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Short-term and long-term dynamics between macroeconomic indicators and market fluctuation: A study of Colombo Stock Exchange

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Abstract

As a developing market, the high volatile fluctuations with instability patterns are the common phenomenon in the Colombo Stock Exchange of Sri Lanka. The miscellaneous type of micro and macro-economic conditions directly effect on the market fluctuations. By using Vector Autoregressive Regression and Vector Error Correlation Model to capture the linear inter-dependencies, this study examines the equilibrium relationships between the stock market indices and macro-economic factors in Sri Lankan during the period from January, 2009 to December 2015. The study revealed that macroeconomic variables have direct effect on high volatility in stock market fluctuations in the Colombo Stock Exchange. Furthermore, the results show that Colombo stock exchange is highly sensitive to the macroeconomic variables such as market capitalization, real gross domestic product and broad money supply.

Keywords: *Colombo Stock Exchange, long run and short run relationship, vector autoregressive regression*

1. Introduction

The unexpected economic booms and busts in the global economy resulted un-behavioral fluctuations of financial indices including the stock market indices. In general, investors gain high return for their stocks which market prices are going up in the companies that are performed well. Thus, identification the effect of macroeconomic variables on assets prices is more necessitate for making a profitable investment; especially, government investment policies, local and international portfolio guidelines, stability of macro-economic factors such as interest rates, inflation, money supply and exchange rates as

well as political stability of the country have significant influence over the stock market indices (Anderson et al., 2002; Azeez et al., 2006).

The numerous types of methodologies can be seen in the literature to estimate the market predictions. Among them, the time series analysis is an essential methodology which comprises the tools for analyzing the time series data to identify the meaningful characteristics.

In this study, we review selected number of research studies from this vast literature. Fama et al. (1981) carried out a number of studies under the ameliorating weighted based market portfolio with respect to the stock market indies (Fama, 1981; Fama, 1990) in the multi-period economy. Based on the empirical results he argued that, macro-economic factors directly affected to the future dividends, interest rates as well as stock market fluctuations. Similarly, Masih et al. (1996) empirically conformed that, dynamic causal chain relations among the macroeconomic factors such as interest rate, inflation and the exchange rate caused unstable economies in South Asia during the past three decades (Masih et al., 1996). These findings have received a significant attention of academics and uncovered a new research direction for small developing economics.

Theoretically, the influence of macroeconomic variables on assets has been driven under the two time spans namely long run and short run equilibriums. As a result of these complications with respect to the time, various types of novel methodologies have been developed after the 1970th and successfully applied for financial applications (Russell et al., 2004). Among them, the capital asset pricing model (CAPM) of Sharpe (Chen et al., 1986; Wei et al., 2011) arbitrary pricing theory (APT) of Roll (1984), Intertemporal Capital Asset Pricing Model (Merton, 1973) vector auto regressive model (VAR) and vector error correlation model (VECM) proposed to handle incomplete, noise and uncertain data in the multidisciplinary systems are widely applied in empirical studies.

The CAPM illuminates the relationships between the risk and returns. It is the common phenomenon that, the behaviors of risk always change proportional to the returns. In this scenario, Azeez et al. (2014) analyzed the asset price relationships in Japan based on CAPM during the pre and post bubble economic periods between 1980 and 2014. The estimated results clearly suggested that money supply, inflation, industrial production and exchange rates have significance influence on expected returns. Richard et al. (2010, as cited in Jayathilake & Rathnayaka, 2013) did a similar study and successfully applied the APT to examine the long term relationships between the stock indices and selected economic variables in UK (). The estimated results clearly suggested that an APT technique leads to more reliable than CAPM techniques.

Goswami and Jung (1997) conducted a similar type of study to examine the short term and long term equilibrium relationships between the selected macro-economic variables with respect to the stock indices in Korea using APT, VAR and VECM methodologies (Goswami & Jung, 1997). Their result reveals that Korean Stock Exchange is strongly co-integrated with economic variables; especially, industrial production, inflation and short-term interest rates positively and long term interest rates and oil prices negatively affect to stock prices in Korea respectively. Moreover, the results clearly suggested that forecasting ability of VECM is better than VAR estimates.

The Colombo Stock Exchange is one of the most modernized stock exchanges in the South Asia providing a fully automated trading platform for locals as well as international investors. Currently, 297 trading companies have been representing 20 businesses sectors under the two main price indices namely All Share Price Index (ASPI) and S&P Sri

Lanka 20 Price Index (S&P SL20). The ASPI is the principal stock index, which measures the market capitalizations of all the listed companies (Rathnayaka et al., 2014).

Highly volatile market fluctuations with instable patterns are the common phenomenon in the CSE. Especially, as a developing market, the innumerable micro and macro-economic conditions are highly involved. In a Sri Lankan context, limited studies have seen on our interest. Among them, Samaratunga (2009) and Fernando et al. (2012) examined numerous macro-economic variables such as money supply, treasury bills and inflation rates positively influence for their influence over market fluctuations. In recently, based on univariate and multivariate techniques, Rathnayaka et al. (2014) investigated the trends and cycle patterns in the CSE and pointed out that, economic conditions directly affected on market volatility during 2007 to 2012.

The objective of this study is to examine the dynamic relationships between market fluctuations and macroeconomic variables in Sri Lankan context. In order to investigate the relationships, Johansen's Vector Error Correlation Modeling (1991) was employed. The rest of the paper is organized as follows. Next section develops the hypotheses and explains the methodology used in the study. Third section three briefly presents the results including VECM results and the paper ends up with the conclusion.

2. Methodology

The current study mainly deals with the empirical methodology which consists of Johansen co-integration, Vector Autoregressive Regression and Vector error correlation methodology to explain the long term and short term predictability and profitability of technical trading strategies.

In general, the economic data are often non-seasonal and highly fluctuate over the time. Theoretically, if the series is distributed with non-constant mean over the time, such the series is said to be non-stationary (Kumara et al., 2011). Thus, as an initial step in the financial data analysis, it is necessary to test for the stationary and non-stationary conditions before using them for further analysis. In the literature, several methods can be seen to determine the existence of unit roots. They are Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP).

As a next step, co-integration test methods was formed to determine the long – run relationships and VAR and VECM were formed to capture these linear interdependencies among long –run or transitory aspects. The VAR methodology can be generalized as the univariate auto-regression model which use for forecasting systems of interrelated time series to analyze the dynamic impact of random disturbances on the systems of variables. The model explains the evolution of set of p endogenous variables over the time period t where, t = 1, ..., T. The variables are collected in a $p\times$ 1 vector y_t, which has the i th element, $y_{i,t}$, the time t observation of the i th variable. For example, if the i th variable is ASPI, then $y_{i,t}$ is the value of ASPI at time t (Granger et al., 1986, Johansen et al., 1990).

$$y_t = c + A_1 y_{t-1+} A_2 y_{t-2+\cdots +} A_p y_{t-p+} \epsilon_t \qquad (1)$$

Where y_t is a non-stationary vector ($p \times 1$) with the l (1) lag of y. Intercept c is a $k \times 1$ vector of constant to be estimated and A_i is a time-invariant $p\times p$ matrix and ϵ_t is a $p \times 1$ vector of error term that may be contemporaneously correlated but are uncorrelated with their own lagged values. Engle and Granger (1987) point out that, if a non-stationary linear combination exits, the time series said to be co-integrated (Engle & Granger,

1987).On the other hand, if the series have stationary linear combination, it interpreted a long-run and short-run equilibrium relationship among the variables (Granger, 1986).

In generally, the error correction models can be used for determining the long- run as well as short-run relationship with respect to the time. In this study, Johansen co-integration with VECM is adapted to examine the links between long-run and short-run dynamic equilibrium relationships between stock market index and different type of economic growth conditions related to Sri Lanka.

$$\Delta y_t = \delta + \lambda t + \beta y_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \varepsilon_t \tag{2}$$

Where y_t is distributed under the $I(1)$ against the alternative $I(0)$ and p, λ and t represent the lag length of the auto regressive process, the coefficient on a time trend and time trend variables respectively.

As an initial requirement, VECM necessitates the time series to be co-integrated with the same order. If the series be non- stationary, the series to be difference d times until it will become under the stationary. Granger et al. (1986) noted that; if the variables are co-integrated under same conditions, then VECM can be used for evaluating the equilibrium relationship exist among the variables to find long run as well as short run relationship between variables. The vector error correlation model for the variable x can be implicated by equations as follows.

$$\Delta y_t = \delta + \sum_{i=1}^{n} \beta_{ia} \Delta y_{t-1} + \sum_{i=1}^{n} \alpha_{ib} \Delta x_{t-1} + \sum_{i=1}^{n} \varphi_{ic} \Delta z_{t-1} + \lambda_1 ECT_{t-1} + e_{1t} \tag{3}$$

In the above equation (3), the serially uncorrelated error term (e_{it}) normally distribute and wide noise. Furthermore, the term ECT_{t-1} represents the lag error correlation term that is derived from the co-integration relationship and measure the magnitude of past disequilibrium. To investigate the long term as well as short term dynamic relationships between market fluctuations and macroeconomic variables in Sri Lankan context, multivariate time series techniques such as Johansen's co-integration technique, Vector Autoregressive Regression and VECM methodologies were employed. The data were obtained from annual reports of Central Bank of Sri Lanka, the monthly trading reports from CSE, various types of background readings and other relevant sources and etc. Monthly data for seven year period from January 2009 to December 2015 were extracted and tabulated. All the selected macroeconomic variables are presented in Table 1.

Table 1
Definition of variables

Variables	Definition of Variables
$ASPI_t$	All share Price Index of market-ended closing prices
$CCPI_t$	Month-end Colombo Consumers' Price Index (2002 = 100)
FDI_t	Month-end 12 month fixed deposit rate
GDP_t	Month-end per capita real Gross domestic product
MC_t	Month-end per Market capitalization (Rs. billion)
$M2_t$	Month-end per Broad money (M2)
$M1_t$	Month-end per Narrow money (M1)
REV_t	Month-end per Revenue (Rs. billion)

3. Results

At the initial stage, stationary and non-stationary conditions were measured using two different Unit root approaches namely Augmented Dickey-Fuller test statistic (ADF) and Phillips-Perron test statistic (PP). According to Table 2, all the variables are integrated in a same time in their first differences. Furthermore, PP test results confirmed that, all the selected variables can be categorized under the I(1) process.

Table 2
Results of ADF and PP Tests

	Level data (P-value)			1st Difference(P-value)	
Sector	ADF Test	PP Test	Sector	ADF Test	PP Test
ASPI	0.1768	0.0010	ASPI	0.0000	0.0000
BT	0.0567	0.0887	BT	0.0000	0.0000
CCPIM	0.0000	0.0000	CCPIM	0.0000	0.0001
FDI	0.0000	0.0000	FDI	0.0000	0.0000
GDP	0.2294	0.2346	GDP	0.0320	0.0000
M1	0.3324	0.2253	M1	0.0000	0.0000
M2	0.5249	0.1501	MC	0.0000	0.0000
MC	0.4186	0.4066	M2	0.0000	0.0000
REV	0.0000	0.0000	REV	0.0000	0.0001

In the second stage, Johansen (trace) co-integration rank test and Maximum Eigenvalue test were employed to test whether there is any co-integrating relationship between the variables. Table 3 shows the number of co-integrating vectors for selected variables.

Table 3
Results of Co-integration

Co-integration Rank Test (Trace)			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Prob.**
None *	0.682621	230.8552	0.0004
At most 1 *	0.523937	164.2909	0.0268
At most 2	*0.455075*	*121.2429*	*0.0896*
At most 3	0.382061	86.03075	0.1932
At most 4	0.299734	58.11151	0.2979
At most 5	0.285582	37.44636	0.3268
Co-integration Rank Test (Maximum Eigenvalue)			
None *	0.682621	66.56426	0.0066
At most 1 *	0.523937	43.04795	0.0320
At most 2	*0.455075*	*35.21219*	*0.4465*
At most 3	0.382061	27.91924	0.5676
At most 4	0.299734	20.66515	0.7091
At most 5	0.285582	19.50464	0.3765

*Note : Trace test indicates 2 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values*

Estimated co-integration rank test (0.0896 >0.05) and Max-eigenvalue (0.4465>0.05) test suggested that there are two co-integration equations exist at the 0.05 level of significance. Furthermore, results show a significance association among the stock market indices and the selected macro-economic variables in the long run.

In the next stage, maximum likelihood method based on VECM is set up to investigate these causality relations between dependent and independent variables. Theoretically, when the variables are co-integrated in same order, maximum likelihood method based on VECM can be performed to find the causality between the underline variables.

Table 4
Results of co-integration

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	*-0.824613*	*0.165935*	*-4.969489*	*0.0000*
C(2)	140.2245	140.3277	0.999265	0.3185
C(3)	0.251236	0.164713	1.525292	0.1282
C(4)	0.393016	0.096080	4.090532	0.0001
C(5)	-123.1285	128.4486	-0.958582	0.3385
C(6)	-12.37431	117.9301	-0.104929	0.9165
C(7)	0.005998	0.002815	2.131076	0.0339
C(8)	0.002982	0.002742	1.087883	0.2775
C(9)	-19.79749	164.2168	-0.120557	0.9041
C(10)	-184.7608	162.7329	-1.135362	0.2571

According to the result in Table 4 the coefficient of co-integrated is significant at the 0.05 level of significance ($p<0.05$) with negative sign (-0.824613). It means that, there is causality generally shows the short run relationships from independent variables such as FDI, GDP, M1, MC, M2 and REV to dependent variable ASPI.

Table 5
Wald test Results

Variables	CCPIM	FDI	GDP	M1	MC	M2	REV
Chi-square Test	0.039	0.050	0.470	0.004	0.001	0.003	0.037
Probability	0.040	0.051	0.475	0.004	0.003	0.003	0.038

The short-run adjustments along the co-integrating equilibrium relationships were then developed to test whether any short run causality exists between independent and dependent variables. The Vector error- correlation estimates with Wald statistic results in Table 5 reveals that, short run causality running from M2 (0.0034< 0.05), M1(0.0044<0.05), CCPIM (0.0401< 0.05), MC (0.0003<0.05) and REV (0.0381< 0.05) to ASPI. However, short run elasticity of FDI (0.0506 = 0.05) with respect to the ASPI is very low but is reasonably significant. However, only GDP does not have has not seen any short term relation between ASPI.

4. Conclusion

The Economical Time series are widely used to develop the economic relationships, especially for the nonlinear models under the stationary and non-stationary frameworks for predestining and forecasting future patterns. This study sheds light on design and

explaining the long term and short term predictability of technical trading strategies in the CSE during seven year period spanning from 2009 January to 2015 December.

The results detected that the Colombo Stock Market is more sensitive to external factors such as changers in interest and exchange rates. For instance, Masih et al. (1996), Samarakoon et al. (1996), Goswami and Jung (1997), Qiao et al. (2008), Rjoub et al. (2009) and Rathnayaka et al. (2014) reported similar type studies based on various type of methodologies with respect to macro-economic variables.

We strongly believed that these findings will be useful to both investors domestic and internationals and policy makers for make better investment decisions using the both long-run equilibrium and long-periodic co-movements.

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