Macroeconomic Forces and Stock Prices:Evidence from the Bangladesh Stock Market

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24 April 2013

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April 21, 2013

Abstract

The study examines the influence of a selective set of macroeconomic forces on stock market prices in Bangladesh. The Dhaka Stock Exchange All-Share Price Index (DSI) is used to represent the prices in the stock market while deposit interest rates, exchange rates, consumer price index (CPI), crude oil prices and broad money supply (M2) are selected to represent the macroeconomic variables affecting the stock prices. Using monthly data from 1992m1-2011m6, several time-series techniques were used which include Cointegration, Vector Error Correction Model (VECM), Impulse Response Functions (IRF) and Variance Decompositions (VDC). Cointegration analysis, along with the VECM, suggests that interest rates, crude oil prices and money supply are positively related to stock prices, exchange rates are negatively related to stock prices, and CPI is insignificant in influencing the stock prices, in the long-run. Both the IRF and VDC suggest that shocks to macroeconomic variables explain a small proportion of the forecast variance error of the DSI, but these effects persist for a long period.

Keywords: Asset Prices, Macroeconomic Factors, Dhaka Stock Exchange, Cointegration

JEL Classification: C22, E44, E58, G12

Introduction

Stock markets, where shares and bonds are traded and issued through exchanges and over-the-counter markets, form an integral part of the financial markets and are important for the development of an economy. Stock markets contribute to the economy by providing businesses with access to capital and investors with opportunities for capital gains. Research has shown that stock market development contributes significantly to the economic growth of a country (Levine and Zervos, 1996)[1]. Since stock market prices are subject to fluctuations, it is essential to determine the forces influencing the stock prices for efficient functioning and development of the stock market and country.

There are many reasons for there to be an interest to determine the forces influencing the stock prices. Firstly, this may interest investors, so they can forecast stock prices accurately to make apt decisions regarding their stock portfolio for maximum gains. Secondly, businesses may find this useful; as stock price is an indication of the financial health of the companies, businesses may be interested to determine the future stock prices as it will allow them to assess their ability to issue bonds or obtain financing in the future. Thirdly, policymakers and economists may find this useful, so they can predict stock prices as prices of stocks reflect changes in economic activity in the long run (Cheung and Lai, 1999).

Stock prices are expected discounted dividends, i.e. discounted value of future cash flows derived from a stock. Theoretically, stock prices are modelled as:

$$P = \sum_{t=1}^{n} \frac{E(CF)}{(1+R)^t}$$

[1] For a debate on the relationship between financial/stock market development and economic growth, see Gurley and Shaw (1955, 1960, 1967), McKinnon (1973), Shaw (1973), Goldsmith (1969) and Levine (2004)

where *P* refers to the stock price, *CF* refers to the expected cash flows derived from a stock and *R* refers to the discount rate. Hence, any forces influencing the *R* or *CF* will affect the stock prices. However, theoretical models do not provide an 'identity' of these exogenous economic forces (Bodhurta et al., 1989), i.e. do not identify the economic forces influencing the stock prices. Macroeconomic variables are potential candidates for these forces because macroeconomic changes simultaneously affect many firms' cash flows and may influence the risk-adjusted discount rate (Shiller, 1981; Leroy and Porter, 1981; Flannery and Protopapadakis, 2002), or simply, discount rate.

The purpose of the research will be to try to find a long-term relationship between macroeconomic forces and stock prices for an emerging stock market in a less developed country. The study will focus on an emerging market because the behaviour of stock prices in these countries is not tied to economic fundamentals (Gunasekarage et al., 2004) and, therefore, makes it difficult to predict the forces affecting the stock prices. Moreover, studies on emerging markets have shown that returns and risks in these markets are higher relative to those in stock markets in developed countries (Harvey, 1995a). It will be interesting to determine what factors cause these higher risks and returns and study the relationship between macroeconomic forces and stock prices in emerging stock markets.

This research will study the relationship between a selective set of macroeconomic variables and stock prices in the Bangladesh stock market. The Bangladesh stock market is an established capital market and deemed as the next Asian success story by JPMorgan Chase, Citigroup, and Merrill Lynch (Bloomberg, 1997); its stocks have performed well in recent years and prices gained nearly 50% over one year in 2010 (2nd highest in the world after Sri Lanka)[2]. However, the stock market is still

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[2] Bespoke Investment Group (2010)

developing and the analysis made in this study can, therefore, be used to shed light on other emerging stock markets.

For the purpose of the study, the stocks from the Dhaka Stock Exchange (DSE), the primary stock market of Bangladesh, will be considered as it covers majority of the stocks in the country and will allow a more comprehensive analysis. The DSE uses three share price indices - DSE All-Share Price Index (DSI), DSE General Price (DGEN) Index, and DSE-20[3]. The DSI is a statistical compilation of all the stocks in the DSE including Z-category shares and will be used as a proxy for stock prices. The study will cover the last two decades since the DSE became very active during this period due to developments in the capital markets of Bangladesh, such as exemption of tax dividends on stock market investments to increase stock trades, off-loading of shares of government-owned companies, allowing investment of black money[4] into the capital market, etc.

The next section reviews the existing literature on the topic and discusses the methodologies used in the papers. Section 3 describes the macroeconomic variables used in the study along with their hypothesized relationships with the stock prices. Section 4 discusses the sources from which the data were collected and provides descriptive statistics of the data. Section 5 explains the econometric model and methodologies used in the study. Section 6 provides the empirical results with interpretations. Section 7 concludes the paper and offers further remarks.

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[3] DGEN Index excludes Z-category securities, and no mutual fund, bond and debenture are considered in this index. DSI is formed with all enlisted securities excluding mutual fund, bond and debenture. DSE-20 is structured with the 20 best enlisted companies depending on performance and specific criteria

[4] Money undisclosed to the tax authorities and on which due taxes have not been paid

Literature Review

Chen, Roll and Ross (1986) (CRR) was one of the pioneer papers that tried to identify the macroeconomic variables that influenced stock returns and determined this relationship for the New York Stock Exchange (NYSE). They used a regression framework to test whether macroeconomic innovations such as monthly growth in industrial production, expected inflation and unexpected inflation[5], and an interest rate spread variable have systematic influences on stock market returns. To this end, they estimated a Vector Autoregression (VAR) model of lagged stock market returns and used the residuals of the macroeconomic variables as unanticipated innovations arising from them. They found that industrial production, changes in the risk premium, term structure, unexpected inflation and changes in anticipated inflation were significant in explaining expected stock returns in the NYSE. They also used value-weighted NYSE index as a macroeconomic variable, and found that it has an insignificant influence on expected returns.

Poon and Taylor (1991) used the dataset for the London stock market and the same macroeconomic variables as CRR and found that no significant relationship exists between stock returns and the macroeconomic variables. Diacogiannis (1986) and Cheng (1995), similarly, determined that there is no conclusive result regarding the relationship of relevant macroeconomic variables with the capital market of the U.K. Günsel and Çukur (2007), using the same variables as CRR, looked into different industries in the U.K. and found that macroeconomic factors have a significant effect in the U.K. stock exchange market; however, each factor affect different industry in different manner.

[5] Expected inflation was constructed following Fama and Gibbons (1984)

Further work on the topic has extended the analysis by incorporating different framework/setting and conducted the study using different econometric methods. Bodhurta et al. (1989) undertook an analysis for seven major industrial countries – United States, Japan, United Kingdom, Germany, France, Canada and Australia. They chose the same explanatory variables as CRR, and to incorporate an international setting, introduced deviations from Purchasing Power Parity, typified as real exchange rate changes, and interest rate parity. They were able to demonstrate that several of the international analogs of the CRR domestic variables - stock index returns, industrial production, bond returns, unanticipated inflation and oil prices are significant in explaining the average stock returns in the cross-section sample.

Mukherjee and Naka (1995) used a different methodology to determine the relationship between macroeconomic forces and stock returns. They employed Johansen's (1991) Vector Error Correction Model to examine whether relevant macroeconomic variables and the Tokyo Stock Exchange (TSE) index were cointegrated for the period 1971-1990. They found that a cointegrating relationship exists and that stock prices contributed to the relation. The relationships between stock index and exchange rates, inflation, money supply, and industrial production were as hypothesized and the same as existing literature. Nasseh and Strauss (2000) used Johansen's cointegration procedure and variance decompositions method for 1962-1995 for six European countries: France, Germany, Italy, The Netherlands, Switzerland and the U.K., and found support for the existence of a long-run cointegrating relationship between stock prices and domestic interest rates, consumer prices, real industrial production, business surveys of manufacturing orders, and International (German) movements in stock prices.

There have only been a few studies focused on the emerging markets in less developed countries. Wongbangpo and Sharma (2004) studied the stock markets of the five ASEAN countries, namely Indonesia, Malaysia, Singapore, Philippines and Thailand, and their relationship with select macroeconomic variables. They found that in the long-run, the stock prices were positively related to growth in output, and negatively to the aggregate price level. A negative long-run relationship between stock prices and interest rates was observed in Philippines, Singapore and Thailand. High inflation in Indonesia and Philippines was found to influence the long-run negative relation between stock prices and the money supply, while the money growth in Malaysia, Singapore and Thailand was found to be responsible for the positive effect on their stock markets. Lastly, the exchange rate variable was positively related to stock prices in Indonesia, Malaysia, and Philippines, which can be explained by the high competition in the world exporting market.

Mookerjee and Yu (1997) and Maysami and Koh (2000) studied the Singapore stock market and found that changes in Singapore's stock market levels form a cointegrating relationship with changes in price levels, money supply, short- and long-term interest rates. Gunasekarage et al. (2004) examined the long-run relationship between macroeconomic factors and all-share price index from 1985-2001 for the Colombo Stock Exchange and found that the consumer price index and treasury-bill rate coefficients are significant and negative, money supply coefficient is significant and positive, but exchange rate had no influence on share price index. Frimpong (2009) conducted a study on Ghana for the period 1990-2006 and found that exchange rates are positively related to the Ghana Stock Exchange All-Share index (GSE), and inflation and money supply are negatively related to the GSE.

Macroeconomic Forces and the DSI: Hypothesized Relations

This section covers the macroeconomic variables chosen for the study and their hypothesized relationships with the DSI. The variables chosen were based on financial theory and established literature - deposit interest rates (IR), exchange rate (ER), consumer price index (CPI), crude oil prices (OP) and broad money supply (M2)[6].

The intuition behind the relationship between deposit interest rates and stock prices forms the basis for the hypothesized negative relationship between the variables. Interest rates represent the opportunity cost for investors in the equity markets (Asprem, 1989). An increase in the interest rates results in high opportunity cost of holding cash and leads investors to substitute between stocks and other interest-bearing securities. Moreover, the interest rates, through their effect on the risk-free rate, will cause an increase in the discount rate (Mukherjee and Naka, 1995). Thus, stock prices are expected to fall and vice versa.

Solnik (1987), Soenen and Hennigar (1988) and Ma and Kao (1990), among others, indicate that exchange rates play a significant role in affecting the performance of a stock market. For this study, a positive relation is hypothesized between exchange rate (against the U.S. dollar)[7] and stock prices based on the classic theory of Hume (1752). As goods in the Bangladesh economy become relatively more expensive in the international market due to an appreciation of the Bangladeshi Taka (falling exchange rate) against the U.S. dollar, demand for exports reduce and, at the same time, demand for imports increase, thus leading to lower Taka-denominated cash flows into the Bangladeshi companies and hence, lower stock prices. This is evident from the

[6] Amount of money in circulation in the economy

[7] A weighted average exchange rate against the U.S. Dollar was compiled (and not against a basket of currencies) since most international transactions are conducted in U.S. Dollar

theoretical model of stock valuation. The opposite should hold when the Bangladeshi Taka depreciates against the U.S. Dollar.

The relation between consumer price index and stock returns has been generally theorized to be negative (Fama and Schwert, 1977). A fall in consumer price index lowers the nominal risk-free rate and decreases the discount rate in the stock valuation model, leading to higher stock prices. Mukherjee and Naka (1995) suggest that the effect of a lower discount rate would be neutralized if cash flows decrease with the CPI. DeFina (1991), however, documents that cash flows do not decrease at the same rate as inflation or CPI, and, hence, it is expected that the fall in discount rate will lead to higher stock prices. It must be noted though, that prices, in general, may be subject to greater fluctuations in the developing countries, which may render the relationship insignificant. Thus, a negative or insignificant relationship is expected between CPI and stock prices.

Crude oil prices are used in this study following Hassan and Hisham (2010). Oil prices serve as an input for production in sectors, such as agriculture and manufacturing, and thereby account for real economic activities taking place in the country. A high oil price will result in reduced economic activities, and lower expected cash flows and stock prices. Hence, a negative relationship is hypothesized between oil prices and stock prices. The opposite relationship is expected to hold as well. It should be noted that crude oil price is an external factor - the objective is to see whether international factors play a role in the stock markets of Bangladesh.

The relationship between money supply and stock prices is not straightforward because changes in money supply have important direct effects on stock prices via portfolio changes, and indirect effects via its effects on real activity variables (Mookerjee and Yu, 1987). As money growth rate is likely to be positively related to inflation, it will increase the discount rate and, hence, lower stock prices. However, since prices are considered constant in this study, the effect of money supply on stock prices may be through other mechanisms. Sellin (2001) argues that a positive money supply shock will alter expectations about future monetary policy and lead people to anticipate tightening monetary policy in the future. The subsequent increase in bidding for bonds will drive up the current rate of interest. As the interest rate goes up, the discount rate increases, and the present value of future earnings decline, leading to a fall in stock prices. The increase in money supply may also lead to a boost in companies' cash flows resulting from the increased money supply (Mukherjee and Naka, 1995; Chaudhuri and Smiles, 2004), known as corporate earnings effect, which is likely to increase stock prices. For this study, a negative relationship is expected between money supply and stock prices since prices and interest rates are subject to greater fluctuations in developing countries.

Data

4.1 Data Sources

For the purpose of this paper, monthly data has been collected for the period January 1992 to June 2011. The period was chosen purposefully since the Bangladesh economy has undergone major changes during this period, such as trade liberalisation in the 1990s, capital market developments in the 2000s, etc., and it will be interesting to analyse the relationship between the macroeconomic variables and stock index during this period. Firstly, the monthly Dhaka Stock Exchange All-Share Price index data is obtained from the Dhaka Stock Exchange and its website[8]. Next, five macroeconomic variables have been chosen. These include the deposit interest rate, the exchange rate (domestic currency for US dollar), consumer price index (with a base year of 2005), per barrel price of crude oil in U.S. Dollar, and broad money supply in local currency. Data on consumer price index, exchange rate, deposit interest rates and crude oil prices were collected from the International Financial Statistics of the International Monetary Fund. Data on broad money was collected from the Monthly Trends publications of the Bangladesh Bank. Other variables were also considered for the study initially, such as call money rate and industrial production index, but due to unreliability and unavailability of data, they had to be excluded from the study.

[8] www.dsebd.org

4.2 Data Statistics

This sub-section provides descriptive statistics and time-plots (attached in Figure A-1a:f in the Appendix) for the data under study. The purpose is to observe the trends that the variables have displayed over the period and analyse the changes that have taken place. For the sake of the study, all the variables (except interest rates[9]) have been converted into natural logarithms[10]. The following table gives a summary of the descriptive statistics of the variables:

Table 0:1: Descriptive Statistics of Variables - January 1992 to June 2011

	Summary Statistics – Logged Variables (except IR)					
Variable	DSI	IR	ER	CPI	OP	M2
Mean	6.99	8.22	3.98	4.42	3.44	13.75
St. Dev.	0.76	1.21	0.22	0.32	0.65	0.80
Maximum	8.87	11.39	4.30	5.05	4.89	15.30
Minimum	5.66	5.77	3.66	3.93	2.34	12.47
Note: DSI is Dhaka Stock Exchange All-Share Price Index, IR is deposit interest rate, ER is exchange rate, CPI is consumer price index, OP is oil prices and M2 is broad money. All the variables (except interest rates) are in natural logarithms						

Source: Dhaka Stock Exchange, Bangladesh Bank and International Financial Statistics

The time plot in Figure A-1a shows that in the span of 1992M1-2011M6, the DSI has registered an upward trend. The DSI series shows spikes in 1996 and 2010, both were due to bubbles[11] in the stocks.

The deposit interest rates were fairly stable in the period under consideration, with low standard deviation, as seen in Table 4.1 and Figure A-1b. The deposit interest

[9] Interest rates were kept in their original forms due to the nature of the data

[10] Natural logarithms are taken as they stabilize variance, handle covariates which are only positive, and make a symmetric distribution so coefficients are not influenced by extreme values

[11] A bubble means that the prices of the stocks were above their fundamental values

rates were lower during the periods of the stock market crashes, as banks were forced then to lower the interest rates that they pay out on deposits to customers.

The exchange rate of Bangladeshi Taka against the U.S. Dollar has been on an upward trend for the entire period, as seen in Figure A-1c. The Bangladesh economy is highly reliant on imports for luxury products and raw materials. Since these transactions are conducted in U.S. Dollars, the exchange rate of the Bangladeshi Taka against the U.S. Dollar has been rising. However, the appreciation of the U.S. Dollar against the Bangladeshi Taka has ceased since the global financial crisis in 2006-2007, as transactions in U.S. Dollar have reduced.

The consumer price index, which is taken to account for inflation[12], has risen steadily over the entire period, as seen in Figure A-1d.

The crude oil prices data in Figure A-1e show that the prices have remained mostly stable until 2006. Since then, crude oil prices have seen major fluctuations with record-high prices during the recent global financial crisis. The prices were lower in 2008; a stronger US dollar in the international market and a decline in European demand are among the likely causes of the decline.

The broad money supply data in Figure A-1f shows that M2 has steadily increased for the entire period except for two shocks in 1996 and 2006. However, the overall trend in the broad money data has been upward.

[12] Precisely, difference of log CPI is inflation

Econometric Methodology

The purpose of the study is to determine if a long-run relationship exists between the DSI and macroeconomic factors for Bangladesh. The econometric model to be used for the paper is as follows:

$$\ln DSI_t = \beta_0 + \beta_1 IR_t + \beta_2 \ln ER_t + \beta_3 \ln CPI_t + \beta_4 \ln OP_t + \beta_5 \ln M2_t + \varepsilon_t$$

where the variables are as they have already been defined, and ε_t is the error term in the model. β_0 represents the constant term in the model and β_1, β_2, β_3, β_4 and β_5 represent long-run parameters.

Time-series econometrics requires an analysis of the time-series properties and paths of the economic variables in a regression equation before estimation in order to assess if a long-run relationship can be estimated for the model. A long-run relationship exists if the variables are non-stationary in levels and stationary in first differences. More specifically, it should be ensured that the variables in the study are integrated of order d, where $d \geq 1$, i.e., they should be stationary in differenced forms, denoted as $I(d)$.

Unit root, or non-stationarity of the variables, in the time series involved is important before proceeding further with the analysis. When testing for stationarity of the variables involved, conventional unit root tests like Augmented Dickey Fuller (1979) (ADF) and the Phillip-Perron (1988) tests, in the presence of structural breaks in the time series of the variables, may present test statistics that are strongly misleading. This may result in the inferences drawn from them to be highly inaccurate. For example in the event of a standard ADF regression:

$$y_t = \alpha + \delta t + \sum_{j=1}^{p} \gamma_j \Delta y_{t-j} + \rho y_{t-1} + \varepsilon_t$$

A deterministic level shift will cause the primary coefficient of concern in the ADF regression, ρ, to be biased towards 1 while a change in the trend slope makes the estimator tend to 1 in probability as the sample size increases. Hence, the ADF test may indicate presence of unit root even when the time-series is stationary around the deterministic break component. In fact, such flaws may be extended to other classes of traditional unit root tests as well (Perron, 1989, 1997 and Zivot and Andrews, 1992, Perron and Vogelsang, 1992).

Perron (1989) first proposed a solution to this problem, where he figured for inclusion of an exogenous structural break at time T_b, the time of break is known a priori. Perron used a modified Dickey-Fuller (DF) unit root tests which included dummy variables to account for one known, or exogenous structural break. The break point of the trend function is fixed (exogenous) and chosen independently of the data. Perron's (1989) unit root tests allowed for a structural break under both the null and alternative hypothesis. However the usage of an exogenous break was criticized and thus Zivot and Andrews (1992), and Perron and Vogelsang (1992) both formulated unit root tests where the break was endogenously derived. Of these two, however, Zivot and Andrews (1992) allowed the structural break not under the null hypothesis of a unit root but only under the alternative. This is thus a very undesirable feature, and subsequently Vogelsang and Perron (1998) showed that if a unit root exists and a break occurs in the trend function the Zivot and Andrews test will either diverge or will not be invariant to the break parameters (Haldrup. et al., 2012).

Essentially these classes of tests follow in the methodology first established by Perron (1989), and the following equations are estimated:

$$x_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t$$

$$x_t = \alpha_0 + \gamma DT_t * + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t$$

$$x_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \gamma DT_t + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t$$

Where the intercept dummy DU_t represents a change in the level; DU_t =1 if (t > TB) and zero otherwise; the slope dummy DT_t (also DT_t*) represents a change in the slope of the trend function; DT^* = t-TB (or DT_t*= t if t > TB) and zero otherwise; the crash dummy (DTB) = 1 if t = TB +1, and zero otherwise; and TB is the break date. Each of the three models has a unit root with a break under the null hypothesis, as the dummy variables are incorporated in the regression under the null. The alternative hypothesis is a broken trend stationary process.

However, Perron had suggested that most economic time series may be adequately modeled using either model A or model C. Hence, subsequent literature has primarily applied model A and / or model C (Waheed et al., 2006).

Although Perron and Vogelsang (1992) adopted a similar methodology, they had tailored the tests for usage on raw (non-trending) data. This was improved subsequently by Perron (1997), where the methodology was updated to test for unit root in trending data series. Hence, we apply the unit root tests as derived by Perron (1997)

Structural Breaks in time series data by a shock occur either instantaneously or gradually. Instantaneous change to the new trend function is modeled in Additive Outlier (AO) model and the change that takes place gradually is modeled in Innovational Outlier (IO) model. From the viewpoint of this paper, it is reasonable to follow the IO model, as policy reforms at macro level do not cause the target variable to respond instantaneously to the policy actions.

Thus following Perron (1997), we ran an IO model to test for stationarity under presence of structural break:

$$x_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \gamma DT_t + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t$$

It may be seen that the preceding model conforms to Model C from the three equations originally outlined by Perron (1989). As stated, in our tests we accounted for structural breaks in both the slope and intercept. This unit root test was ran under the Eviews add-in program *'ppuroot'* which after having been provided with a maximal lag length (usually either 4 or 12, based on the frequency being either based on quarterly or yearly intervals), internally derives the optimal lag length for the test.

After testing the variables for unit root, the next step entails determining if cointegration exists among the variables. Engle and Granger (1987) suggest that a long-term equilibrium relation between stock prices and macroeconomic factors can be determined using cointegration analysis. If two or more series individually have unit root, but some linear combination of them has a stationary process, then the series is said to be cointegrated. The Johansen (1991) method is an extension of Engle and Granger procedure, allowing for more than one cointegrating equation and it this procedure which will be undertaken. Suppose for a multivariate case:

$$x_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \gamma DT_t + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t$$

$$Y_t = \delta + \Theta_1 Y_{t-1} + \Theta_2 Y_{t-2} + u_t$$

where Y_t is a vector of k variables, i = 1,2 Θ_i is $k \times k$. This can be manipulated and written as:

$$\Delta Y_t = \delta - \Theta_2 \Delta Y_{t-1} + \Pi_k Y_{t-1} + u_t$$

where $\Delta Y_t = Y_t - Y_{t-1}$, and $\prod_k = \Theta_1 + \Theta_2 - I_k$. If the rank of $\prod_k$ is zero, then there are no cointegrating vectors. In the presence of cointegration, $\prod_k$ has rank $r \leq k - 1$, and then, $\prod_k = \alpha\beta'$, where α is $k \times r$ and β' is $r \times k$. Then, this can be written as:

$$\Delta Y_t = \delta - \Theta_2 \Delta Y_{t-1} + \alpha\beta' Y_t + u_t$$

where β' is the cointegrating matrix, $\beta' Y_t$ represents the r linear combination and α represents the speed of adjustment towards the long-run equilibrium relationship. In order to perform Johansen tests, we need to compute the k eigenvalues of $\hat{\Pi}_k$, which is the estimate of $\prod_k$. It is assumed that $\hat{\lambda}_1 > \hat{\lambda}_2 > ... > \hat{\lambda}_k$ is the squared canonical relationship ordered from the largest to the smallest. If there are r cointegrating relationships, then $log(1 + \lambda_j) = 0$ for $j=r+1,...,k$. Test for $H_0 : r \leq r_0$ versus $H_A : r > r_0$, i.e. under the null, the number of cointegrating vector is at most r_0, under the alternative, it is larger than r_0.

$$\lambda_{trace}(r_0) = -T \sum_{j=r_0+1}^{k} \log(1 - \hat{\lambda}_j)$$

This is called a Trace test. The maximum eigenvalue test is also conducted to test for the number of cointegrating relationships. Under the maximum eigenvalue test, $H_0 : r \leq r_0$ versus $H_A : r = r_0 + 1$, i.e. under the null, the number of cointegrating vector is at most r_0, under the alternative, it is equal to $r_0 + 1$.

$$\lambda_{\max}(r_0) = -T \log(1 - \hat{\lambda} r_0 + 1)$$

If at least one cointegrating relationship exists among the variables, a causal relationship among them can be determined by estimating the Vector Error Correction Model (VECM). In this study, the relevant short-run VECM equation with a lag length p is modeled as:

$$\begin{aligned} \Delta \ln DSI_t = \alpha_0 + \alpha_{1t} \sum_{i=1}^{p} \Delta \ln DSI_{t-i} + \alpha_{2t} \sum_{i=1}^{p} \Delta IR_{t-i} + \alpha_{3t} \sum_{i=1}^{p} \Delta \ln ER_{t-i} + \alpha_{4t} \sum_{i=1}^{p} \Delta \ln CPI_{t-i} \\ + \alpha_{5t} \sum_{i=1}^{p} \Delta \ln OP_{t-i} + \alpha_{6t} \sum_{i=1}^{p} \Delta \ln M2_{t-i} + \varphi \varepsilon_{t-1} + \upsilon_{1t} \end{aligned}$$

where the variables are I(1) and as previously defined, α_1, α_2, α_3, α_4, α_5 and α_6 represent short-run elasticities, ε_{t-1} is the error correction term, with its coefficient φ, which conveys the long-run information contained in the data and denotes the speed of adjustment to long-run equilibrium after a shock to the system. The VECM builds on cointegration by incorporating error correction terms that account for short-run dynamics, and, if a long-run equilibrium condition is valid and cointegration exists, it explains short-run fluctuations (as represented by the $\alpha_{1,} \ldots \alpha_{6}$) in the dependent variable (Frimpong, 2009). The optimal number of lags is determined by lag length in VAR using AIC.

Impulse Response Functions (IRF) and Variance Decompositions (VDC) will be constructed after estimating the VECM. IRF is a useful tool for characterizing the dynamic responses implied by estimated VECM. Consider a first-order VAR for the n-vector y_t:

$$y_t = \mu + Ay_{t-1} + \varepsilon_t$$

where μ is the vector of intercepts and $\varepsilon_t \sim IN(0, \Sigma)$. The IRF of a shock to a variable, for instance, IR, on variable DSI after k periods is:

$$\begin{aligned} IRF(DSI, IR, k) = [E(y_{DSI,t} \mid \varepsilon_{IR,t-k} = 1, \varepsilon_{\backslash IR,t-k} = 0, \varepsilon_{t-k+1} = 0, \ldots, \varepsilon_t = 0] \\ - E[y_{DSI,t} \mid \varepsilon_{IR,t-k} = 0, \varepsilon_{\backslash IR,t-k} = 0, \varepsilon_{t-k+1}. = 0, \ldots, \varepsilon_t = 0] \end{aligned}$$

where $\varepsilon_{\backslash IR,t}$ is the vector ε_t excluding the IR element. The IRF measures the effect of a shock of 1 unit occurring at period *t-k* in say, IR, or Deposit Interest Rate, on DSI, *k* periods later, assuming there are no other shocks at period *t-k*, or in the other intervening periods (*t–k+1,…t*). The IRF shows impulse responses of the select variable in the VECM system in regards to the time paths of the variable's own error shock against the error shocks to other variables in the system. Since the innovations of error terms are likely to be contemporaneously correlated, a mechanism of Impulse Response via the Generalized Impulse Response method is implemented, to ensure orthogonalization of the innovations, so as to ensure that interpretation of an impulse response is straightforward. This helps to ensure to rule out contemporaneous correlations amongst the error terms, the presence of which would imply that a shock to one variable is likely to be accompanied by shocks to some of the other variables. Unlike other mechanisms of orthogonalization of innovations where the interpretation of specific impulses rests on the ordering of variables within the VAR system, the Generalized Impulse Response has no such concern on the VAR ordering. The VDC is implemented to show the percentage of the movement of the t-step ahead forecast error variance of the select variable in the VECM system that is attributed to its own error shock in contrast to error shocks to other variables in the system (Gunasekarage, 2004).

Empirical Results

6.1 Results of Unit Root Tests

It is essential to confirm the order of integration of the variables before the model is estimated and tested for cointegration. As mentioned earlier, Perron's (1997) Innovative Outlier unit root test was utilized for this and was conducted for all the variables with structural breaks allowed for both in intercept and time trend, with the optimal lag length chosen by the test program on Eviews itself. The null hypothesis for this test implies presence of nonstationarity in the presence of structural break in both intercept and trend. Where the test statistic for the variable was greater than the critical value for the test, the null of unit root was rejected and vice versa.

Table 0:1: Results of Unit Root Tests

Variable	Perron's (1997) Unit Root Test	
Levels		
	Test-Statistic	Break Point
Log(DSI)	-5.427	1996M10
IR	-3.686	2004M04
Log(ER)	-3.404	2004M11
Log(CPI)	-4.751	2001M01
Log(OP)	-4.139	1999M02
Log(M2)	-2.602	2003M06
First Differences		
Log(ΔDSI)	-15.223***	1996M10
ΔIR	-6.963***	2008M06
Log(ΔER)	-15.096***	2006M03
Log(ΔCPI)	-10.189***	1995M03
Log(ΔOP)	-12.377 ***	2008M06
Log(ΔM2)	-15.283***	2006M06
The critical values for t-statistics at 1% and 5% significance levels this test (inclusive of structural break in both intercept and slope under null hypothesis) is -6.32 and -5.59.		

- *** and ** denote the rejection of unit root/non-stationarity for the Perron (1997) unit root test at 1% and 5% significance levels respectively

The variables show non-stationarity in levels and stationarity in first differences, after allowing for structural breaks in both the intercept and the slope. Furthermore, since the primary objective is to see whether the null hypothesis of unit root in presence of structural breaks is violated, the column which presents the derived structural break events do not merit elaboration. As can be observed from Table 6.1 above, all the variables are non-stationary in levels, and stationary in first differences, a necessary pre-condition for cointegration analysis.

6.2 Results of Optimum Lag Length Tests

In choosing the specification of the cointegration model, it is necessary to specify the number of lags in the autoregressive specification (Chaudhuri and Smiles, 2004). For this purpose, the Likelihood Ratio, Final Prediction Error, Akaike, Schwarz and Hannan-Quinn Information Criterion (HQIC) were used to determine the appropriate lag length. The AIC, SIC and HQIC are chosen based on lowest values over the lags considered (allowed for a maximum of ten lags in this case). The Akaike criterion suggests that a lag of five is optimal, whereas the Schwarz criterion indicates a lag of one. Since the number of observations considered in the study is 234, i.e. below 250, the AIC is a better fit for the model. With a small sample such as the one considered for this study, the SIC may choose too small a model, and it is a bigger mistake to select too few lags (dynamic misspecification) than to select too many, which is why the optimal lag length is chosen by the AIC.

Table 0:2: VECM Lag Order Selection Criteria

Lag	LR	FPE	AIC	SIC	HQIC
0		4.6^{-9}	-2.16	-2.07	-2.12
1	4374.6	2.1^{-17}	-21.37	-20.73*	-21.11
2	123.86	1.7^{-17}	-21.60	-20.41	-21.12*
3	66.87	1.7^{-17}	-21.58	-19.84	-20.88
4	74.43	1.7^{-17}	-21.59	-19.30	-20.67
5	86.98	1.6^{-17}*	-21.66*	-18.82	-20.51
6	57.24	1.7^{-17}	-21.59	-18.21	-20.22
7	75.44	1.7^{-17}	-21.60	-17.68	-20.02
8	61.34*	1.8^{-17}	-21.56	-17.08	-19.75
9	38.71	2.2^{-17}	-21.41	-16.38	-19.38
10	44.92	2.5^{-17}	-21.29	-15.71	-19.04

*indicates lag order selected by the criterion

6.3 Results of Johansen Cointegration Tests

Table 6.3 shows the results for the Johansen Cointegration test performed to investigate the long-run relationships of the variables in the model. However, the number of cointegrating vectors generated by the Johansen test may be sensitive to the lag length. Hence, the optimum lag length estimated in the previous section via AIC (five) is used to determine the number of cointegrating relations.

However, a question also arises regarding the proper assumption of trends in the Johansen Cointegration framework. Here, since the most of the variables in question come to exhibit some form of trending, we select the trend assumption as constant, wherein we exclude the possibility that the levels of the data have quadratic trends, and we restrict the cointegrating equations to be stationary around constant means. However this specification still puts a linear time trend in the levels of the data. (Stata Time Series Reference Manual, Release 11, 2009).

Table 0:3: Results for Johansen Cointegration Test

No. of CE(s) [H_0]	λ_{max} Statistic	95% Critical Value [Max.]	99% Critical Value [Max.]	λ_{trace} Statistic	95% Critical Value [Trace]	99% Critical Value [Trace]
r=0	41.58	39.37	45.10	104.51	94.15	103.18
r≤1	32.59	33.46	38.77	62.93*	68.52	76.07
r≤2	14.57	27.07	32.24	30.35	47.21	54.46
r≤3	10.35	20.97	25.52	15.78	29.68	35.65
r≤4	5.36	14.07	18.63	5.42	15.41	20.04
r≤5	0.06	3.76	6.65	0.06	3.76	6.65

- r denotes the number of cointegrating relationships
- CE refers to cointegrating equations
- * indicates that the number of CE selected by the estimator correspond to this row

The first column in Table 6.3 shows the null hypothesis assumed for the Maximum Eigenvalue and Trace Tests. The value of λ_{trace} under the null of r = 0 (no cointegration) is 104.51, which is greater than 94.15, the 5% critical value reported from Osterwald-Lenum (1992), so the null of no cointegration can be rejected in support of one cointegrating equation. For r ≤ 1, the λ_{trace} statistic is less than the critical value at 1% and 5% significance levels, which forms the basis for accepting the null hypothesis of at most one cointegrating vector. An alternative measure that is used to determine the number of cointegrating vectors is λ_{max}. The λ_{max} shows that at the 5% significance level, the null hypothesis of no cointegrating vector is rejected since the value of 41.58 is greater than 39.37. Similar to the λ_{trace} statistic, for r ≤ 1 and other values of r, the λ_{max} measure is less than the critical value at 5% significance level. Therefore, it can be assumed that there is at least one cointegrating vector. According to both λ_{trace} and λ_{max} statistics, it can be confirmed that there is at least one long-run equilibrium relationship between the Dhaka Stock Exchange All-Share Price Index and macroeconomic variables. Lags of six and seven were considered to check for robustness; they also indicated one cointegrating relationship.

6.4 Results of Long-Run Cointegration Model

Table 6.4 shows the long-run cointegrating model. The long-run relationships were as hypothesized in the study and these are reported below:

Table 0:4: Long Run Cointegrating Model

Regressor	Coefficient	Std. Error	z-statistics
Constant	1.39	-	-
Interest Rate	0.12	0.07	-1.79*
Exchange Rate	-5.26	1.33	3.94***
Consumer Price Index	-3.01	2.26	1.33
Crude Oil Prices	0.70	0.21	-3.28***
Broad Money Supply	2.66	1.19	-2.23**

***, ** and * denote significance of variables at the 1%, 5% and 10% levels respectively. Note: Dependent Variable - DSI

According to the table, the actual long-run relationship can be represented by:

$$DSI - 0.12IR + 5.26ER + 3.01CPI - 0.69OP - 2.66M2 - 1.39 = \varepsilon_{i,t} \qquad (1)$$

Which, after rearranging becomes:

$$DSI = 0.12IR - 5.26ER - 3.01CPI + 0.69OP + 2.66M2 + 1.39 + \varepsilon_{i,t} \qquad (2)$$

As may be inferred from the estimates, the model posits that interest rates and DSI index is positively related and impact of interest rates is statistically significant at 10%. This was unexpected as, theoretically, high deposit interest rates lead investors to invest less in risky assets and, consequently, lower stock prices are expected. However, this converse result is not uncommon according to the literature. Mukherjee and Naka (1995), Maysami and Koh (2000), and Bulmash and Trivoli (1991) found a positive relation between the short-term interest rates and stock market prices, and a negative relationship between long-term interest rates and stock prices. The relationship between deposit interest rates and stock prices in this study are, therefore, consistent with the results of the short-term interest rates. One possible explanation for this is that if the interest rates is increased now, it means that they will fall in the future. When investors find that interest rates have increased, they buy more stocks now since they know that lower interest rates in the future will result in even higher stock prices then, hence, higher capital gains for investors. Higher demand for stocks now leads to higher current stock prices.

The exchange rate and the DSI are significantly and negatively related in the long-run. This was not hypothesized since, theoretically, it is expected that increasing exchange rates (Taka depreciation against the U.S. Dollar) will result in money inflows, and, consequently higher investment in the DSE stocks, and, higher DSI. Maysami and Koh (2000) report the same relation as in this study. Maysami and Koh (2000) found that the Singapore Dollar exchange rate (against the U.S. Dollar) and the Singapore stock market are negatively related. They state that an appreciation of the Singaporean Dollar lowers imported inputs and allows the exporters in the country to be more competitive internationally. This is received as favourable news for the Singapore stock markets and, hence, positive stock returns are generated as a result. Perhaps, this also holds true for the Bangladesh exchange rate. Depreciation in Taka, instead of resulting in money inflows, results in increased imported materials leading to the exports being uncompetitive in the world economy. Consequently, this will lower stock demand and, hence, lower stock prices. Mukherjee and Naka (1995) and Brown and Otsuki (1990) report a positive relation for the Japanese stock market. Gunasekarage (2004) found that exchange rates have no significant relationship with the Colombo stock prices. This was due to limited participation by the foreign investors.

It was hypothesized that the relationship between CPI and the DSI in the long-run will be either negative or insignificant due to large price changes. Long-run cointegrating model shows that the relationship between CPI and stock prices is negative. The relationship, though, was statistically insignificant, which confirms that large price changes in Bangladesh affect the theorized relationship. Price fluctuations in developing countries are more prevalent due to lower regulations, competition, etc. and explain why the relationship was found insignificant. The relationship found here is consistent with evidence in the literature - Lintner (1973), Oudet (1973), Bodie (1976), Nelson (1976), Mukherjee and Naka (1995) and Gunasekerage (2004) found a negative relationship between CPI and stock prices.

The relationship between crude oil prices and the DSI was found to be positive in the long-run, contrary to the hypothesis. Chen et al. (1986) found an insignificant relationship between oil prices and the NYSE. Hassan and Hisham (2010) found a negative relationship between crude oil prices and the Jordan Stock Exchange. However, this is consistent with evidence found recently. It has been recently seen that crude oil prices and stock prices are positively related. For e.g., the Standard & Poor's (S&P) 500 Index and the oil prices from 1998-2008 have demonstrated a positive relationship with each other with a correlation of 0.55, and 0.86 since 2008 (Smirnov, 2012). For the DSI, the relationship was positive with oil prices and consistent with recent results, though, inconsistent with theory. This is expected as the DSI is likely to be strongly influenced by other stock price indices, such as S&P 500 index, etc.

The relationship between money supply and stock prices was found to be positive and significant at 5% level in the long-run. This is consistent with most studies in the literature, such as Bulmash and Trivoli (1991), Mukherjee and Naka (1995) and Gunesekarage (2004). This means that the corporate earnings effect plays a strong role for the Bangladesh economy. An increase in money supply leads to a boost in companies' cash flows, which results in increased stock prices. This result is inconsistent with Frimpong (2009), who found a negative relationship between the Ghana stock prices and money supply.

6.5 Results of Error Correction Mechanism:

Table 6.5 below reports the short-run results of the Vector Error Correction Model regarding the short run dynamics of DSI, the stock price index. The sign and magnitude of the error correction coefficient (adjustment coefficient) indicate the direction and speed of adjustment towards the long-run equilibrium path. A negative error correction coefficient implies that in the event of a positive deviation of the model from the long-run equilibrium, in the absence of variation in the independent variables, which implies that the value of DSI is above its equilibrium, is corrected by changes in the dependent variable. This confirms the existence of a long–run relationship. The size of the coefficient of the error correction term in this study implies that about 5.3% of the disequilibrium in the long-run relationship is corrected every month as DSI settles back into its equilibrium value. The error term coefficient was significant at the 5% level.

The short-run results indicate that DSI positively affects the DSI at the first lag; the results from the latter lags are insignificant. CPI positively affects the stock prices at the third lag, but it was insignificant for other lags. Interest rates, exchange rates, oil prices and money supply mostly affect the DSI negatively, but these variables are also statistically insignificant at most lags. Other lags were also considered for robustness and better results. Lags of four and seven revealed a negative sign for the error correction term but it was not significant. The other variables, similarly, did not result in more significant or robust estimates. Impulse Response Functions are employed later in an attempt to explain the short-run results better.

Table 0:5: Vector Error Correction Model

Regressors	Coefficient	Standard Error	z-statistics
Speed of Adjustment	-0.053	0.022	-2.42**
ΔDSI_{t-1}	0.172	0.071	2.44**
ΔDSI_{t-2}	-0.012	0.071	-0.17
ΔDSI_{t-3}	0.110	0.071	1.55
ΔDSI_{t-4}	-0.002	0.072	-0.02
ΔIR_{t-1}	-0.025	0.024	-1.03
ΔIR_{t-2}	0.028	0.024	1.15
ΔIR_{t-3}	-0.023	0.025	-0.92
ΔIR_{t-4}	0.017	0.025	0.65
ΔER_{t-1}	-0.968	0.924	-1.05
ΔER_{t-2}	0.093	0.935	0.10
ΔER_{t-3}	-0.576	0.937	-0.61
ΔER_{t-4}	-0.708	0.958	-0.74
ΔCPI_{t-1}	-0.172	0.883	-0.20
ΔCPI_{t-2}	0.247	0.895	0.28
ΔCPI_{t-3}	1.803	0.903	2.00**
ΔCPI_{t-4}	-0.020	0.889	-0.02
ΔOP_{t-1}	0.090	0.087	1.04
ΔOP_{t-2}	0.074	0.088	0.84
ΔOP_{t-3}	-0.055	0.088	-0.62
ΔOP_{t-4}	-0.023	0.087	-0.26
$\Delta M2_{t-1}$	-0.186	0.282	-0.66
$\Delta M2_{t-2}$	-0.026	0.319	-0.08
$\Delta M2_{t-3}$	0.026	0.308	0.08
$\Delta M2_{t-4}$	0.045	0.259	0.17
Constant	0.001	0.015	0.05

The following table below details the short run adjustment coefficients for the other variables in question:

Table 6.6 : Adjustment Coefficients of the other Variables

Variables	Coefficients	Standard Error	Z-Stat
ΔIR	0.222	0.062	3.57***
ΔER	0.001	0.002	0.58
ΔCPI	0.006	0.002	3.73 ***
ΔOP	0.044	0.017	2.53**
ΔM2	0.003	0.005	0.67

With respect to the original signs of the coefficients of the variables in the long run relationship (as shown in Equation 1), it may be inferred here that the adjustment coefficients mostly point to the validity of the cointegrating relationship between DSI and the other variables. For interest rate, given its negative sign in Equation 1, a positive unit disequilibrium from the long run relationship (an unit increase in DSI) from last month results in interest rate adjusting back to equilibrium by 22% correction of the one unit disequilibrium in the current month (at the same time as DSI is adjusting). However, adjustment coefficients for the other variables are minuscule in magnitude, with only CPI and Oil prices possessing statistically significant adjustment coefficients. The positive adjustment coefficient for CPI while being small, is statistically significant, and given its negative sign in the long run model (Equation 1), the estimate for CPI instead points to steady divergence from equilibrium in the event of disequilibrium from the long run relationship. However, since the long run estimate of CPI was statistically insignificant, formal and meaningful interpretations may have to be withheld regarding its dynamics.

For a more comprehensive picture regarding the short run dynamics of the variables, interpretations of Impulse Response Functions would be more meaningful.

6.6 Diagnostic Tests for the VECM

For statistical accuracy and efficiency of the residuals in the VECM, diagnostic tests are performed. The results for the diagnostic tests are attached in Table A-1. With regard to the test for autocorrelated residuals, the *p*-value corresponding to Lagrange Multiplier (LM) statistics is significantly higher than the 10% level of significance. Hence, we can accept the null hypothesis of no autocorrelation in the residuals. The Eigenvalue Stability Circle (ESC) reports stability of the residuals in the VECM. In the case of a two-variable model with one lag, stability conditions are such that one of the eigenvalues is equal to one, and the other is smaller than one in absolute terms. The result reported in the ESC in Table A-1 is exact generalization of this condition to the six-variable model with five lags. With regard to the Jarque-Bera test, we reject the null hypothesis of normality since the *p*-value is 0.00. However, this will not significantly distort results as, more importantly, the residuals are stable and non-autocorrelated.

6.7 Robustness of Results in the VECM

To check for robustness in the VECM estimation results, lags of six and seven were considered for the long-run model. All the variables reported the same directional relationship with the stock prices at six lags; however, oil prices and money supply were insignificant in explaining stock price changes. Lags of seven reported the same relationships between stock prices and the macroeconomic variables as the fifth lag, but the relationship between money supply and stock prices was insignificant. This shows that the relationships between stock prices and interest rates, exchange rates and consumer price index were robust. However, money supply and oil prices were sensitive to lag lengths and the estimates for these variables are not robust.

6.8 Results of Impulse Response Functions and Variance Decompositions

The results for the Impulse Response Functions are reported in Figure A-2. Impulse Response Analysis entails analysing the incremental impact of a shock to the whole system. Hence, we are primarily concerned about the behaviour of the short-run dynamics of the model in the presence of any external shock emanating from any of the variables particularly on DSI. Figure A-2 shows the effect of macroeconomic shocks on the DSI. Four years of data are forecasted and their effects plotted via Impulse Response Functions.

An interest rate shock of one Generalized Standard Deviation causes the DSI to fluctuate initially, however, from the 15th month onwards, the effect from the shock recedes and in the 30th month, the effect settles to an apparent permanent level of about 0.06 units over the baseline. An exchange rate shock results in a big dip in the DSI in the initial periods, however with passage of time, this impact gradually withers away and around the 30th period, the impact settles just above the baseline, implying that a shock emanating from interest rates has no tangible or apparent long run effect on DSI, which is in contrast to the relationship derived in the long run model earlier. With regards to shock from exchange rate, the first 6 months witness a continuous slide in DSE before settling at a permanent value of 0.04 units below the baseline. With regards to a unit Generalized S.D. shock from CPI, the impact lessens after the fifth month, before becoming negative after the 15th momth, and at the end of the time-span (4 years; 48 months) the impact settles permanently on a constant value below the baseline. Oil prices shock lead to a large increase in the DSI initially and the effect increases with time before again settling at a permanent level of 0.06 units over the baseline. Similarly Money supply shock leads to a slight fall in the DSI in the first month, but then increases the DSI over time, which supports the cash flow effect of money supply, before settling in at a constant level after the 8th month. In general, most of the variables seem to have a permanent effect on DSI in the long run as can be inferred from the impulse response diagrams, which also reflects the dynamics of the long run relations model derived earlier. However, only interest rates seemingly do not have a permanent level of impact on DSI.

Our views are further reinforced from the inferences which we can draw from the Cumulative Impulse response functions for DSI (Figure A-3, Appendix), which cumulatively sums up impulse responses of a particular variable, in this case, DSI over successive time periods, so as to glean the aggregate impact of a shock at the end of n-periods. In keeping with the inferences drawn from the individual impulse response functions as well as the long run relation model derived earlier, it can be seen that at the end of the 4 year projected span, most of the variables' cumulative impact over the 4 year span on DSI is either positive (for shocks from DSI, oil prices and Money Supply) or negative (for exchange rate). The cumulative responses of DSI to interest rates and CPI are more of a mixed bag, with the deposit interest rates, at the end of the 4 year old, having a cumulative shock of just below the baseline of zero. This may appear at odds with the coefficient for interest rates in the long run model, which suggested a positive relationship between interest rates and DSI. However from the theoretical standpoint, it merits justification, since here, we extract a discernible, negative, albeit small final impact of interest rates on DSI, which is also predicted by theory. Similarly, for CPI, its cumulative impact too seems to be indistinguishable from zero at the end of 4th year, and furthermore, since the coefficient for CPI is statistically insignificant at 10 percent in the long run model, this particular outcome maybe is line with earlier findings and also has theoretical justifications as well (which were elaborated earlier).

Table 6.7 reports the Variance Decomposition test results. Twenty months of the model are forecasted and the results indicate that most of the variations in the DSI are explained by the DSI itself. In the 5^{th} period, 94.58% of the variation in the DSI was explained by shocks to itself, 2.09% by ER and 2.54% by OP. At the end of the 10^{th} period, 4.98% and 5.65% of the variations in the DSI were explained by shocks to ER and OP respectively. The results obtained from VDC combined with IRF indicate that the macroeconomic shocks from other variables explain a minority of the forecast error variance in the DSI, though, exchange rates and oil prices have a significant influence on the stock prices. It must be noted though that most of the shocks from the macroeconomic variables are permanent and persist for a long period, as is to be expected in conventional VEC system.

Table 0.7: Variance Decomposition of DSI

Period	Std. Error	DSI	IR	ER	CPI	OP	M2
1	0.099	100.000	0.000	0.000	0.000	0.000	0.000
2	0.151	99.032	0.199	0.336	0.015	0.414	0.005
3	0.188	97.691	0.129	0.595	0.011	1.553	0.020
4	0.223	96.372	0.108	1.059	0.249	2.127	0.086
5	0.253	94.578	0.085	2.098	0.443	2.541	0.255
6	0.281	92.929	0.069	2.985	0.513	3.063	0.441
7	0.305	91.460	0.064	3.680	0.511	3.617	0.667
8	0.326	89.925	0.066	4.206	0.476	4.292	1.034
9	0.346	88.560	0.068	4.613	0.442	4.988	1.328
10	0.363	87.356	0.073	4.976	0.411	5.650	1.535
11	0.380	86.291	0.078	5.239	0.382	6.299	1.711
12	0.395	85.270	0.083	5.479	0.355	6.934	1.879
13	0.410	84.255	0.085	5.732	0.330	7.546	2.053
14	0.423	83.282	0.084	5.977	0.310	8.136	2.210
15	0.436	82.348	0.082	6.211	0.294	8.714	2.351
16	0.448	81.449	0.079	6.417	0.282	9.279	2.493
17	0.459	80.579	0.076	6.605	0.273	9.833	2.633
18	0.470	79.731	0.073	6.784	0.268	10.375	2.769
19	0.481	78.910	0.069	6.949	0.265	10.908	2.898
20	0.491	78.109	0.067	7.102	0.265	11.434	3.022

6.9 Robustness of Results in the IRF and VDC

To test for robustness, a VAR model was constructed in first differences, and IRF and VDC drawn from its estimates. The IRF demonstrated short-run results very similar to the IRF from the VECM model. The results for the VDC from the VECM and VAR models are also similar. A very low percentage of the changes in stock prices is explained by the variables, though exchange rate explains a high proportion of the changes in stock prices.

7. Conclusion

The study investigates the long-term relations between macroeconomic variables and the Dhaka stock market prices using Johansen's methodology of multivariate cointegration analysis and Vector Error Correction Model. The macroeconomic forces were represented by interest rates, exchange rates, consumer price index, crude oil prices and money supply while the Dhaka Stock Exchange All-Share Price Index was used to represent changes in the Dhaka stock market prices.

The main findings revealed that there is a long-term relationship between the stock prices and macroeconomic variables. According to the cointegration analysis and the VECM estimated in the study, the stock prices and macroeconomic variables are related significantly, though not in accordance with the hypothesized relationships. The interest rate was positively related with the stock prices; this was unexpected as higher interest rates, theoretically, shift investors away from stocks and vice versa. The exchange rates are negatively related with the stock prices – meaning that Taka depreciation leads to higher imported inputs and, hence, lower exports and lower stock prices and vice versa. The consumer price index is found to be negative, but insignificant in explaining the stock prices. This was hypothesized as large price changes in Bangladesh may render an insignificant relationship between CPI and stock prices. The relationship between crude oil prices and stock prices was found to be positive and significant; this is consistent with recent results from other stock exchanges. The broad money supply is positively related with the stock prices which confirms that the corporate earnings effect leads to a boost in companies' cash flows and, hence, higher stock prices. The macroeconomic variables, except oil prices and money supply, were robust to different lag lengths.

The short-term results of the VECM revealed that around 5.3% of the disequilibrium in the long-run model is corrected every month as DSI reverts back to its equilibrium. However, the DSI and macroeconomic variables were insignificant at most lags in the ECM specification for DSI. Since the VECM results were inconclusive, the Impulse Response Functions and Variance Decompositions were undertaken. An interest rate shock causes the DSI to fluctuate initially, but a tendency to converge to equilibrium just above the baseline is seen. An exchange rate shock results in a large fall in the DSI initially, but the gap remains steady afterwards, implying a persistent effect on DSI. A consumer price index shock leads to an increase in the DSI initially, but then the relationship becomes negative and also in the long run assumes a persistent or constant negative effect on DSI. Oil prices shock lead to a large increase in the DSI initially and the effect increases slowly over time before too settling on a permanent impact level. Money supply shock increases the DSI over time, which supports the corporate earnings effect, but settles to a constant level in the long run. Overall, the results for the impulse response function seems to imply that most of the macroeconomic variables have a permanent and long run impact on DSI, and thus largely validates the results in the long run model. The cumulative impulse response functions further affirm our findings, with important differences being the cumulative impacts of deposit interest rates and CPI, the first of which was found to be small and negative, the latter in accordance with economic theory, while CPI shows no discernible cumulative impact on DSI after 4 years, a reflection of the statistical insignificance of CPI in the long run model as well as economic theory. The Variance Decomposition results indicate that the macroeconomic shocks emanating from variables apart from DSI explain a small proportion of the forecast error variance in the DSI, though, exchange rates and oil prices have a significant influence on the stock prices. Most of the shocks from the macroeconomic variables to the DSI are permanent and are persistent. Diagnostic tests in the VECM were performed to ensure that there was no autocorrelation in the residuals and that they were stable.

In light of the analysis made in the study, policymakers and economists in Bangladesh need to be careful when they try to influence the economy through changes in key macroeconomic variables comprising the interest rates, exchange rates, consumer price index and money supply. The important takeaway from this study is that developing country macroeconomics or dynamics is different from developed country macroeconomics. The theorized macroeconomic relationships with the stock prices do not hold for Bangladesh mostly and this should be considered when policies are made. Stock markets are inefficient and underdeveloped in developing countries and, hence, central banks of these countries should be careful in designing its monetary policy. Country-specific traits should be taken into account and research should be conducted before any policy is implemented. They should also be aware of international factors such as crude oil prices as these also have a significant impact on the economy. Further research on the topic may also want to consider other macroeconomic variables such as call money rate, long-term government bond rate and industrial production index, which are important economic drivers and may significantly influence the stock prices. The Bangladesh stock market is an established capital market and its development is crucial for the growth of the country. Thus, the government and policymakers should aim to influence the key macroeconomic variables in a way that ensures that stock prices are stable and stock markets are performing in an efficient and effective manner.

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Appendix

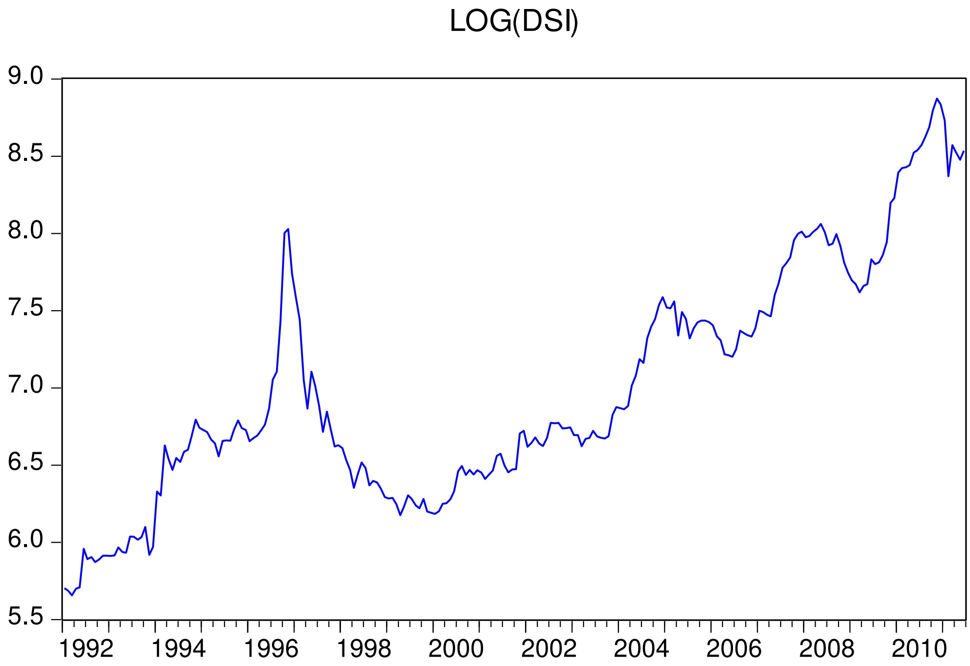


Figure A-1a: Time-Series Plot of Log(DSI) in Levels

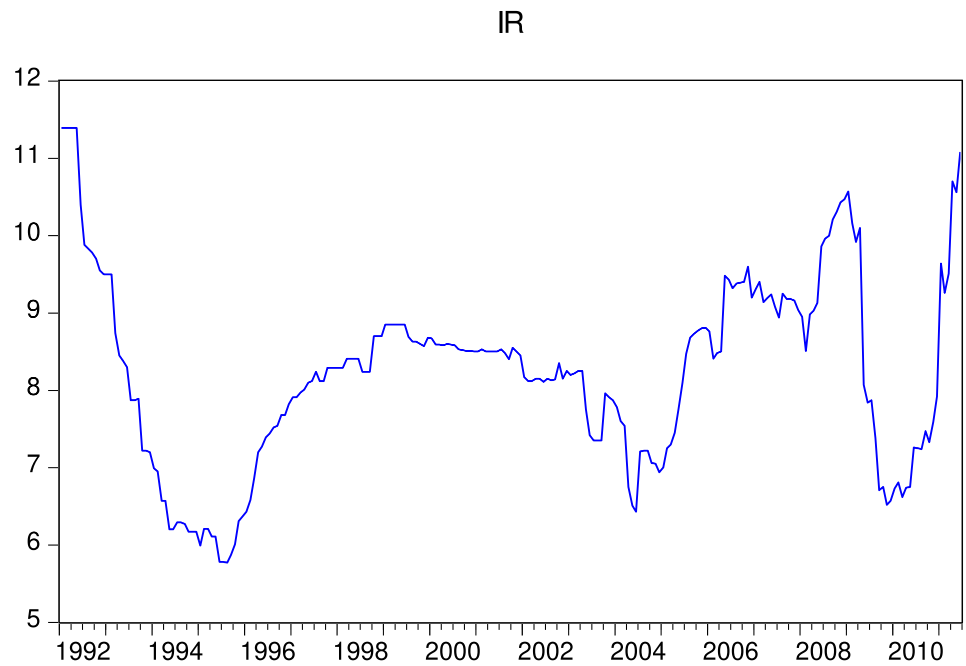


Figure A-1b: Time-Series Plot of Interest Rates in Levels

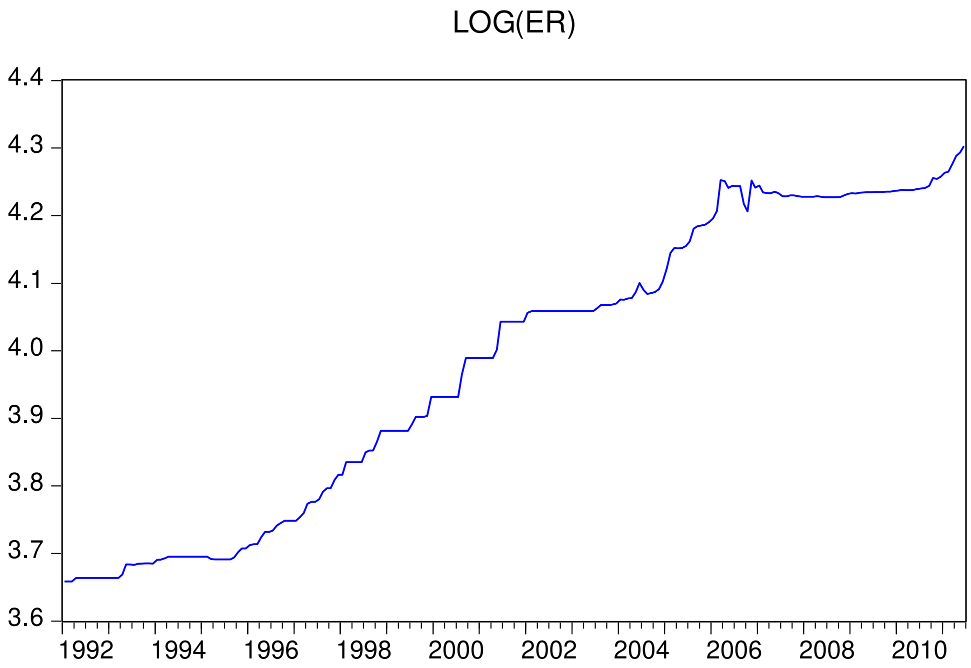


Figure A-1c: Time-Series Plot of Log(ER) in Levels

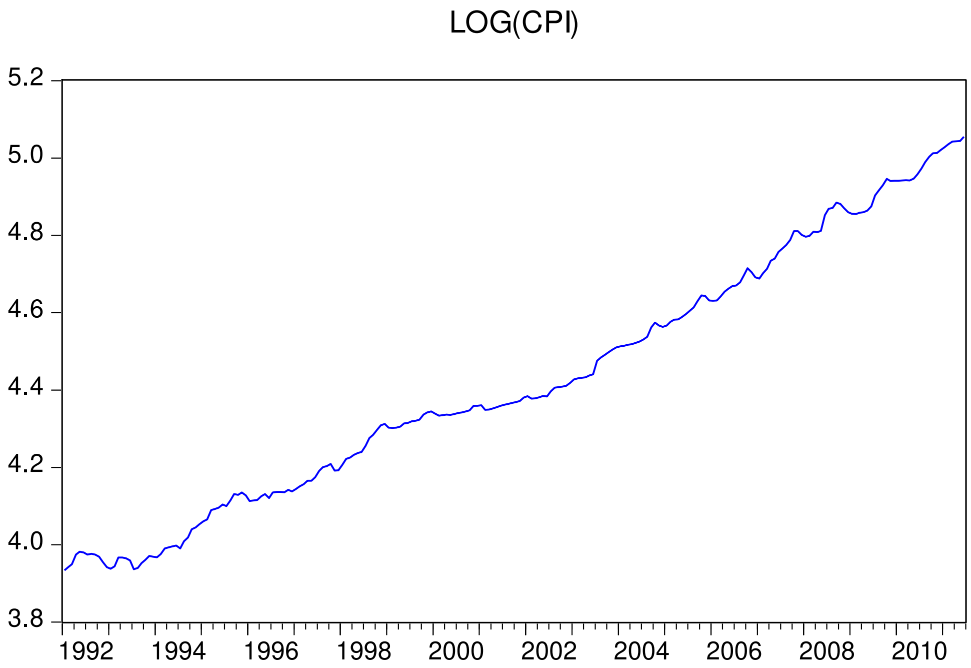


Figure A-1d: Time-Series Plot of Log(CPI) in Levels

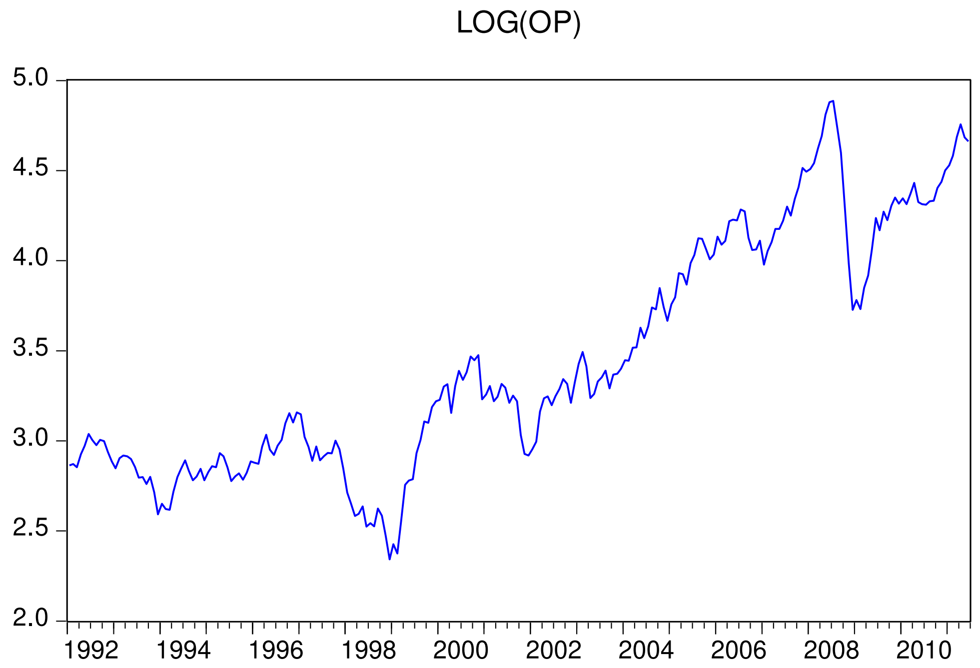


Figure A-1e: Time-Series Plot of Log(OP) in Levels

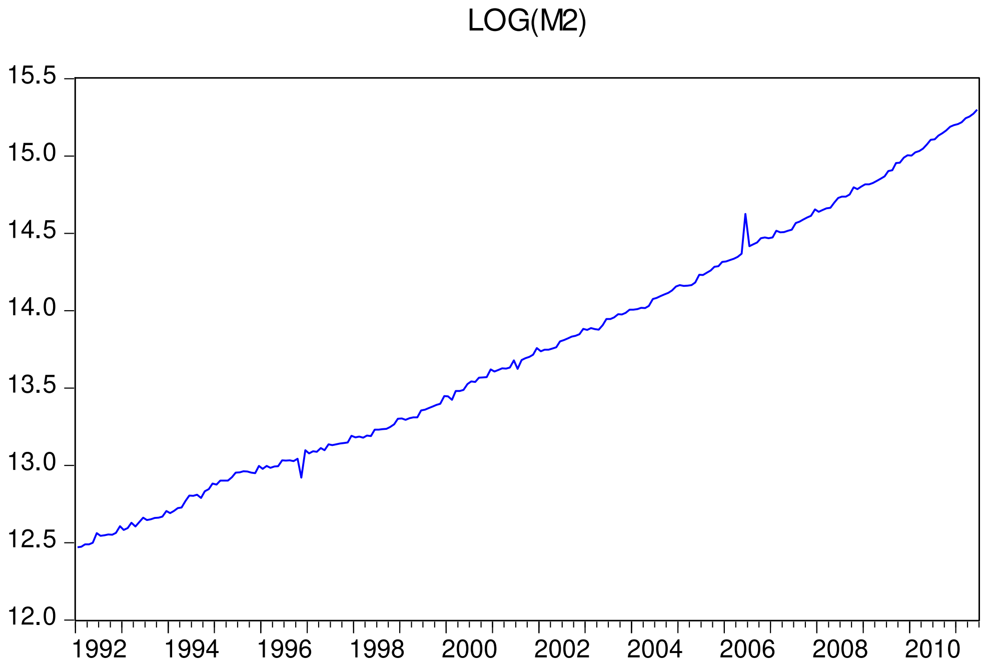
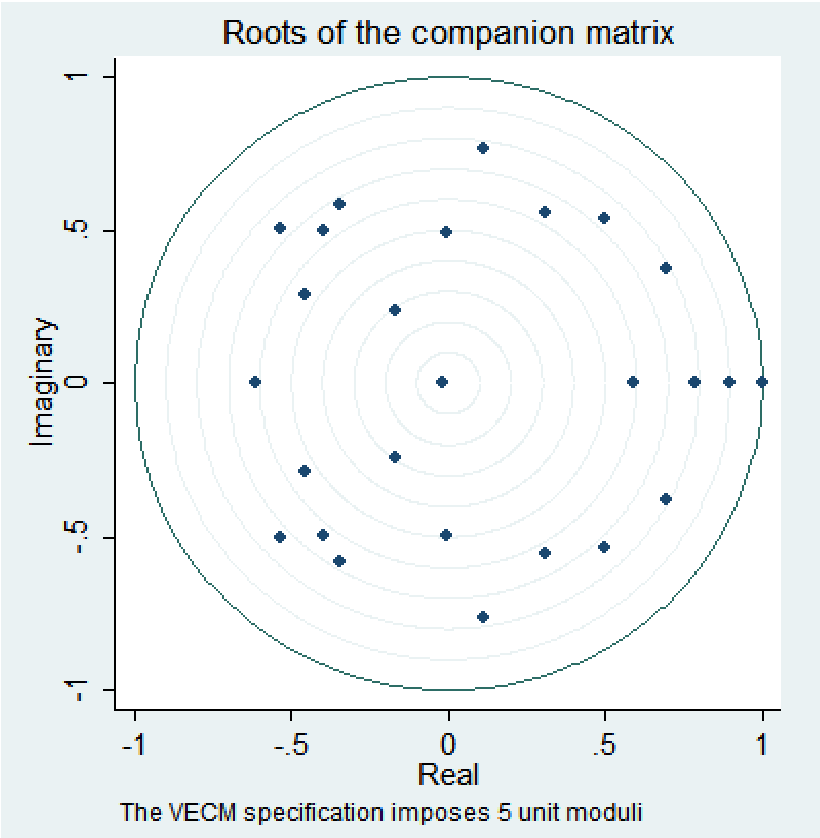


Figure A1-f: Time-Series Plot of Log(M2) in Levels

Tests	p-value
Autocorrelation Test	
LM(5)	0.77
Normality Test	
Jarque-Bera	0.00

Stability Test



Eigenvalue Stability Circle

Table A-1: Diagnostic Tests for the VECM

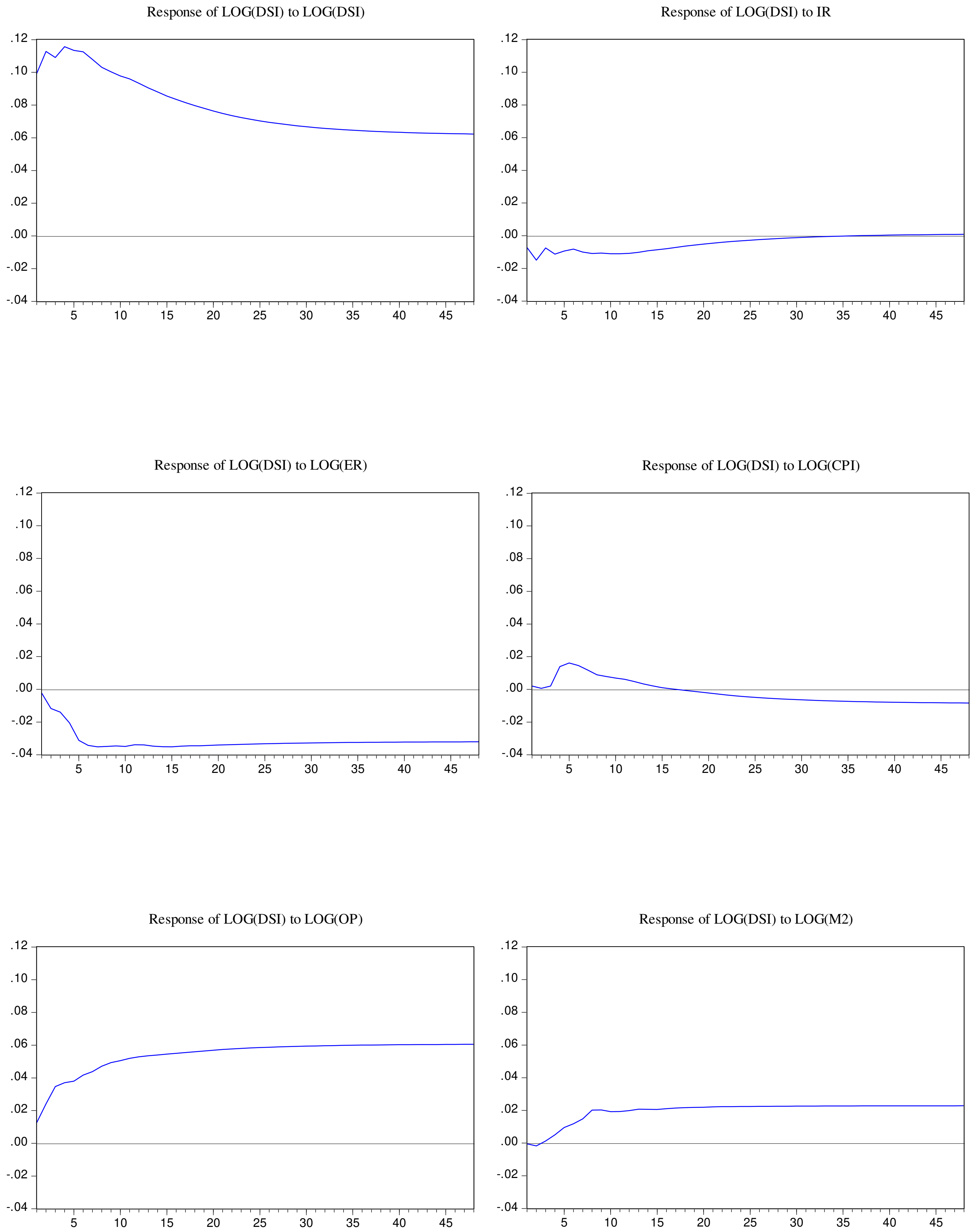


Figure A-2: Impulse Response Functions

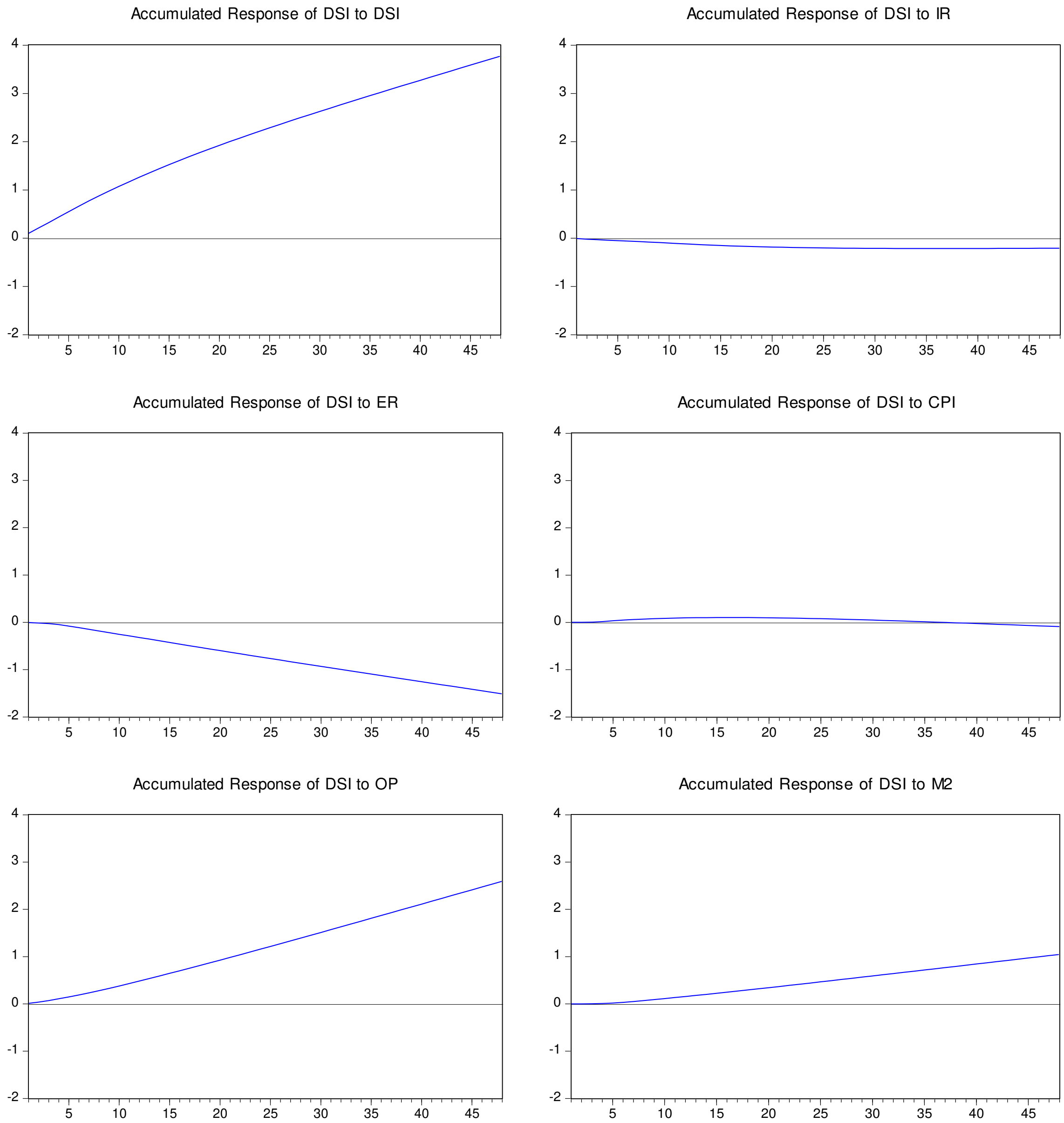


Figure A-3: Cumulative Impulse Response Functions