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DYNAMIC RELATIONSHIPS BETWEEN MACROECONOMIC VARIABLES AND STOCK MARKET SECTOR INDICES: EVIDENCE FROM COLOMBO STOCK EXCHANGE

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ABSTRACT

This study aims to investigate the dynamic movements of sector price indices against the macroeconomic variables. Therefore, this study employs vector error correction and autoregressive models with the monthly data from January 2007 to December 2016 to examine the impacts of the exchange rate, money supply, oil prices and interest rate on sector price indices. We focused on the manufacturing, plantation, telecommunication, and trading sectors as they represent the main economic activities such as industry, agriculture and services. Our findings help to conclude that the macroeconomic influence on stock market price indices listed in Colombo Stock Exchange is dynamic as different sectors are exposed to specific macroeconomic variables with different sensitivities. These findings encourage the investors to diversify their portfolios and time their investments based on the macroeconomic conditions. Policymakers should rethink their strategies to control and encourage different sectors such as plantation and manufacturing because they have bidirectional causality with macroeconomic conditions.

Keywords – Dynamic Relationships, Macroeconomic Variables, Vector Error Correction, Colombo Stock Exchange, Sector Indices

1. INTRODUCTION

The stock market is one of the essential components of a free-market economy because it provides companies with access to capital funds in exchange for ownership. Economic activities could affect the respective stock market because specific economic policies such as monetary policy and exchange rate policy can substantially affect the stock prices (Barakat, Elgazzar & Hanafy, 2016; Hising, 2011). In contrast, stock market activities could impact the respective economy (Barakat et al., 2016). An adverse change in stock prices could have negative implications for an economy, while a favourable change in stock prices build investor and consumer confidence enabling the economy to grow (Maysami, Howe, and Hamzah, 2005).

This causal relationship is commonly observed in developing countries like Bangladesh and Malaysia (Tan, Lin & Arsad, 2006; Ahmed & Imam, 2007). The majority of the existing literature (see footnote 3) relating to the Colombo stock exchange discusses the unidirectional relationship from economic factors to the stock market. Only a few studies have investigated the bidirectional relationship between economic factors and stock market performances in Sri Lanka (Amarasinghe, 2015; Pallegedara, 2012; Athapaththu & Jayasinghe, 2010).

Colombo Stock Exchange (CSE) is the only stock market in Sri Lanka and represents nearly 20%[1] of the gross domestic production (GDP) by 2020. The Security Exchange Commission (SEC) of Sri Lanka strives to achieve 50% of the GDP ratio and emerging market status for the CSE in their road map (ADB, 2016). CSE has 290 companies representing 20 business sectors, with a market capitalisation of Rs. 2,748 Billion as of January 2020. Price indices and total return indices are also calculated for each of the 20 business sectors based on the All Share Price Index (ASPI).

Diversifying risk by investing in different securities across different business sectors is the typical investment practice. The fundamental reason for diversifying is that all industries will not be performing poorly at the same time. Stock markets worldwide classify companies into various business sectors facilitating investors to diversify their investments. A locally developed Sector Classification Framework was used by CSE that categorises listed entities under a single layer system with 20 different industries during our sample period.

[1] Central bank of Sri Lanka reports that GDP of Sri Lanka is Rs. 14,973 bn in 2020. Colombo stock exchange reports that the market capitalization is Rs. 2,748 bn in 2020.

Stocks are one of the most sensitive assets to economic conditions. The causal relationship between macroeconomic variables and stock prices is one of the most debated finance topics over a longer period (Ozbay, 2009). Many empirical studies in both developed and developing market contexts have analysed the impact of macroeconomic variables on all share returns and prices (Amarasinghe, 2015; Barakat et al., 2016; Hising, 2011). However, the dynamic relationship between macroeconomic variables and sector performances is yet to be investigated. The price of a stock is determined by the number of stocks issued and the demand for such stocks. Here, buyers and sellers consider information about the firm, industry, macro environment, and own investment goals. Therefore, identifying the dynamic relationship between different stock market sectors and macroeconomic variables will have significant implications.

Since various sectors are differently sensitive to macroeconomic variables, portfolio managers are interested in studying the dynamic relationships at more disaggregated levels. Therefore, the objective of this research is to analyse the impact of macroeconomic variables on different sector price indices in Sri Lanka rather than all share price index. Moreover, an accurate understanding of the macroeconomic determinants can benefit investors in proactively controlling specific risks in the face of macroeconomic fluctuations, where investors could alter their portfolios to mitigate the risks that the macroeconomy can have on stocks of each industry.

Specific sectors such as plantation and garments can also significantly influence the macroeconomic variables of developing countries like Sri Lanka because they represent more than 50% of the country's total exports[2]. For policymakers, understanding these causal relationships is instrumental in developing industry-wise policies to achieve economic objectives. Furthermore, there are many methodological gaps in the field of macroeconomic analysis. Employing multiple regression with OLS estimation[3] is not sufficient to analyse the cointegrated and correlated macroeconomic variables. Moreover, regression alone does not support understanding the responses to multiple shocks that emerged in the economy. This study addresses such issues relating to methodologies by employing various analytical techniques and tests such as Granger causality, impulse response function and vector error correction model.

[2] In 2020, Central Bank of Sri Lanka reports total exports as Rs. 1859 bn. The value of tea, rubber, coconut and garments is Rs. 1028 bn.

3 Many studies in Sri Lanka employ multiple regression with OLS estimation to investigate the unidirectional relationship between macroeconomic variables and stock market performance. (Amaresh, Anandasayanan & Ramesh, 2020; Nijam, Ismail & Musthafa, 2018; Badullahewage, 2018 ; Balagobei, 2017; Ullah, Islam, Alam & Khan, 2017)

The rest of the paper is organised as follows. The literature review discusses the underlying theories, empirical evidence relating to the stock market performances and macroeconomic variables. The methodology section explains the data, sample, hypotheses and econometric techniques employed in this study. Section four reports the results and discussed the findings. Section five concludes.

2. LITERATURE REVIEW

Chen, Roll, and Ross (1986) explain that economic factors determine discount rates, firms' ability to generate cash flows, and future dividend payouts. These relationships suggest that there is a long-term equilibrium between stock prices and macroeconomic variables. The economist Eugene Fama introduces the Efficient Market Hypothesis (EMH). Importantly, semi-strong form efficiency states that stock prices must contain all relevant publicly available information (Fama, 1970). This assumption implies that no investor can outperform the market by employing publicly available information and historical price movements. Stock prices reflect all historical and publicly available information. The Arbitrage Pricing Theory (APT) developed by Ross (1976) and reclaimed by Chen et al. (1986) provides evidence that macroeconomic variables significantly influence stock returns. They argue that industrial production, changes in the default risk premium and changes in the yield curve between long- and short-term interest rates are highly significant in explaining stock returns.

Mohammad et al. (2017) concluded that all exchange rate, foreign currency reserve and interest rate significantly affect the stock market performance of SAARC[4] countries using OLS multiple regression Model. Jamaludin, Ismail, & Manaf (2017) also study ASEAN[5] countries on the same topic with the panel least square regression techniques. They reveal that the exchange rate, inflation rate and money supply significantly affect the stock returns. Tripathi, Parashar & Jaiswal (2014) conclude that the crude oil prices are highly correlated with the Automobile, Bank, FMCG[6] and IT Sectors while moderately correlated with the Energy Sector of the National Stock Exchange in India.

Menike (2006) studies the effects of the exchange rate, inflation rate, money supply and interest rate on stock prices in Sri Lanka using monthly data from September 1991 to December 2002 with the multiple regression model. The results of her study indicate a negative relationship between the stock returns and the exchange rate. However, Gunasekarage, Pisedtasalasai, and Power

[4] South Asian Association for Regional Corporation

[5] Association of Southeast Asian Nations

[6] Fast Moving Consumer Goods

(2004) find no significant impact from the contemporaneous exchange rate on the stock prices though there is a mixed relationship between the lagged exchange rate and the stock prices. They employ Johansen's Vector Error Correction Model (VECM) to examine the impact of macroeconomic variables: money supply, treasury bill rate, inflation and exchange rate on all share price index in Sri Lanka from January 1985 to December 2001 monthly. *Gunasekarage* et al. (2004) also conclude that treasury bill rate has the most significant impact on changes of ASPI of CSE compared to other variables. According to the VECM estimated in their study, the lagged inflation, money supply and the Treasury bill rate significantly influence the stock market price index.

Athapaththu and Jayasinghe (2010) examine the impact of stock market performance on the economic growth of Sri Lanka from 1997 to 2008 by employing stock market indicators as independent variable and growth in national output as the dependent variable in their model. They conclude that stock market development is a crucial factor in enhancing the economic growth of Sri Lanka. Furthermore, their results are more similar to the finding of previous research of Levine and Zervos, (1988) who studied 47 countries during the period of 1976 to 1993. These studies reveal that the direction of the causal relationship from stock market performance to economic growth. Moreover, Athapaththu and Jayasinghe (2010) find a bidirectional causality between economic growth and the stock market performance. In other words, their conclusion says that both economic growth and stock market performance have impacts on each other.

Amarasinghe (2015) investigates the dynamic relationship between the interest rate and the stock returns in CSE by employing the Granger causality test. Amarasinghe (2015) finds a unidirectional relationship. This relationship shows that only the interest rate granger causes the stock returns. Pallegedara (2012) also confirms this unidirectional relationship. Employing a regression model with OLS estimation, Nijam et al. (2018) examine the impact of macroeconomic variables on stock market performances of CSE. They find that the stock market returns positively associate with the interest rate and exchange rate. Amaresh et al. (2020) show that stock market performances negatively associated with interest rate and GDP in Sri Lanka.

Balagobei (2017) examines the impact of interest rate, inflation, exchange rate, industrial production and money supply on ASPI. They find that, except money supply, other variables affect the stock market performances of Sri Lanka. Badullahewage (2018) reports that exchange rate, interest rate, GDP and balance of payment positively affect the performance of CSE. Money supply has a negative impact on the stock market performances, according to the author.

Many researchers have chosen overall stock market performances to compare with economic variables. However, each sector's exposure to macroeconomic risks are different, and existing literature has paid less attention to analyse the sector performances and macroeconomic variables. Measuring sector exposures helps to manage the risk of specific investments portfolios (Grey, Merton & Bodie, 2006) and generate above-average profits. Therefore, our study investigates the sector-wise performances and macroeconomic variables such as exchange rate, money supply, crude oil and interest rate.

3. RESEARCH METHODOLOGY

3.1 Sample and Variables

This study employs monthly time series data of selected four sector price indices in CSE and macroeconomic variables from January 2007 to December 2016. Selected four sectors are Manufacturing, Plantation, Telecommunication and Trading. Those are chosen for the study as the manufacturing sector represents the industry, plantation sector represents agriculture, telecommunication and trading sectors represent services. Industry, agriculture and service sectors are the elements of functional classification of the economic activities in Sri Lanka as identified by the Central Bank of Sri Lanka. The study considers the values of the selected sector price indices of the CSE as the target variable. The other variables of the study consist of the following macroeconomic variables.

Three months Treasury bill rate is used as a proxy for the interest rate to identify the relationship between the interest rate and the sector index performances as previously employed by Gunasekarage et al. (2004). Consumer Price Index (CPI) is used as a proxy for the inflation rate. The Sri Lankan Rupee (LKR) value per the United States Dollar (USD) is used as a proxy for the exchange rate. Tripathi et al. (2014) use the price of crude oil as USD per barrel basis. Therefore, this study also employs the average crude oil price in terms of USD per barrel as a macroeconomic variable.

3.2 Main Hypotheses

Our study considers the following hypotheses to achieve the research objectives.

H1: Money supply has a significant impact on stock prices.

Generally, an increase in the money supply stimulates the economy by reducing the level of interest. Then the businesses are expected to perform well, and the share prices will increase. However, an increase in money supply has an impact on inflation. Rising inflation reduces the value of shares

as the discounting factor rises and demand for shares decreases (Barakat et al., 2016; Mukherjee & Naka, 1995).

H2: Exchange rate (LKR/USD) has a significant impact on the stock prices.

If the currency depreciates, exports of the domestic country increases. Therefore, the cash flows to export-based companies will increase and the share price of such companies increase (Barakat et al., 2016; Mukherjee & Naka, 1995). However, companies that utilise imported materials and trade imported goods experience a significant cash outflow. Therefore, the exchange rate has positive and negative outcomes on the share prices.

H3: Oil prices have a significant impact on stock prices.

Oil prices directly affect the business as it affects transportation and manufacturing. Indirectly it raises the cost of living and reduces the buying power of consumers. Therefore, higher oil prices decrease the share performances vice versa (Eksi, Senturk & Yildirim, 2012).

H4: Interest rate (T-bill rate) has a significant impact on the stock prices.

Treasury bill rate is used as a part of the discount rate in cash flow valuations of shares. Therefore, a higher T-bill rate decreases the value of shares vice versa (Barakat et al., 2016; Mukherjee & Naka, 1995). Moreover, the higher interest rate discourages business operations and increases the cost of finance. Then the cash flows of the business decrease leading to lower share prices.

Hypotheses one to four are tested using vector autoregressive and vector error correction models. Granger causality test is also used to check the following hypotheses.

Literature suggests that there is an impact from stock market performances on the macroeconomic variables (Amarasinghe, 2015; Athapaththu and Jayasinghe, 2010; Barakat et al., 2016). Therefore, the following hypothesis is tested.

H5: Manufacturing, plantation, telecommunication, and trading sector performances affect the money supply, exchange rate, oil prices and interest rate in Sri Lanka.

3.3 Data Collection

The monthly values for each sector index have been established by obtaining an average of the daily last price traded for the period under consideration from Bloomberg market data. Data for the 91-days Treasury bill yield was collected from the weekly economic indicators published by the Central Bank

of Sri Lanka (CBSL), where an average of such weekly data gathered would constitute the monthly rate. The monthly average exchange rate (LKR/USD) data was obtained from the CBSL, while data for the nominal average spot USD per barrel of crude oil prices was collected from the Global Economic Monitor Commodities Database of the World Bank.

3.4 Analytical Techniques

When testing the long-run relationship among macroeconomic variables, recent studies (see Barakat et al., 2016; Ozbay, 2009; Maysami et al., 2005; *Gunasekarage* et al., 2004) have widely used Vector Auto-Regressive (VAR) model or Vector Error Correction Model (VECM) by Johansen and Juselius (1990). As the first step to this process, a test for stationarity should be performed to determine the order of integration of the variables. A Vector Autoregressive (VAR) Model would then be developed to identify the optimal lag length to be used when testing for cointegrating vectors. In this study, the lag order selected by the Akaike Information Criteria (AIC) is chosen as the optimal lag length of the model. Suppose the variables are known to be integrated of the same order. In that case, the Johansen Co-integration test is performed to obtain the number of cointegrating vectors. If no cointegrating equations are found, a VAR Model is estimated employing the optimal lag length for the given variables. If there are cointegrated equations, VECM model is estimated. VAR models are estimated using the ordinary least squares (OLS) estimator computed separately from each equation. Estimation and inference in cointegrating systems of VECM are based on the maximum likelihood method. The time trends in the data appear to be approximately linear, and hence, trend(constant) is specified when modelling these series.

3.5 Research Model

3.5.1 Sector Price Specification

Each sector index price is given as a function of macroeconomic variables.

$$lY_t = \int \{lms_t + lexr_t + loil_t + tbill_t\} \quad \textbf{(1)}$$

Where;

lY_t = Natural log of stock prices of each sector at time t

lms_t = Natural log of money Supply at time t

$lexr_t$ = Natural log of the exchange rate at time t

$loil_t$ = Natural log price of a Crude Oil barrel at time t

$tbill_t$ = Interest Rate at time t

Then, this study employs the following multivariate linear time series models to achieve the objectives of the research by capturing the joint dynamics of the macroeconomic variables.

3.5.2 Vector Auto-Regressive (VAR) Model in differences

$$\Delta Y_t = C + A\sum_{i=1}^{p} \Delta Y_{t-i} + B\sum_{i=1}^{p} \Delta X_{t-i} + \varepsilon_t \quad \textbf{(2)}$$

where Y_t is a (m×1) vector of endogenous variables, X_t is an n vector of exogenous variables given in function (1) , and i is the number of lag or the order of the VAR.). p is the optimum lag length. The error term ε_t is a vector of innovations that are independent and identically distributed (Sun, Ford, & Dickinson, 2010). C, A and B are matrices of the estimated coefficients as given below (Brook, 2008).

$$C = \begin{pmatrix} c_{10} \\ \vdots \\ c_{m0} \end{pmatrix} \; A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{pmatrix} \; B = \begin{pmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{m1} & \cdots & b_{mn} \end{pmatrix} \quad \textbf{(3)}$$

VAR in differences is used as all variables are stationary at the first difference. The objective of the study is to identify the causal relationship between macroeconomic variables and stock market sector price indices.

3.5.3 Vector Error Correction Model (VECM)

Following equation represents both short-run and long-run dynamics by extending the model (2) to incorporate the long-term adjustment or error correction term (ECT).

$$\Delta Y_t = C + A\sum_{i=1}^{p} \Delta Y_{t-i} + B\sum_{i=i}^{p} \Delta X_{t-i} + \varphi\, z_{t-1} + \varepsilon_t \quad \textbf{(4)}$$

C, A and B are short-run dynamic coefficients. φ is the speed of adjustment parameter or error correction in the long-run. Z_{t-1} is the error correction term. It is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressors. This contains the long-run information derived from the long-run cointegrating relationship.

The following cointegrating equation represents the long-run dynamics of the given model explicitly (Brook, 2008).

$$Z_{t-1} = Y_{t-1} - \alpha_0 - \delta_1 X1_{t-1} - \cdots - \delta_n Xn_{t-1} \quad \textbf{(5)}$$

Further, this study also employs impulse response functions and Granger causality to carry out further analysis. Results of the robustness checking for each model are available upon request. Stata 14 software is used to analyse the above models.

4. RESULTS AND DISCUSSION

4.1 Model Selection

Table 1: Stationarity test results (Dicky Fuller-GLS)

Lags	GLS mu Statistics							
	Manufacturing		Plantation		Trading		Telecom	
	Level	D1	Level	D1	Level	D1	Level	D1
5	0.534	1.310	1.670	3.375**	0.748	2.314**	0.934	2.987**
4	0.448	1.322	1.497	3.164**	0.828	2.788**	0.893	2.880**
3	0.283	1.524	1.328	3.710**	0.478	2.704**	0.915	3.209**
2	0.083	1.966**	1.157	4.608**	0.311	3.945**	0.641	3.449**
1	0.016	3.228**	1.246	6.120**	0.415	5.230**	0.658	5.005**

Data scales are different, and therefore, natural log values are derived for the study. Treasury bill rate is taken at its original form. Table 1 presents the results of the modified Dickey-Fuller Test known as DF-GLS performed on each variable. The values of all the variables are non-stationary at the level and stationary at the first difference. Therefore, VAR and VECM models can be fit for the sector price models.

Table 2 below demonstrates the number of cointegrating equations for each sector by employing the Johansen cointegration test. Since the plantation sector models are not cointegrated, VAR model is appropriate. The manufacturing, trading and telecommunication sectors have one cointegrating equation for each sector. Though the Manufacturing sector is cointegrated, the VECM model is not efficient and hence the VAR model is used for the analysis.

Table 2: Johansen cointegration test results

Maximum Rank	Trace Statistic			
	Manufacturing	Plantation	Trading	Telecom
0	79.840	63.550**	88.110	69.030
1	36.410**	27.320	42.530**	37.610**
2	17.460	11.700	18.640	20.680
3	5.290	4.22	4.450	8.150
4	0.015	0.008	0.000	0.220

Note: Optimum lag length for manufacturing, plantation and trading is four and for telecommunication is two according to varsoc results.

4.2 Sector-wise Analysis of Results

4.2.1 Manufacturing Sector

Table 03: Manufacturing (man) Sector - Vector Auto-regression Estimates

Independent Variable	Coefficient
Δ ln man sector price (-1)	0.285**
Δ ln Money supply (-1)	1.178*
Δ ln Money supply (-3)	-1.617**
Δ ln Oil prices (-1)	0.137**
Δ ln Oil prices (-3)	-0.109*
Δ T-bill (-3)	-2.832**

Note: ** Significant at 5% level, * Significant at 10% level. The dependent variable is Δ lman and only the significant results are reported. Lag value is given in the parentheses.

Table 03 represents the VAR estimates of the manufacturing sector. The reported adjusted R square value indicates that 37% of the variation in percentage change of the manufacturing sector price is explained by all the regressors in the model. One period lagged percentage change in the manufacturing sector index price (Δlmant-1), money supply (Δlmst-1) and oil prices (Δloilt-1) positively and three period lagged percentage change in money supply (Δlmst-3), oil prices (Δloilt-3) and three periods lagged change in T-bill rate (Δtbillt-3) negatively affect the current period percentage change in the Manufacturing Sector price (Δlman). VAR Model estimated is robust as the residuals of the model are normally distributed, model is stable, and autocorrelation of residuals is not observed.

Table 04: Manufacturing Sector - VAR Granger Causality

Equation	Excluded	Chi-sq
Δlman	Δlms	11.847**
	Δlexr	4.922
	Δloil	10.609**
	Δtbill	13.930***
	All	35.130***
Δlms	Δlman	12.94**

Note: *** Significant at 1% level, ** Significant at 5% level

Table 4 shows the results of the granger causality test for the manufacturing sector price index and the selected macroeconomic variables at first difference. Results indicate that the percentage change in money supply and percentage change in manufacturing sector prices have a bidirectional causal relationship. All other excluded variables except percentage change in exchange rate Granger-cause percentage change in manufacturing sector prices individually. Overall, all excluded variables have an impact on the percentage change in manufacturing sector prices collectively.

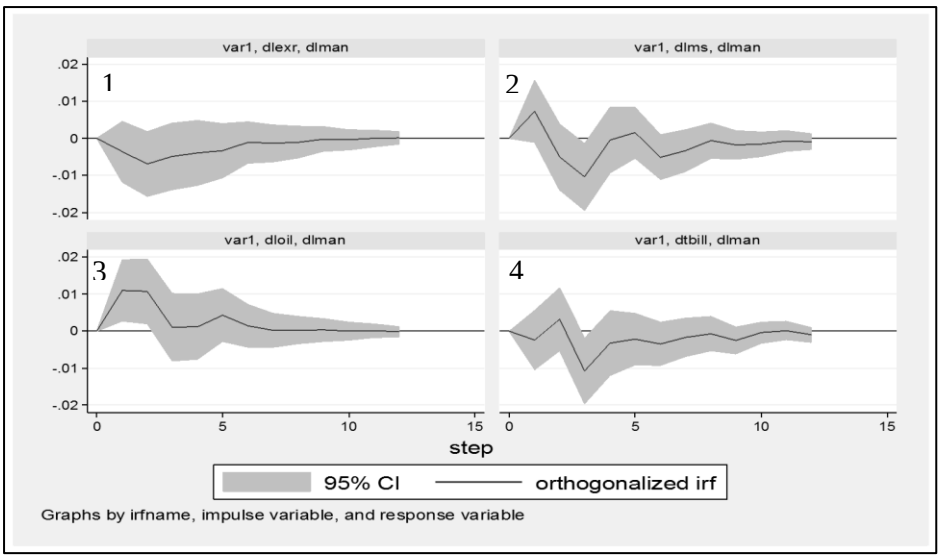

Figure 1: Response of Δlman to one SD shocks of explanatory variables

Figure 1 represents the impulse responses of the model and depicts the responses of Δlman to Δlms, Δlexr, Δloil, and Δtbill.

1 Δlman to Δlexr: One standard deviation shock of percentage change in exchange rate to percentage change in manufacturing sector prices shows no response initially. However, slight negative responses are observed from the 1st month which gradually stabilise from the 12th month into the future.

2 Δlman to Δlms: One standard deviation shock of percentage change in money supply to percentage change in manufacturing sector prices shows a bumpy response. There is a positive response at 1st month and negative response from second month to 4th month. After another positive response at 5th month, a series of small negative responses are observed. The price index gradually stabilises from the 12th month into the future.

3 Δlman to Δloil: One standard deviation shock of percentage change in oil prices to the percentage change in manufacturing sector prices demonstrates a positive response from the 1st month, which then gradually stabilise from the 10th month into the future.

4 Δlman to Δtbill: One standard deviation shock of the change in T-bill rate to percentage change in manufacturing sector prices demonstrates a slightly negative response at 1st month. Then a positive response at 2nd month and negative response thereafter till that shows a steady reaction from the 10th month into the future.

4.2.2 Plantations Sector

Table 05: Plantation (plt) Sector - Vector Auto-regression Estimates

Independent Variable	Coefficient
Δ ln plt Sector price (-1)	0.332***
Δ ln Money supply (-1)	3.034**
Δ ln Money supply (-3)	-2.895**
Δ ln Exchange rate (-1)	-1.220*
Δ ln Oil prices (-1)	0.276***
Δ T-bill (-2)	4.413***
Δ T-bill (-3)	-2.629**

Note: *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level. The dependent variable is Δ lplt and only the significant results are reported. Lag value is given in the parentheses.

Table 5 represents the VAR estimates of the plantation sector. The adjusted R-squared value of the VAR Model for the plantation sector indicates that 38% of the variation in the percentage change in plantation sector prices are explained by all the explanatory variables in the model. One period lagged percentage change in the plantation sector index price ($\Delta lplt_{t-1}$), money supply (Δlms_{t-1}) and oil prices ($\Delta loil_{t-1}$), two periods lagged change in the T-bill rate ($\Delta tbill_{t-2}$) positively and three period lagged percentage change in money supply(Δlms_{t-3}), change in T-bill rate ($\Delta tbill_{t-3}$), one period lagged percentage change in the exchange rate ($\Delta lexr_{t-1}$) negatively affect the current period percentage change in the plantation sector index price.

VAR model estimated is robust as the model is stable and autocorrelation of residuals is absent. However, the residuals of the model are not normally distributed. The sample size is larger enough to overcome this issue.

Table 6 reports the Granger causality test results for the plantation sector price index and the selected macroeconomic variables at first difference.

Table 06: Plantation (plt) Sector - VAR Granger Causality

Equation	Excluded	Chi-sq
Δlplt	Δlms	19.112***
	Δlexr	6.878
	Δloil	13.850***
	Δtbill	16.380***
	All	43.479***
Δlexr	Δlplt	15.715***

Note: *** Significant at 1% level, ** Significant at 5% level

All excluded variables except percentage change in exchange rate granger-cause percentage change in plantation sector prices individually. Overall, all excluded variables have an impact on the percentage change in plantation sector prices collectively. However, the percentage change in plantation sector prices has an impact on the percentage change in the exchange rate.

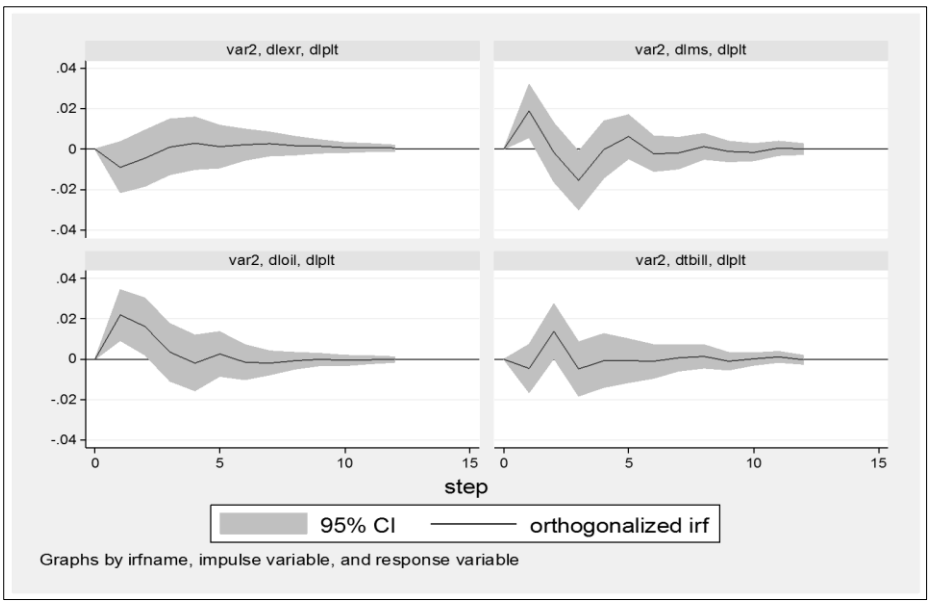

Figure 2: Response of Δlplt to one SD shocks of explanatory variables

Figure 2 demonstrates the Impulse Responses of the model and depicts the responses of Δlplt to Δlms, Δlexr, Δloil, and Δtbill.

1 Δlplt to Δlexr: One standard deviation shock of percentage change in the exchange rate to the percentage change in plantation sector prices shows a negative response at 1st and 2nd months. Then, slight positive responses are observed from the 3rd month which gradually stabilise from the 12th month into the future.

2 Δlplt to Δlms: One standard deviation shock of percentage change in money supply to the percentage change in plantation sector prices shows a bumpy response. There is a positive response at 1st month and a negative response from the second month to 4th month. Then, a positive response at 5th month followed by two negative responses at 6th and 7th months. Another positive response is observed in the 8th month and then two negative responses at 9th and 10th months. The price index gradually stabilises from the 12th month into the future.

3 Δlplt to Δloil: One standard deviation shock of percentage change in oil prices to the percentage change in plantation sector prices demonstrates a significant positive response at the 1st month, and it gradually decays till 3rd month. There is a negative response at 4th month and followed by a positive response at 5th month. After that, the price index experiences a series of negative responses until it gradually stabilise from the 12th month into the future.

4 Δlplt to Δtbill: One standard deviation shock of the change in T- bill rate to the percentage change in plantation sector prices demonstrates a slightly negative response at 1st month. Then a significant positive response at 2nd month and a negative response at 3rd month are observed. After that, it shows a steady response from the 4th month into the future.

4.2.3 Trading Sector

Table 07: Trading Sector (trd) - VECM Short-term Estimates

Independent Variable	Coefficient
ECT	0.051***
Δ ln trd sector price (-1)	0.340**
Δ ln trd sector price (-2)	-0.202*
Δ ln Money supply (-3)	-2.196**
Δ T-bill rate (-3)	-5.219***

Note:***Significant at 1% level, ** Significant at 5% level, *Significant at 10% level; The dependent variable is Δ ltrd and only the significant results are reported. Lag value is given in the parentheses.

Table 07 represents the VECM estimates of the trading sector. The adjusted R-squared value of the VECM Model for the telecommunication sector indicates that 50% of the variation in the percentage change in trading sector prices are explained by all the explanatory variables in the model.

Table 08: Trading Sector (trd) - VECM Long-term Estimates

Variable	Parameter	Coefficient
Constant	α_0	9.724
ln Money supply	δ_1	-8.209***
ln Exchange rate	δ_2	22.776***
ln Oil prices	δ_3	-1.181***
T-bill rate	δ_4	-25.570***

Note: ***Significant at 1% level, ** Significant at 5% level, *Significant at 10% level

$$\text{ECT} = Z_{t-1} = Y_{t-1} - \alpha_0 - \delta_1 \text{lms}_{t-1} - \delta_2 \text{lexr}_{t-1} - \delta_3 \text{loil}_{t-1} - \delta_4 \text{tbill}_{t-1}$$

Error correction term or the long-term adjustment parameter has a positive sign, and it is significant at 1% level. The exchange rate and interest rate growth have a substantial impact on the long-term adjustment parameter of the equation as given in Table 8. One period lagged percentage change in the trading sector index price (Δltrd_{t-1}), positively and, two periods lagged percentage change in the trading sector index price (Δltrd_{t-2}), three periods lagged percentage change in money supply (Δlms_{t-3}) and three periods lagged change in T-bill rate (Δtbill_{t-3}) negatively affect the current period percentage change in the trading sector index price. VECM model estimated is free from autocorrelation and stable. However, residuals are not normally distributed. The sample size is sufficient to overcome the residual normality problem.

Figure 3 demonstrates the impulse responses of the model and depicts the responses of lttrd to lms, lexr, loil, and tbill.

1 ltrd to lexr: One standard deviation shock of exchange rate growth to trading sector price growth demonstrates a small positive response from 1st month to 3rd month. After that there is a significant long-term positive response.

2 ltrd to lms: One standard deviation shock of money supply growth to trading sector price growth shows a small positive response at 1st month and thereafter, a significant long-term negative response.

3 ltrd to loil: One standard deviation shock of crude oil price growth to trading sector price growth shows a positive response from 1st month to 4th month. After that, there is a long-term negative response from the 5th month.

4 ltrd to tbill: One standard deviation shock of T-bill rate growth to trading sector price growth demonstrates a significant long-term negative response from 1st month

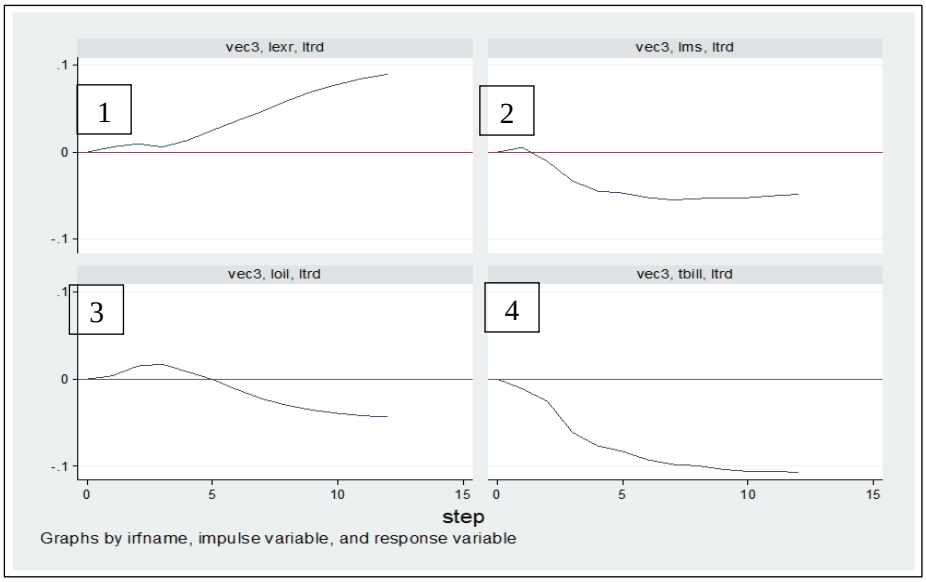

Figure 3: Response of trading sector price growth to one SD shocks of explanatory variables

4.2.4 Telecommunication Sector

Table 9 and 10 show the VECM estimates of the telecommunication sector. The adjusted R-squared value of the VECM Model for the telecommunication sector indicates that 21% of the variation in the percentage change in telecommunication sector prices are explained by all the explanatory variables in the model. Error correction term or the long-term adjustment parameter has a negative sign, but it is not significant. One period lagged percentage change in the telecommunication sector index price ($\Delta ltel_{t-1}$), money supply (Δlms_{t-1}) and oil prices ($\Delta loil_{t-1}$), positively and one period lagged percentage change in the exchange rate ($\Delta lexr_{t-1}$) negatively affect the current period percentage change in the telecommunication sector index price (ltel).

VECM Model estimated is robust as the model is free from autocorrelation and residuals are normally distributed. The model is also stable.

Table 09: Telecommunication Sector (tel)- VECM Short-term Estimates

Variable	Parameter	Coefficient
ECT	φ	-0.025
Δ ln tel Sector price (-1)	β_{11}	0.322***
Δ ln Money supply (-1)	β_{21}	1.121*
Δ ln Exchange rate (-1)	β_{31}	-0.744*
Δ ln Oil prices (-1)	β_{41}	0.109**

Note: ***Significant at 1% level, ** Significant at 5% level, *Significant at 10% level. The dependent variable is Δ ltel and Only the significant results are reported. Lag value is given in the parentheses.

Table 10: Telecommunication Sector (tel) - VECM Long-term Estimates

Variable	Parameter	Coefficient
Constant	α_0	-8.807
ln Money supply	δ_1	-1.043***
ln Exchange rate	δ_2	3.955***
ln Oil prices	δ_3	0.185
T-bill rate	δ_4	-7.690***

Note: ***Significant at 1% level, ** Significant at 5% level, *Significant at 10% level

$$\mathrm{ECT} = \mathrm{Z}_{t-1} = \mathrm{Y}_{t-1} - \alpha_0 - \delta_1 \mathrm{lms}_{t-1} - \delta_2 \mathrm{lexr}_{t-1} - \delta_3 \mathrm{loil}_{t-1} - \delta_4 \mathrm{tbill}_{t-1}$$

Figure 4 demonstrates the impulse responses of the model and depicts the responses of ltel to lms, lexr, loil, and tbill.

1 ltel to lexr: One standard deviation shock of exchange rate growth to telecommunication sector price growth demonstrates a long-term negative response from the 1st month.

2 ltel to lms: One standard deviation shock of money supply growth to telecommunication sector price growth shows a long-term positive response from the 1st month.

3 ltel to loil: One standard deviation shock of crude oil price growth to telecommunication sector price growth shows a long-term positive response from the 1st month.

4 ltel to tbill: One standard deviation shock of T-bill rate growth to telecommunication sector price growth demonstrates a small positive

response at 1st month and followed by two negative responses at 2nd and 3rd months. Thereafter, there is a long-term positive response from the 4th month.

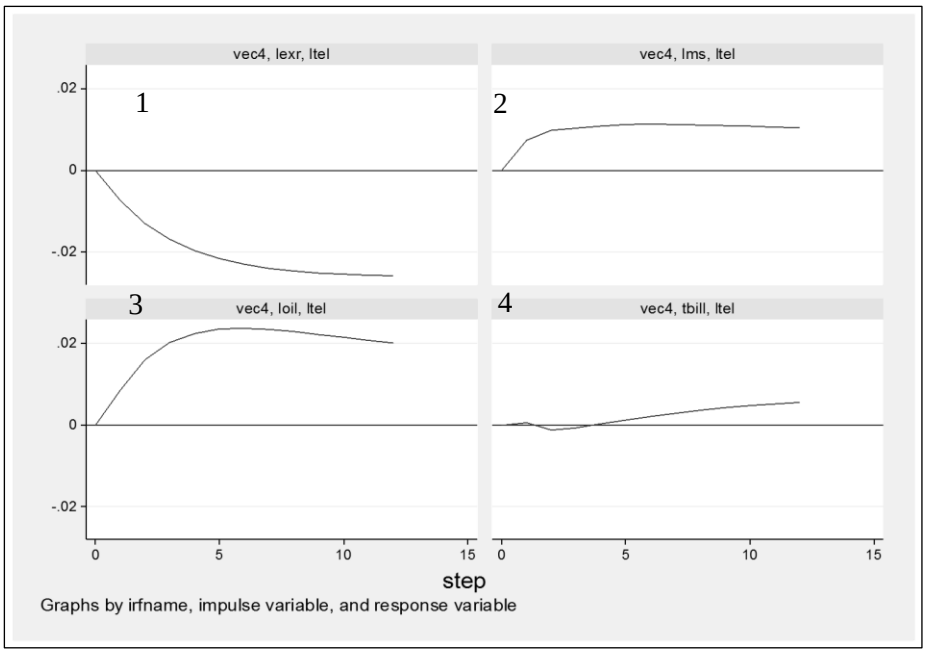

Figure 4: Response of telecommunication sector price growth to one SD shocks of explanatory variables

4.2.5 Summary of the results

Previous period percentage change in money supply and crude oil prices positively affects the percentage change in the manufacturing sector's price growth, plantation sector, and telecommunication sectors in the short run. Three periods lagged percentage change in money supply negatively affects the percentage change in price growth of manufacturing, plantation and trading sectors in the short-term. Change in the T-bill rate before three periods affects the manufacturing, plantation and trading sectors in the short-term negatively. Only the percentage changes in prices of plantation and telecommunication sector are affected by the one-period previous percentage change in the exchange rate in the short-term. Two periods lagged T-bill rate positively affects the percentage change in plantation sector prices. Three periods lagged percentage change in oil prices negatively affects the percentage change in the prices of the manufacturing sector. Moreover, the percentage change in the prices of the manufacturing sector granger causes the percentage change in the money supply. The percentage change in the prices of plantation sector granger causes the percentage in the exchange rate.

4.3 DISCUSSION

4.3.1 Money Supply

Money supply (lagged one) has a positive relationship between all the sectors except the trading sector. Generally, an increase in money supply leads to lower interest rates. A lower interest rate increases the stock performances. The plantation sector has the highest exposure to the money supply. The impact on the trading sector is negative. A rise in the money supply also increases inflation leading to lower performances in the trading sector.

Menike (2006) also finds mixed results for the relationship between money supply and performances of the Colombo Stock Exchange. She finds that the majority of the stock prices positively associates with the money supply. Our finding is consistent with Menike. However, Balagobei (2017) finds no association and Badullahewage (2018) shows a negative relationship.

4.3.2 Exchange Rate

The exchange rate (LKR/USD) negatively relates to the plantation and telecommunication sector price indices. An increase in the exchange rate depreciates the rupee (LKR) value. Foreign companies own more stake of the telecom sector companies. As the rupee depreciates, they are reluctant to take the cash away and thus reinvest in the domestic business. As a result, stock prices of the telecommunication sector increases. The plantation sector in Sri Lanka is an export-oriented industry. Therefore, when the currency depreciates, the sector performs better. Results show that plantation sector exposure to the exchange rate is very high.

Most of the previous literature documents a positive relationship between the exchange rate and the CSE performances (Balagobei, 2017; Nijam et al., 2018; Badullahewage, 2018). According to Gunasekarage et al. (2004), the exchange rate does not significantly influence the ASPI in Sri Lanka. Consistent with our finding, Menike (2006) documents a negative relationship between exchange rate and stock prices. The author identifies a highly significant negative relationship between the exchange rate and the trading sector's price index. However, this study evidence that the trading sector is not exposed to the exchange rate. Menike (2006) also confirms that there is no significant relationship between manufacturing sector prices and the exchange rate, similar to our finding.

4.3.3 Crude Oil Prices

Crude oil prices (one period lagged) positively affect all the sector price indices except the trading sector index prices. Three periods lagged crude oil prices negatively affected the manufacturing sector index prices. Companies pass the oil price burden to the customer, and hence a positive impact from

the crude oil prices on the stock prices can be observed. However, manufacturing sector prices experience a negative impact from three period lagged oil prices. Passing the burden of increased oil prices would increase the manufacturing sector costs in terms of material prices and labour costs after a few periods. This increase in the cost of living may also decrease the trading sector performances.

Eksi et al. (2012) confirm that the manufacturing sector prices are highly sensitive and negatively related to the crude oil prices. However, Tripathi et al. (2014) confirm that oil prices have a significant positive relationship with Energy, auto, FMCG, and IT sector performances in India.

4.3.4 Interest Rate

The interest rate (three periods lagged) has a negative relationship with all the sector price indices except telecommunication. Higher interest always discourages the business sectors and leads to poor performances. Since most telecommunication providers are foreign companies, they may borrow from foreign markets. Our negative relationship is consistent with Gunasekarage et al. (2004), Menike (2006) and Balagobei (2017). Menike (2006) identifies a highly significant negative relationship between the interest rate and the price indices of the manufacturing and trading sectors.

We confirm that the trading sector has the highest exposure to the interest rate and, then, the manufacturing sector. According to Menike (2006), the most significant variable influencing the manufacturing sector is the interest rate. Surprisingly, the plantation sector has a significant positive impact from the one period lagged interest rate. Nijam et al. (2018) and Badullahewage (2018) document a positive relationship between interest rate and the overall stock market performances.

4.3.5 Impact of sector performances on the economic variables

Granger causality results confirm that certain sector performances can have a significant impact on the macroeconomic variables. The manufacturing sector has a significant impact on the money supply. When the manufacturing sector performances are poor, governments increase the money supply with the purpose of increasing production.

The plantation sector has a significant impact on the exchange rate because it is a significant exporter in Sri Lanka. Barakat et al. (2016) also confirm that there is bidirectional causality between money supply and stock performances and between exchange rate and stock performances in emerging markets.

5. CONCLUSION

This study aimed to investigate the dynamic movements of sector price indices against the macroeconomic variables. Therefore, we examined the relationship between sector price indices and macroeconomic variables by employing Granger causality tests, VAR and VECM models. We selected manufacturing, plantation, telecommunication and trading sectors representing industry, agriculture and services functions of the economy. Our sample period is limited from 2007 to 2017.

Our analysis helps to conclude that the macroeconomic influence on stock market price indices in Colombo Stock Exchange (CSE) is dynamic because different sectors are exposed to specific macroeconomic variables with different sensitivities. The trading sector is more exposed to macroeconomic risks as interest rate, crude oil prices and money supply negatively affect the sector performances. The trading sector has no impact from the exchange rate. The telecommunication sector is also affected by all the macroeconomic variables selected. Interest rate, crude oil prices and money supply positively affect the sector performances while exchange rate affects negatively. Therefore, the service sector is more vulnerable to macroeconomic risks.

Interest rate and exchange rate negatively affects the plantation sector. Crude oil prices and money supply positively impact the same. Interest rate negatively impacts the manufacturing sector, while crude oil prices and money supply positively affect the sector. The exchange rate has no impact on the manufacturing sector. However, the manufacturing sector has an impact on the money supply, and the plantation sector has an impact on the exchange rate. The findings also encourage the investors to diversify their portfolios and time their investments based on the macroeconomic conditions. Policymakers should rethink their strategies to control and encourage different sectors such as plantation and manufacturing because they have bidirectional causality with macroeconomic conditions.

Future research can think about structural breaks for pre-and post-war periods with a more extensive and frequent data set (i.e. weekly data instead of monthly data for other sectors). Explanatory variables such as inflation, gross domestic product, industrial production, and per capita income could also be incorporated in future research.

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