
MGR	t-Statistic	1.326	2.713
	Prob	0.217	0.027
UN	t-Statistic	0.232	3.693
	Prob	0.822	0.006
INT	t-Statistic	0.522	2.444
	Prob	0.614	0.040
5% Critical Value	t-Stat 1.950		

4.5. Johansen Co-integration tests

Cointegration tests are essential for analyzing the relationships between macroeconomic variables and stock market movements in a long-term context. Johansen's (1991) Cointegration method can be applied to test for long-run equilibrium relationships, indicating at least one cointegration among them (Dinh, 2020a). Johansen's method avoids normalization issues and remains robust against non-normality (Lütkepohl, 2013), transforming macroeconomic modelling by providing a framework for assessing variable integration and long-run economic associations (Subrata, 2020). After employing Johansen's cointegration test, the researcher utilised trace statistics and maximum eigenvalue tests.

Table 5: Co-integration Analysis Output

	Eigenvalue	Trace Statistic	Critical Value (5%)
INT	0.76844	0.05	3.76
UN	0.65005	1.55	3.76
MGR	0.77417	0.06	3.76
GR	0.70652	1.22	3.76
INF	0.61015	3.18	3.76

There are many approaches for determining the optimal lag duration, including the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz's Bayesian Information Criterion (SBIC), and Hannan-Quinn Information Criterion (HQIC) (Paulsen, 1984; Nielsen, 2006). Traditional approaches often favour reduced lag orders, which may reduce prediction performance (Nicholson et al., 2020). Inadequate lag selection may generate several kinds of challenges: too few lags can produce autocorrelation, while too many lag orders can result in overfitting and increased residual variance. Incorrectly stated lag lengths may also affect statistical power, provide inconsistent results, and lead to model misspecification (Lütkepohl et al., 2021; Wooldridge, 2009; Braun and Mittmik, 1993). Optimal lag selection is critical for model stability, ensuring Gaussian errors, minimizing the loss function, and improving prediction accuracy. Therefore, avoiding heteroscedasticity and omitted variable bias; robustness tests between one and two lags are recommended (Elalaoui et al., 2021; Surakhi et al., 2021; Jalil and Rao, 2019). After considering various lag length recommendation, the researcher performed the Johansen test for cointegration using a selected lag of one to determine long-run equilibrium between the stock market index and the five macroeconomic variables. The findings support the null hypothesis of no cointegration among the analysed variables, as demonstrated by trace statistics for UN (1.55), INT (0.05), MGR (0.06), GR (1.22), and INF (3.18), all of which have lower values than the critical value of 3.76. This conclusion contradicts previous research that has shown strong long-term relationships between macroeconomic variables and stock indexes. The findings are consistent with prior research findings (Sukmawati and Haryono, 2021; Mukhlis et al., 2018; Almansour and Almansour, 2016; Ibrahim and Musah, 2014). However, the results regarding unemployment contradict Pan (2018). In addition, numerous studies have identified long-term relationships between interest rates and stock market returns, which contradict these findings (Lee, 2020; Pradhan et al., 2015; Barakat et al., 2016; Jareño and Negrut, 2016; Demir, 2019). Contrary to the current findings, earlier research suggests that macroeconomic variables, including GDP growth rate, inflation and money supply growth (MSG), have significant long-term relationships with stock market returns (Mohnot et al., 2024; Ligocká, 2023; Hasan et al., 2022; Bhuiyan and Chowdhury, 2020; Olokoyo et al., 2020; Demir, 2019; Mukhlis et al., 2018;

Barakat et al., 2016; Jareño and Negrut, 2016; Peiró, 2016; Pradhan et al., 2015b). The absence of cointegration raises significant issues about the study's Arbitrage Pricing Theory (APT) paradigm, which holds that stock prices should be responsive to macroeconomic factors (Chen, Roll, and Ross, 1986; Ross, 1976). If these characteristics influence stock prices, a long-term stable relationship will be expected. Nevertheless, the absence of such an association indicates that the DSEX index may not accurately reflect the macroeconomic conditions that it aims to represent. The results reveal that the stock market may not sufficiently reflect the impact of macroeconomic data, which is a key assumption of the Efficient Market Hypothesis (EMH). The EMH, especially its semi-strong form, asserts that stock prices should react to all publicly accessible information, including macroeconomic indicators. The DSEX index's inability to develop a stable relationship with these attributes indicates that the market may not be successfully integrating this information into stock pricing. Therefore, fluctuations in the index may not reflect changes in underlying economic circumstances, potentially leading to mispricing and inefficiencies. Fama (1970) contends that an efficient market allows informed investors to earn only competitive expected returns, with prices responsive instantly to public information. However, the lack of cointegration implies that the market may not completely respond to relevant macroeconomic data, resulting in price changes based on outdated or incomplete information (Rayball, 1994). The findings show that long-term investors, who often base their investment strategies on macroeconomic trends (Bhuiyan and Chowdhury, 2020), may struggle to discover credible signals in the DSEX index effectiveness about the broader economic situation. This has major consequences for Bangladeshi policymakers, highlighting the need to promote long-term economic development by increasing the size, complexity, and overall infrastructure of the stock market while simultaneously stabilising macroeconomic circumstances. A stock market that does not adequately reflect underlying economic data could undermine the efficiency of institutional and individual investment plans. Prior research, for example, underscored that policymakers should avoid employing the money supply as a main policy instrument to influence the Korean stock market in the long term (Lee, 2020). Such findings underline the necessity of developing a more responsive and transparent market environment in Bangladesh, which can better meet the demands of investors and contribute to more steady economic development.

4.6. Vector autoregression model

When there is no cointegration between variables, the VAR model is acceptable because it allows each variable to be regressed on its historical values as well as the present values of others (Elalaoui et al., 2021; Subrata, 2020).

Table 6: VAR model output

Equation	RMSE	R-sq	chi2	P>chi2
INF	.000075	0.5526	12.35001	0.0021
GR	.000081	0.4737	9.002186	0.0111
MGR	.000061	0.7077	24.21438	0.0000
UN	.000080	0.4881	9.534375	0.0085
INT	.000085	0.4262	7.427126	0.0244

According to Table 6, the Money Supply Growth Rate (MGR) has the best predictive accuracy, with the lowest RMSE of 0.000061 and the highest R-squared value of 0.7077, indicating a significant relationship with the dependent variable. Inflation (INF) likewise performs well, explaining more than 55% of the variance (R-squared = 0.5526) and reaching statistical significance (chi-squared = 12.35001, p = 0.0021). The GDP Growth Rate (GR) and Unemployment Rate (UN) have lesser associations, with R-squared values of 0.4737 and 0.4881, respectively, although both are statistically significant. The Interest Rate (INT) has the lowest R-squared value of 0.4262, implying that it explains the least variation while being statistically significant (p = 0.0244). In this circumstance, policymakers should prioritise monitoring short-term macroeconomic statistics to make timely measures that stabilise the economy and improve stock market performance. According to Beck and Stanek (2019), improving financial markets is critical for lowering the reliance on domestic savings for investment. Strengthening the stock market improves capital-raising abilities, which Pradhan et al. (2014) believe are critical for overall economic health and growth.

Given the considerable short-term dependence of these variables, monetary policy must be adaptive, reacting rapidly to changes in macroeconomic indicators to preserve investment and boost consumer confidence. According to Pradhan (2015b), transparent and effective monetary policies may help with change, connecting stock market development to overall economic growth. Policymakers must strategically control inflation, while financial managers must comprehend short-term interest rate dynamics (Lee, 2020). To reduce interest rate volatility and make credit more available for stock investments, central bank lending rates must be aligned with those of deposit money institutions. During times of stock market volatility, a thorough knowledge of such macroeconomics trends allows for improved portfolio management and diversification strategies (Barakat et al. 2016). Policymakers and investors need to recognise the potential risks of stock market volatility is crucial, since downturns may result in severe losses (Demir, 2019). Overall, these findings highlight the relevance of short-term dynamics and the development of financial markets in creating an effective economic environment.

4.7. Pairwise Granger-causality tests

This section addresses the findings of the Pairwise Granger-causality tests, which evaluate the directional impact of macroeconomic variables on stock market performance, shedding light on the causal relationships within the economic framework.

Table 7: Granger causality tests summary

Null Hypothesis	Prob.	Decision	Relationship
Inflation does not Granger cause DSEX Index Performance	0.865	Accepted	one-way causal relationship
DSEX Index Performance does not Granger cause Inflation	0.004	Rejected	
GDP Growth Rate does not Granger cause DSEX Index Performance	0.932	Accepted	one-way causal relationship
DSEX Index Performance does not Granger cause GDP Growth Rate	0.020	Rejected	
Money Supply Growth Rate does not Granger cause DSEX Index Performance	0.603	Accepted	one-way causal relationship
DSEX Index Performance does not Granger cause Money Supply Growth Rate	0.000	Rejected	
Unemployment Rate does not Granger cause DSEX Index Performance	0.516	Accepted	one-way causal relationship
DSEX Index Performance does not Granger cause Unemployment Rate	0. 016	Rejected	
Interest Rate does not Granger cause DSEX Index Performance	0.055	Accepted	one-way causal relationship
DSEX Index Performance does not Granger cause Interest Rate	0.042	Rejected	

The absence of causality between inflation and the DSEX index indicates that inflation rates do not predict stock market performance. In contrast, the DSEX's considerable effect on inflation implies that changes in stock prices may shape inflation expectations, implying a one-way relationship in which market performance influences inflation patterns. The one-way causal relationship between the DSEX and inflation ($p = 0.004$) implies that policymakers should use stock market movements to forecast inflationary pressures. This result is consistent with the findings of Hasan et al. (2022), but it contradicts Almansour and Almansour (2016) and Ibrahim and Musah (2014), who found no direct association between inflation and stock market performance. Therefore, policymakers can implement timely monetary measures to reduce inflation while maintaining market stability by constantly tracking stock performance. Additionally, a proactive strategy to incorporate stock market data into inflation control plans may improve monetary policy's efficacy.

Secondly the DSEX's impact on GDP implies a one-way causal relationship in which a flourishing stock market may drive economic expansion, validating the concept that stock performance can boost GDP growth. The findings contrast those of previous studies (Ligocká, 2023; Mostafa, 2020; Pradhan et al., 2015b). This underscores the importance of policymakers adopting actions that promote stock market expansion, since they may boost capital availability for firms while also stimulating general economic activity. Therefore, encouraging more public engagement in the stock market could increase these impacts.

The money supply growth rate may not be a direct predictor of stock market behaviour, as shown by the lack of a causal relationship between changes in the money supply and stock performance. On the other hand, a robust stock market index performance might promote more lending and liquidity, demonstrating that stock performance has a substantial impact on the expansion of the money supply. DSEX and Money Supply have a one-way causal relationship (Rejected, 0.000). These findings are contrary to the findings of earlier studies (Ibrahim and Musah, 2016; Plihal, 2016; Almansour and Almansour, 2014). If the policymaker can increase market confidence may result in more liquidity, which is beneficial for investors and the economy as a whole.

Furthermore, it was shown that there is no causal relationship between unemployment and stock (DSEX) performance, indicating that labour market fluctuations have minimal impact on stock movements. However, the DSEX's influence on unemployment implies that a rising stock market may lead to job creation, establishing a relationship between stock performance and employment levels. The study reveals a one way or unidirectional causal relationship between the DSEX and the unemployment rate (rejected at 0.016). The results are consistent with Sibande et al. (2019) and Algieri, Brancaccio, and Buonaguidi (2020), but contradict Tiryaki, Erdoğan, and Ceylan's (2017) conclusions. As a result, policymakers should prioritise initiatives that promote stock market expansion as a method for increasing employment. Thats why promoting a strong stock market may assist in lowering unemployment risks, demonstrating the interdependence between financial markets and labour market dynamics.

Finally, the study concluded that the lack of a causal association between interest rates and stock performance demonstrates that changes in borrowing costs do not directly predict market behaviour. In contrast, the DSEX's impact on interest rates shows that strong stock performance might inform monetary policy decisions, resulting in a reverse relationship in which stock market patterns can shape interest rate

policies. The study finds a unidirectional causal relationship between the DSEX and interest rates (rejected at 0.042), which is in line with previous research on the nature of this relationship (Wickramasinghe, 2023; Hasan et al., 2022; Bahloul et al., 2017; Barakat et al., 2016; Mahzabeen, 2016). This conclusion, however, contradicts Ibrahim and Musah's (2014) finding that interest rates have no causal association with stock market index performance. When setting interest rates, policymakers should recognize the causal relationships between stock performance and interest rates might help monetary policy work more effectively, particularly during times of economic instability.

5. Conclusion

In conclusion, this study revealed that all variables are non-stationary at level I(0) but become stationary at the first difference, I(1) through Augmented Dickey-Fuller tests. The findings highlight no long-term equilibrium relationship between macroeconomic variables and stock market performance, as revealed by Johansen's cointegration tests. The lack of such relationships indicates that changes in one variable do not have a predictable long-term influence on others. Then granger causality test reveals one-way or unidirectional relationships between economic variables and stock market performance. These results show moderate to substantial short-term relationships between the DSEX broad index and macroeconomic variables, as shown by high R-squared and significant chi-squared coefficients. While inflation does not Granger cause DSEX index performance, the index accurately anticipates inflation patterns, demonstrating its importance as a policymakers' predictive tool.

Furthermore, the DSEX index provides predictive powers for GDP growth, money supply growth, unemployment, and interest rates, highlighting its significance in comprehending wider economic dynamics. Importantly, the findings show the DSEX broad index performance acts as an effective indicator for anticipating future changes in macroeconomic dynamics in Bangladesh. The literature assessment revealed a dearth of research on emerging countries and a scarcity of studies on the nature of the relationship between macroeconomic variables and the Bangladesh stock market index. The findings have added to the literature by throwing light on this uncharted territory. To improve decision-making and maintain market stability, investors and governments should pay close attention to important variables including the interplay between macroeconomic data and stock market swings.

5.1. Limitations

The research, which spans the years 2013 through 2023, could not completely account for long-term trends or anomalies, thereby overlooking previous changes and newly developing stock market patterns. Its only emphasis was on the DSEX broad index, which would not accurately reflect the total performance of Bangladesh's stock market and might provide incomplete or biased results if other indexes or market sectors were left out. Reliance on secondary data increases the possibility of errors and incompleteness, which may compromise the validity of the conclusions and interpretations. Furthermore, the study focused on a narrow range of macroeconomic variables, thus ignoring other important aspects that might affect stock market performance.

5.2. Implications

The study's findings have major theoretical and practical implications. Firstly, understanding the unidirectional relationship between the DSEX index performance and key macroeconomic variables is essential to developing effective financial policies. These implies that, although the stock market may impact other economic indicators, the contrary is not always true for many variables. Moreover, it contradicts standard economic theories that propose a more integrated connection between macroeconomic factors. The results demonstrate how stock market changes may influence broader economic circumstances, emphasising the need for a more sophisticated approach to economic management. Policymakers may use this insight to create targeted monetary policies aimed at fostering market stability, such as adjusting the macroeconomic dynamics to directly impact stock market performance and maintain economic resilience. Recognizing these causal relationships allows policymakers to make better-informed choices that not only promote stock market health but also enhance long-term economic development. This strategy may assist in guaranteeing that the stock market is a more stable and resilient component of the overall economy, contributing to long-term economic growth.

5.3. Future research directions

Future studies should broaden the time frame to encompass times before 2013 and after 2023 to capture long-term trends and anomalies. This extended timeframe would provide a more comprehensive perspective of past developments and developing patterns in the stock market, facilitating deeper insights into stock market behaviour over time. Additionally, researchers should include a wider variety of stock market indices, such as the DS30 and DSE Shariah Index, in addition to the DSEX broad index. Including these indexes and market sectors would provide a more accurate picture of Bangladesh's stock market performance and assist in mitigating any biases. To mitigate the constraints of secondary data, future studies should investigate gathering primary data to increase accuracy and dependability. Furthermore, the researcher should examine a broader range of macroeconomic variables, such as government fiscal policies, foreign currency reserves, exchange rates, and oil prices, which will improve knowledge of the variables that influence stock market movements.

Data availability: The datasets generated and analyzed during the current study are available on the Dhaka Stock Exchange, Investing.com, Macrotrends and the World Bank websites.
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Fairuz Anjum Binte Habib (0009-0008-1336-2103) have obtained a Bachelor of Business Administration (BBA) in Finance and Banking from the International University of Business Agriculture and Technology (IUBAT) and an MBA in Finance from the Bangladesh University of Professionals, where she demonstrated remarkable academic excellence. Her research interests include classroom education, capital markets, financial technology, and artificial Intelligence. She has served as a lecturer for over one year at a private university in Bangladesh and has experience in various educational institutions throughout her professional journey. Currently, she is working on multiple articles related to artificial intelligence, banking, and absenteeism, which are being considered for notable international journals. Her primary goal is to be an inspiring educator at a well-regarded university, contributing significantly to the fields of education and research.