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Impact of Macroeconomic Variables on Stock Market Returns: A Case Study of Colombo Stock Exchange, Sri Lanka

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Abstract

Unexpected circumstances with respect to the social and economic conditions, the stock market indices have been moving up and down with high volatility. 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 2016 to capture the linear inter-dependencies, by using Vector Autoregressive Regression and Vector Error Correlation Model. Estimated co-integration rank test and Max-eigenvalue test suggested that there are two co-integration equations exist at the 0.05 level of significance. Furthermore, findings revealed that macroeconomic variables have direct effect on high volatility in Stock Market fluctuations. Moreover, the results concluded that Colombo Stock Exchange (CSE) is highly sensitive to the macroeconomic variables such as real gross domestic product and broad money supply.

Keywords: Max-eigenvalue Test and Colombo Stock Exchange, Vector Autoregressive Regression, Vector Error Correlation Model

Introduction

Stock market is a place where aggregates stocks for buyers and sellers in a single platform. As a result of some unexpected circumstances in the modern economy, within very short periods of time the stock market indices have been moving up and down with high volatility. To identify these unusual behaviors, the new hypotheses have been developing rapidly by integrating both concepts of economics, mathematics with pillars of modern financial methods. In this study, we review selected number of research studies from this vast literature. Among them, Fama et al. (1981) has been carried out some significant study under

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the ameliorating weighted based market portfolio (Fama, 1990) under the multi-period economy.

In General, interest rates is essential tool for controlling the stock prices in an attractive level. For an example, if a company borrows money to expand their business, higher interest rates will affect the cost of its debt and will reduced the company profits. As a result, share price of their company may be going down. On the other hand, if the company is going to expand their economy, stock prices may rise. Under this situation, investors may buy more stocks for the future profits (Anderson et al., 2002; Azeez et al., 2014). Inflation is another economic factor that effect on stock market volatility. Theoretically, increases in inflation will increase the cost of living thus channeling scare resources meant for investment to consumption. This often slows sales and reduces profits. Furthermore, this decreases the demands for investments. However, if the Stock prices may go down, and investors may start selling their shares and move to fixed-income investments (Engle et al., 1987; Granger, 1986).

There are number of studies which are carried to find out the impacts of macroeconomic fundamentals on stock exchange are available in the literature. Kumar et al. (2014) carried out a study to find the relationship between stock index and exchange rates from Tehran stock index of Iran. In the same period of time, Azeez et al. (2014) have carried out a study to measure the exchange rate volatility with respect to the real exchange rate, GDP per capita, trade openness and foreign direct investment in SAARC countries includes Pakistan, India and Sri Lanka and found a negative relationship between exchange rate volatility and foreign direct investment. Goswami et al. (2015) 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 Vector error correction methodology (VECM).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 Vector Auto regression (VAR) estimates.

The Colombo Stock Exchange (CSE) is one of the most modernized stock exchange in the South Asia providing a fully automated trading platform for locals as well as international investors. However, highly volatile market fluctuations with instable patterns are the common phenomenon in the CSE (Rathnayaka et al., 2014). Especially, as a developing market, the

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innumerable micro and macro-economic conditions are highly involved. In a Sri Lankan context, limited studies have seen on our interest. Among them, Samarathunga et al. (2008) and Rathnayaka et al. (2014; 2015) 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. (2013) 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. Section three briefly presents the results including VECM results and the paper ends up with the conclusion.

Data and Methodology

Data Sources

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 2016 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
RM_t	Month-end Reserve Money
PCI_t	Month-end Petroleum - Crude oil imports
GDP_t	Month-end per capita real Gross domestic product
$REER_t$	Month-end Real Effective Exchange Rate Index
$M2b_t$	Month-end per Broad money (M2b)
GP_t	Month-end Gold Price

The Model, Unit Root and Co-integration

The current study mainly deals with the empirical methodology which consists of Johansen co-integration, Vector Autoregressive Regression and Vector error correlation methodology

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to explain the long term and short term predictability and profitability of technical trading strategies.

In general, 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 such as 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 (Rathnayaka et al., 2014; Rathnayaka et al., 2015). 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× 1 vector yt, which has the i th element, yi,t, the time t observation of the i th variable. For example, if the i th variable is ASPI, then yi,t is the value of ASPI at time t (Granger et al., 1986, Jayathilaka et al., 1990, Aruwamadu et.al,2014).

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

Where y_t is a non-stationary vector (p × 1) with the l (1) lag of y. Intercept c is a k × 1 vector of constant to be estimated and Ai is a time-invariant p× p matrix and ϵ_t is a p × 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.

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

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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 (Seneviratna et al., 2013; Seneviratna et al., 2013).

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

In the above equation (3), the serially uncorrelated error term (e_{it}) normally distribute and wide noise. Furthermore, the term ECT_{i-1} represents the lag error correlation term that is derived from the co-integration relationship and measure the magnitude of past disequilibrium.

Results and Discussions

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

Unit Root Test for Stationary Checking

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 the 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.

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Table 2: Results of ADF and PP Tests

Variable	Significance Results		Variable	Significance Results	
	Level data (P-value)			1st Difference(P-value)	
	ADF Test	PP Test		ADF Test	PP Test
ASPI	0.0386	0.0376	D(ASPI)	0.0000*	0.0000*
GDP	0.0765	0.2578	D(GDP)	0.1147	0.0001*
M2b	1.0000	1.0000	D(M2b)	0.0000*	0.0000*
PCI	0.0001	0.0001	D(PCI)	0.0001*	0.0001*
REER	0.1554	0.3021	D(REER)	0.0000*	0.0000*
RM	0.9989	0.9999	D(RM)	0.0000*	0.0000*
GP	0.1837	0.2857	D(GP)	0.0000*	0.0000*

Note: Significant at 5%.

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 *		0.586332	0.0000
At most 1 *	0.478139	130.1441	0.0000
*At most 2 **	*0.287680*	*80.71718*	*0.0553*
At most 3	0.229005	43.43917	0.1222
Co-integration Rank Test (Maximum Eigenvalue)			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Prob.**
None *	0.586332	67.08447	0.0001
At most 1 *	0.478139	49.42692	0.0034
*At most 2 **	*0.387680*	*37.27800*	*0.0589*
At most 3	*0.229005*	*19.76554*	*0.3576*

Note: Trace test indicates 2cointegratingeqn(s) at the 0.05 level:

** denotes rejection of the hypothesis at the 0.05 level*

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Estimated co-integration rank test (*0.0553*>0.05) and Max-eigenvalue (*0.0589*>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. Indeed, co-integrated results indicated that variable have long run association and they are moving together in long run period of time.

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: Co-integrated Results

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.932902	0.120406	7.747953	0.0000*
C(2)	-0.069355	0.116524	-0.595203	0.5520
C(3)	-1.818608	7.595474	-0.239433	0.8109
C(4)	6.954369	7.945016	0.875312	0.3819
C(5)	-0.006392	0.006748	-0.947215	0.3440
C(6)	0.004174	0.006230	0.669977	0.5032
C(7)	-0.001437	0.001919	-0.748842	0.4543
C(8)	0.001378	0.001977	0.697164	0.4861
C(9)	-0.000184	0.000539	-0.341251	0.7331
C(10)	-0.000635	0.000537	-1.183662	0.2372
ASPI = C(1)*ASPI(-1) + C(2)*ASPI(-2) + C(3)*GDP(-1) + C(4)*GDP(-2) + C(5)*GP(-1) + C(6)*GP(-2) + C(7)*M2B(-1) + C(8)*M2B(-2) + C(9)*PCI(-1) + C(10)*PCI(-2) + C(11)*REER(-1) + C(12)*REER(-2) + C(13)*RM(-1) + C(14)*RM(-2) + C(15)				

Note: Significant at 5%.

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 (-0.932902). It means that, there is causality generally shows the short run relationships from independent variables to dependent variable ASPI.

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Table 5: Wald Test Results

ASPI	GDP	M2b	PCI	REER	RM	GP
Chi-Square	1.2473	60.187	0.4481	3.5614	2.6448	0.7773
Probability	0.0000*	0.0000*	0.7992	0.0552	0.0080*	0.6779

Note: Significant at 5%.

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 M2b (0.0000< 0.05), GDP(0.0000<0.05) and RM (0.0080< 0.05) to ASPI. It means that lag values equal 0 and not jointly can influence dependent variable ASPI. However, short run elasticity of REER (0.0552 = 0.05) with respect to the ASPI is very low but is reasonably significant. However, only PCI and GP do not have has not seen any short term relation between ASPI.

Conclusion and Policy Implication

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 years from 2009 January to 2016 December.

The results detected that, the Colombo Stock Market is more sensitive to external factors such as changers in Broad Money and Reserve Money. For instance, Masih et al. (1996), Samarakoon et al. (1996), Maysami et al. (1996), Goswami et al. (1997), Qiao et al. (2008) and Rathnayaka et al. (2013) 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 investors both domestic and internationals and policy makers for make better investments based on the both long-run equilibrium and long-periodic co-movements.

References

Fama, E., 1981. Stock Returns, Real activity, Inflation and Money. *American Economic Review*, Volume 71, pp. 545-565.

DOI: http://doi.org/10.4038/kjm.v6i0.7541

Anderson, R. G., Hoffman, D. L. & Rasche, R. H., 2002. A vector error correction forecasting model of the US economy. *Journal of Macroeconomics*, Volume 24, pp. 569-598. https://doi.org/10.1016/S0164-0704(02)00067-8

Azeez, A. & Yonezawa, Y., 2014.Macroeconomic factors and the empirical content of the Arbitrage Pricing Theory in the Japanese stock market. Japan and the WORLD ECONOMY, Volume 18, pp. 568-591.https://doi.org/10.1016/j.japwor.2005.05.001

Engle, R. E. & Granger, C., 1987. Cointegration and error-correction: representation, estimation and testing. *Econometrica*, p. 251–276.https://doi.org/10.2307/1913236

Granger, C. W. J., 1986. Developments in the study of cointegrated economic variables. *Oxford Bulletin of Economics and Statistics*, Volume 48, p. 213–228. https://doi.org/10.1111/j.1468-0084.1986.mp48003002.x

Kumar, A., 2011. An Empirical Analysis of Causal Relationship between Stock Market and Macroeconomic Variables in India. *IJCSMS International Journal of Computer Science & Management Studies*, 11(1).

Rathnayaka R. M. K. T., Seneviratna, D.M.K.N., Jianguo W, Grey system based novel forecasting and portfolio mechanism on CSE, Grey Systems: *Theory and Application*, 6(2), 126-142, 2016, Emerald Group Publishing Limited; https://doi.org/10.1108/GS-02-2016-0004

Masih, R. & Masih, A. M., 1996. Macroeconomic activity dynamics and Granger causality: New evidence from a small developing economy based on a vector error-correction modelling analysis. *Economic Modelling*, Volume 13, pp. 407-426. https://doi.org/10.1016/0264-9993(96)01013-9

Rathnayaka R. M. K. T., Seneviratna, D.M.K.N., Jianguo W, Grey system based novel approach for stock market forecasting, Grey Systems: *Theory and Application*, 5(2), 178-193, 2015, Emerald Group Publishing Limited ; http://dx.doi.org/10.1108/GS-04-2015-0014

Arumawadu, H.I., Rathnayaka, R.M.K.T., Seneviratna, D.M.K.N., New Proposed Mobile Telecommunication Customer Call Center Roster Scheduling Under the Graph Coloring Approach, *International Journal of Computer Applications Technology and Research*, 5(4), pp.234–237, 2016. https://doi.org/10.7753/IJCATR0504.1010

Jayathileke, P. M. B. & Rathnayaka, R.M. K.T, 2013.Testing the Link between Inflation and Economic Growth: Evidence from Asia. *Communications and Network*, Volume 4, pp. 87-92.

Arumawadu H. I., Rathnayaka, R.M.K.T., Illangarathne S.K., K-Means Clustering For Segment Web Search Results, *International Journal of Engineering Works*, 2(8), 79-83, 2015, kwpublisher.com.

Rathnayaka R. M. K. T., Seneviratna, D.M.K.N., G M (1, 1) Analysis and Forecasting for Efficient Energy Production and Consumption, *International Journal of Business, Economics and Management Works*, Kambohwell Publisher Enterprises, 1 (1), 6-11, 2014,

Arumawadu H. I., Rathnayaka, R.M.K.T., Illangarathne S.K., Mining Profitability of Telecommunication Customers Using K-Means Clustering, *Journal of Data Analysis and Information Processing*, 3(3), 63, 2015, DOI: 10.4236/jdaip.2015.3300.

Rathnayaka R. M. K. T., Seneviratna, D.M.K.N., A Comparative Analysis of Stock Price Behaviors on the Colombo and Nigeria Stock Exchanges, *International Journal of Business, Economics and Management Works*, Kambohwell Publisher Enterprises, 2 (2), 12-16, 2014,

Johansen, S. & Juselius, K., 1990.Maximum likelihood estimation and inference on cointegration with application to the demand for money. *Oxford Bulletin of Economics and Statistics*, Volume 59, p. 169–210. https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x

Rathnayaka R. M. K. T., Seneviratna, D.M.K.N., Wang Zhong- jun, An Investigation of Statistical Behaviors of the Stock Market Fluctuations in the Colombo Stock Market: ARMA & PCA Approach, *Journal of Scientific Research & Reports* 3(1): 130-138, 2013; https://doi.org/10.9734/JSRR/2014/5409

Seneviratna D.M.K.N. and Shuhua M., Forecasting the Twelve Month Treasury Bill Rates in Sri Lanka: Box Jenkins Approach, *IOSR Journal of Economics and Finance (IOSR-JEF)*, 1(1), 42-47, 2013.

Seneviratna, D.M.K.N & Long, W. (2013). Analysis of Government Responses for the Photovoltaic Industry. *Journal of Economics and Sustainable Development*, 4(13), PP 10-15.

Seneviratna, D.M.K.N & Jianguo, W. (2013). Analyzing the Causal Relationship between Stock. *ZENITH International Journal of Business Economics & Management Research*, 3(9), 11-20.

Seneviratna, D.M.K.N & Chen, D. (2013).Using Feed Forward BPNN for Forecasting All Share Price Index. *Journal of Data Analysis and Information Processing*, 2(04), PP 87-94.

Rathnayaka R. M. K. T., Wang Zhong-jun, Enhanced Greedy Optimization Algorithm with Data Warehousing for Automated Nurse Scheduling System, *E-Health Telecommunication Systems and Networks*, 1(4), 2012

Rathnayaka R. M. K. T., Seneviratne D.M.K.N, Jianguo W., Arumawadu H.I., A Hybrid Statistical Approach for Stock Market Forecasting Based on Artificial Neural Network and ARIMA Time Series Models, The 2nd International Conference on Behavioral, Economic and Socio-Cultural Computing (BESC'2015-IEEE), Nanjing, China, 2015.

Rathnayaka R. M. K. T., Jianguo W., Seneviratne D.M.K.N, Geometric Brownian Motion with Ito lemma Approach to evaluate market fluctuations: A case study on Colombo Stock Exchange, 2014 International Conference on Behavioral, Economic, and Socio-Cultural Computing (BESC'2014- IEEE), Shanghai, China, 2014.

Rathnayaka R. M. K. T., Seneviratne D.M.K.N., Jianguo W., Arumawadu H.I., An unbiased GM (1, 1) - based new hybrid approach for time series forecasting, Grey Systems: Theory and Application, 6(3), 322-340, 2016, Emerald Group Publishing Limited; https://doi.org/10.1108/GS-04-2016-0009

Merton, R. C., 1973. An Intertemporal Capital Asset Pricing Model. *Econometrica*, Volume 41, pp. 867-888. https://doi.org/10.2307/1913811

Qiao, Z., Chiang, T. C. & Wong, W. K., 2008.Long run equilibrium, short-term adjustment, and spillover effects across Chinese segmented stock markets and the Hong Kong

stock market. *International Financial Markets, Institutions & Money*, Volume 18, pp. 425-437. https://doi.org/10.1016/j.intfin.2007.05.004

Rathnayaka, R. K. T., Seneviratne, D. K. & Wang, Z., 2013. An Investigation of Statistical Behaviors of the Stock Market Fluctuations in the Colombo Stock Market: ARMA & PCA Approach. *Journal of Scientific Research & Reports*, 3(1), pp. 130-138. https://doi.org/10.9734/JSRR/2014/5409

Rjoub, H., Tu¨rsoy, T. & Gu¨nsel, N., 2009. The effects of macroeconomic factors on stock returns: *Istanbul Stock Market. Economics and Finance*, 26(1), pp. 36-45. https://doi.org/10.1108/10867370910946315

Roll, R. & Ross, S. A., 1984. The Arbitrage Pricing Theory Approach to Strategic Portfolio Planning. *Financial Analysts Journal*, Volume 3, p. 40. https://doi.org/10.2469/faj.v40.n3.14

Russell, D. & James G MacKinnon, 2004. Econometric Theory and Methods. 7 ed. New York: Oxford University Press.

Samarakoon, L., 1996. Predictability of short-horizon returns in Sri Lankan stock market. *Sri Lankan Journal of Management*, pp. 207-224.

Samarathunga, D., 2008. Stock market efficiency and integration: A study of eight economies in the Asia-Pacific Region. s.l.: Central Bank of Sri Lanka.

Wei, Z., 2011. APT Model based on Factor Analysis and An empirical study in China's Growth enterprise Market. IEEE, 11(1), pp. 994-997.