



# Empirical Investigation of Stock Market Behaviour in the Colombo Stock Exchange

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## Abstract

A Stock market or equity market is a platform for the trading of listed company's stocks and derivatives at consented price between buyers and sellers. Day by day stock markets have becoming more institutionalized. In the past few decades, it has been advanced as the main forms of investments for numerous organizations as well as individuals for arranging large investment funds to the general public. Highly volatile fluctuations with instability patterns are common phenomenon in the Colombo Stock Exchange (CSE). Multivariate statistical methods and economic data forecasting techniques were deeply applied to identify the directions and movements of market prices and trade volume rates in CSE during 2006 to 2012. The research findings reveals that, Bank Finance and Insurance, Beverage Food and Tobacco, and Investment Trust sectors are most suitable sectors for investing capitals in the future.

**Keywords:** *auto regression and moving average; Colombo stock exchange; granger causality test; multivariate statistical methods*

## 1. Introduction

In the modern world, various types of methods can be used for investing capitals likely investing gold and other currency related topics, such as investing in foreign currency, savings and by fix deposits etc. In past history, most of them were interesting to save money in the commercial banks for making little interests. Theoretically, inflation rate of the country is highly affected with interest rates. Because of the economic crises in the past decade, the interest rates have been decreasing rapidly with some negative fluctuations. Currently, most of the investors disfavoured to save money in their savings accounts and prefer to invest money directly through the stock markets to make highest returns.

Investing in stock market is the easiest and fastest way for building a healthy financial future. Currently, many investors around the world have been investing huge funds from their capitals. The main purpose for investing in the stocks is to make money directly. In the past three decades, many companies around the world have experienced phenomenal growth and invested huge funds from their capital. It is a long – term investment for companies as well as individuals (Campbell et al., 1997). Day by day many companies have been listed in stock markets rapidly.

The global growth of the market prices and trade volume rates has been changing with highly volatile fluctuations. The prices of the stocks mainly depend on the financial stability of the company, turn over value, share volume and other variety of financial and economic factors (Cai et al., 2008). All these factors are varying from market to market as well as country vice. The previous studies suggest that stability of the stock market, the economic growth development of the country highly affected with each other.

Predictability and forecasting make complicated problems. It is a common phenomenon that, when the

company is running well, the prices of the stocks going up. Otherwise prices of the stocks go down. Not only company performance but also many other macro and micro economic factors directly affected the prices and volume rates of stocks. If the stock sold with profit, it would bring a positive return for the investor; otherwise it makes negative return (Peiris et al., 2011).

Colombo Stock Exchange (CSE) is one of the most modern stock exchanges in South Asia with a fully automated trading platform. Moreover, it has been one of the best performing stock market in the world with market capitalization over US\$23 billion and average daily turnover rising to over US\$18 billion.

This current study mainly focuses on discussing the market performances of the CSE. The main purpose of this study is to identify the directions and movements of market prices and trade volume rates during 6 year periods from 2006 to 2012. CSE can be categorized into 20 sectors. They are; Plantation (PLT), Oil palms (OIL), Plantation (PLT), land and property (L&P), Motors (MTR), Manufacturing (MFG), Telecommunication (TLE), Stores supplies (S&S), Trading (TRD), Services (SRV), Power and energy (P&E), Investment trust (INV), Hotels and Travels (H&T), Health care (HLT), Footwear and Textile (F&T), Information Technology (IT), Diversified Holdings (DIV), Construction and engineering (C&E), Chemicals and Pharmaceuticals (C&P), Beverage Food and Tobacco (BFT), Bank and Finance and Insurance (BFI). Different types of statistical methods have been mainly used to discuss our results; they are: multivariate statistical methods, Econometric statistical techniques, forecasting methods and descriptive statistical Techniques (Fernando et al., 2012).

The rest of the paper is organized as follows. Section II explains about brief overview of existing solutions with pros and cons. Section III expatiates about proposed work with Principal component analysis. Section IV expounds about experimental results and Section V ends up with conclusion and future work.

## 2. Literature Review

According to the previous studies, many researches have done various kinds of studies to find the relationships between macro-economic variables and market fluctuations. Most of the previous research studies have carried based on well-defined stock markets such as New York, London and Bombay. However it is clearly see that, in the this decade researchers have been giving more priority for developing forecasting models for developing market such as Colombo, Bangladesh, Hong Kong etc. for their studies.

Different types of models and methodologies have been developed to in the literature to find the relationships between the micro economic variables with respect to stock market fluctuations. Some of the models are only applicable at the level of theoretical assumptions.

Gupta et al. (2007) attempted to find the short-run and long-runs relationships between stock market validity with respect to the macro and macro-economic variables. Randomly selected six markets and related macro factors likely Inflation, exchange rates, money supply and interest rates were used to find their results. The results suggested that, there is strong co-relation between macroeconomic variables on the stock market price as well as volume indices. In 2008, Islam also had done a similar study based on Kuala Lumpur stock exchange. Their results coincide with Hendry's findings (Gupta et al., 2007).

Chen et al. also did similar type of study to find the relationship between macro-economic variables and market validations in USA (Chen et.al, 2012). They selected different type of macro variables, such as industrial production, inflation and long and short terms interest rates on stock returns. Interest rates were calculated by using Arbitrage Price Theory (APT), which was introduced by Ross in 1976. Co-integration analysis techniques with vector auto regressive models and vector error correlation models were used to discuss the market performances. Their findings suggested that the lagged values of the macro economic variables directly influence on the stock market fluctuations (Chen et al., 2012).

Samarakoon (1998) have done various kind of research based on the Colombo Stock Exchange as well as the stock market fluctuations relating to macro-economic variables. Using the market index and sector indices from 1985 to 1995, Samarakoon has investigated the time series behaviors of the short term (daily, weekly, monthly and quarterly) predictability of the stock returns and inflation in Sri Lanka. Four categories

of inflations were used to identify the relations. They are; contemporaneous, lagged, expected and unexpected inflations (Samarakoon et al, 2008). All these inflations were estimated using ARIMA procedures with Fishers hypothesis test statistic.

In 2012, Pallegedara et.al has done similar type of study to evaluating market efficiency in CSE based on different kind of macro and micro economic variables. Multivariate statistical methods widely applied for predicting the future results under different type of stationary non stationary conditions (Pallegedara et al., 2012).

### 3. Methodology

Highly volatile fluctuations with instability patterns are common phenomenon in the CSE. Innumerable micro and macro-economic conditions and market conditions, international and local political changes, oil prices and interest rates directly involves to generated high volatility fluctuations.

In this study, Multivariate statistical methods with data forecasting techniques were deeply applied to identify the directions and movements of market prices and trade volume rates in CSE during 2006 to 2012. Current study is mainly carried out on the basis of secondary data, which were obtain from CSE daily and monthly reports, annual financial reports of listed companies and all other relevant documents.

The methodology of the study can be describes as follows. In the first phase, Correlation analysis methods were used for identify the significant relationships between macro-economic variables with stock market validations. According to the literature, different type of macro and micro economic variables were identified. They are; per capita Gross Domestic Product of the country (GDP), Inflation (IF), Unemployment Rates (UR), Average Consumer Spending Rates (ACSR), Crude Oil important Rates (COR- US Dollar Billions), Government Revenue (GR) and Total Investment Percent of GDP (INGDP), Gross Income (GI), Net Revenue and net asset value Per Share (NPS).

As a first step of second part of the research, stationary and non-stationary conditions were tested using Augmented Dickey – Fuller test (ADF) and Phillip and Perron test (P-P). Theoretically, stationary series can be only used for further analysis. Hence, if the series is not stationary, 1<sup>st</sup> or 2<sup>nd</sup> differences may be wanted to use for make series stationary.

The general form of the ADF is estimated by the following regression.

$$\Delta y_t = a_0 + a_1 y_{t-1} + \sum_{i=1}^n a_i \Delta y_i + \delta_t + e_t \quad (1)$$

$$\Delta y_t = a_0 + a_1 y_{t-1} + \sum_{i=1}^n a_i \Delta y_i + e_t \quad (2)$$

By using Test statistics results, following hypothesis are tested under the 0.05 significance level for adjudge the stationary or non-stationary pattern of the data series.

H<sub>0</sub>: Data series has a unit root

H<sub>1</sub>: Data series has not a unit root

If we reject the null hypothesis, then the series is stationary, otherwise series is not stationary.

#### **Auto regression and Moving Average (ARMA) Model**

The ARMA models are often used to discuss the behaviors in stationary time series patterns. This model is a

combination of an autoregressive (AR) model and a moving average (MA) model.

The order of the ARMA model in discrete time  $t$  is described by two integers ( $m, n$ ), that are the orders of the AR- and MA- parts, respectively. The general expression for an ARMA-process  $Y(t)$  can be discussed as following:

$$y(t) = \sum_{i=1}^m a(i)y(t-i) + \sum_{i=1}^m b(i)x(t-i) \quad (3)$$

Where;  $a_1, a_2, \dots, a_n$  and  $b_1, b_2, \dots, b_n$  are the coefficients of the AR and MA part of the model respectively.

#### 4. Result and Discussion

Currently, 283 companies are listed in the CSE. It is very difficult to see any patterns and trends in stock returns and spot any groups of stocks that exhibit similar behaviors. The first two months of 2012 has shown flat returns close to zero. However, stock returns have picked up in the second half of the year and have been highly volatile.

Moreover, it is not a possible way to identify any correlations among the stocks, either by using the plot of monthly returns or by examining the covariance matrix due to the complex nature of the matrix. Hence, Principal Component Analysis (PCA) is a one of the most suitable technique to identify the stocks that show some movements.

The results of the eigenvalue of the covariance matrix and proportion of variations are explained by each principal component in Table 1.

Table 1, 1<sup>st</sup> projected results presented that, the first four components explain almost 58% of the total variation. Moreover, Table results shows that the seven components explain only 6.9% of the total variation and that the first seven components collectively explains 81.5% of the total variation. Hence, only seven components are considered for the further analysis.

Table 1: Eigenvalues of the Covariance Matrix – 2012

Component Number		1	2	3	4	5	6	7	8	9	10	11 and above
1 <sup>st</sup> Projected	Eigenvalue	71.07	28.44	27.78	24.76	21.07	19.41	17.70	16.40	14.56	12.06	4.73
	Proportion	0.27	0.11	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.04	0.02
	CMP (%)	27.60	38.60	49.30	58.90	67.10	74.60	81.50	87.90	93.50	98.20	100.00
2 <sup>nd</sup> Projected	Eigenvalue	6.43	3.10	1.38	0.63	0.23						
	Proportion	0.55	0.26	0.12	0.05	0.02						
	CMP (%)	55.00	81.00	96.00	98.00	100.00						

When the dataset was again projected (2<sup>nd</sup> Projected results), the first two components collectively explain 81% of the total variation. So the number of components needed to adequately explain the total variation in the data set can be reduced up to PC2. The most significant stocks included in each principal component of the projected data set is given in the Table 2.

Table 2: Comparison of the Most Significant Stocks Included in each Principal Component of the Projected Dataset with Milanka Price Index- 2012

PC2	GRAN	COMB	SPEN	DCSL	CF	CARG	SAMPH	RCL	JKH	RICH	REXP	NTB	LBF
	LHCL	DFCC	NDB	HNB	RCL	BOGA	CHMX	GRAN	CLDC	SHL	VONE	LOLC	
MPI	COMB	CFIN	DFCC	HNB	LOLC	NTB	SAMP	LFIN	RICH	DIST	SPEN	CF	DCSL
	GRAN	REXP	CFAB	VONE	LHCL	GRAN	JKH	RCL	LGL	SHL	CLDC	LBF	

In this study we utilized All Share Price Index (ASPI) daily data taken from 2012 January to December. PCA was used to select the best performing companies listed in the CSE. This method is almost similar to Milanka Price Index (MPI), which is currently using in CSE to select the best performing 25 companies.

According to the current study results, out of 25 companies 21 are included under the Milanka Price index. So our result suggested that, this proposed model is suitable for selecting best performing sample in CSE.

**Multivariate Statistical Analysis: PCA Approach for Macro and Micro variable Analysis**

In this section, Principal Component Analysis (PCA) is used to identify the relationship between macro and micro-economic variables and stock market validations. Top ten CSE listed company specifics and eight macro-economic variables which affect to the stock market fluctuations in CSE were used.

They are; GDP rate of Sri Lanka, inflation rates, unemployment rates, average consumer spending rates, total investments per country GDP (US dollars), Gross national savings Percent of GDP (US dollars), crude oil important rates (US Dollar Billions) , Government Revenue (R.s Billions) , Net revenue, Net profit and Net Assets value per ordinary share.

As the first step, Kolmogorov-Smirnov test and Anderson-Darling were used to check the normality under the 0.05 level of significance. Moreover, Graphical methods such as Q-Q plot and probability plots are also used to confirmed the results again. If the variables which do not appear to be normally distributed, it can be transformed in order to reach normality by using the natural log function or square root functions.

Out of 283 listed companies in Sri Lanka, only 25 sample observations were selected for any further analysis based on their market performances in 2012. Randomly selected 5 listed companies were used for our further discussions. They are; COMB, LOLC, ASPL, DFCC and BOGA.

This section Principal Component Analysis (PCA) is used to identify the relationship between macro and micro-economic variables and stock market validations. Top level CSE listed company specifics with macro-economic variables which affect to the stock market fluctuations in CSE were used.

Table 3: PC values for the selected variables (ASPL)

Variable	ASPL	COMB	LOLC
GDP Level	0.343	0.320	0.254
Unemployment Rate	0.349	0.184	0.097
Log (Average consumer Spending )	0.198	0.648	0.125
Crude Oil Imports rates	-0.043	-0.363	-0.499
log(Government Revenue)	-0.128	0.314	0.494
Total investment Percent of GDP	0.002	0.146	0.252
Gross national savings Percent	-0.427	0.245	0.510
log(Inflation)	0.286	-0.128	-0.714
Log (COMB _ Gross)	0.356	-0.152	0.147
log(COMB _ Net Revenue)	0.506	0.054	0.158
log(COMB_ Net As value per share)	0.293	0.296	0.106

Source: ASPL Annual Reports and Central Bank Reports -2012

From Table 3 results, Net revenue, Gross values, Crude oil imports rates, inflation rates of the country and gross national servings are the most significant variables, which are directly affecting the stock prices movements. These results suggest that, not only macro variables but also the micro variables influence to the market movements.

**CSC Sector vice analysis: ARMA Approach**

Theoretically, the Granger causality runs only one-way side. According to the Table 4 results, the following null hypothesis can be rejected under the 0.05 level of significance. They are; DIVERSIFIED HOLDINGS

(DIV) Granger Cause ASPI, BANK FINANCE AND INSURANCE (BFI)Granger Cause ASPI , MANUFACTURING (MFG) Granger Cause ASPI, INVESTMENT TRUSTS (INV) Granger Cause ASPI and TRADING (TRD) Granger Cause ASPI.

Table 4: The Pairwise Granger Causality Tests

<b>Null Hypothesis:</b>	<b>Probability</b>
DIV does not Granger Cause ASPI	0.03309
ASPI does not Granger Cause DIV	0.46107
BFI does not Granger Cause ASPI	0.04730
ASPI does not Granger Cause BFI	0.73194
MFG does not Granger Cause ASPI	0.04002
ASPI does not Granger Cause MFG	0.01966
INV does not Granger Cause ASPL	0.04745
ASPL does not Granger Cause INV	0.12795
TRD does not Granger Cause ASPL	0.03368
ASPL does not Granger Cause TRD	0.15822
IT does not Granger Cause ASPL	0.05568
ASPL does not Granger Cause IT	0.25822
TLE does not Granger Cause ASPL	0.05900
ASPL does not Granger Cause TLE	0.60760

Table 5: ADF and PP Test Results

<b>Sector</b>	<b>Significance Results</b>		<b>Sector</b>	<b>Significance Results</b>	
	<b>ADF Test</b>	<b>PP TEST</b>		<b>ADF Test</b>	<b>PP TEST</b>
ASPI	0.0001	0.0002	MFG	0.0034	0.0014
BFI	0.0002	0.0001	INV	0.0001	0.0002
DIV	0.0012	0.0021	TRD	0.0002	0.0021
IT	0.0231	0.0432	TLE	0.0321	0.0122

ADF and PP test results suggested that, BFI, DIV, MFG, INV and TRD are stationary and independent with each other. As a result, ARMA model is most suitable model for predicting future patterns

According to Table 5 results, ARMA (1, 1) model is best fitted for the BFI and MFG sections and ARMA (1, 0) model is suitable for DIV, INV and TRD sections.

Table 6: ARMA model Fittings Analysis

<b>Sec</b>	<b>Fitted model</b>	<b>AICC (E+03)</b>	<b>BIC (E+03)</b>	<b>Error = (Res. S)/N</b>	<b>Sec</b>	<b>Fitted model</b>	<b>AICC (E+03)</b>	<b>BIC (E+03)</b>	<b>Error=(Res.S)/N</b>
<b>ASPI</b>	ARMA (1,1)	-0.149	-0.151	0.0055	<b>INV</b>	ARMA (1,0)	-21.560	-25.40	0.0096
<b>BFI</b>	ARMA (1,1)	-0.156	-0.159	0.0085	<b>MFG</b>	ARMA (1,1)	-0.150	-0.15	0.0054
<b>DIV</b>	ARMA (1,0)	-0.112	-0.114	0.0001	<b>TRD</b>	ARMA (1,0)	-75.690	-76.47	0.0074
<b>IT</b>	ARMA (0,1)	-0.190	-0.192	0.0118	<b>TLE</b>	ARMA (1,3)	-0.237	-0.24	0.0080

## 5. Conclusion

The study sheds light on economic relationships between macro-economic variables that affect to the market fluctuations, with respect to the Colombo stock exchange during January 2008 to 2012. Multivariate statistical techniques were widely applied to predict the future results under different types of stationary and non-stationary conditions. The evidence provide from this study is useful for the shareholders, policy makers and



other stake holders.

Stocks from the banking, finance & insurance, manufacturing, hotel & travels, beverage, food & tobacco, plantation, IT and telecommunications are important in explaining the variations in the CSE. Moreover, Principal component results suggest that GDP rates, inflation and consumer spending rates directly involve changing stock market prices and trade volume rates in the Colombo Stock exchange.

Furthermore, our results indicated that, political situation and political stability of the country also directly affect the market fluctuations in developing markets such as Colombo Stock Exchange.

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