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Macroeconomic Indicators and Association in VECM Model: Case of Malaysia

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Abstract

This research focuses the relationship between Kuala Lumpur Stock Market Composite Index with four macroeconomic determinants, namely real interest rate, exchange rate, inflation rate and GDP from January 1988 to 2019 on a yearly basis. However, most of the studies are carried out in developed countries and large economic nations instead of in emerging markets such as Malaysia. Time series stationarity, cointegration and Granger causality tests and Vector Error Correction Model (VECM) approach are used in this paper. The findings suggest that stock market composite index and exchange rate have a bidirectional Granger-causality. The changes of exchange rate have a significant effect on the changes of stock market as well as economy of Malaysia.

Keywords: Stock Market Composite Index, Macroeconomic Indicators, VECM

Introduction

The economic framework and structure play a large role in determining the proper policies for macroeconomic stability and optimal efficiency in the economy. The economy's strength is determined by the economic framework and structure; and it may be measured using important macroeconomic indicators such as GDP, inflation, etc. The market practitioners and policymakers can benefit much from understanding the macroeconomic indicators and its associations as explanatory factors in economy. The entire economic framework is remarkably complicated, and it takes a lot of effort to comprehend the net of complex associations between macroeconomic factors.

The goal of this study is to examine how the Malaysian equity market reacts to macroeconomic variations, and to examine if composite index can be explained by the country's present economic activities. The associations of the composite index and four fundamental macroeconomic factors, to be specified as exchange rate, inflation rates, real interest rate and GDP which are examined in this paper. All of these variables are important in affecting a country's economic advancement, and fundamental investors frequently utilized their link to estimate future patterns or developments.

A large body of literature highlight that the exchange rate is more observed and evaluated, which is a regulated measure of an economic health of a country. The exchange is analysed, monitored and controlled measure for financial wellbeing of an economy.

Numerous researchers have written to emphasise its significance such as (Bank et al., 2000). Following the collapse of the Breton Woods fixed exchange rate management, a few economies selected to utilise the free exchange rate management, whereas others, especially emerging economies, utilise floating exchange rate or pegged exchange rate administration. As a result, they use currency market interventions to keep their monetary forms stable. This, however, leads to some extremely serious difficulties, such as currency speculation and inadequate market-based processes. Floating exchange rates, on the other hand, cause weakness and have major affects for widespread trade. A free-float exchange rate management is beneficial or harmful to overall trade for an economy. Along these lines, in order to create suitable policies, it is necessary to understand the links between different macroeconomic variables. In the context of the Malaysian economy, current research endeavour to comprehend association between the composite index, exchange rate, real interest rate, GDP and inflation. Understanding the interplay between these variables, it is believed that it will be highly useful in policymaking.

Malaysia economy suffered from financial crisis (2007-08) originated from the US financial crisis. To cope with these issues, Bank Negara Malaysia tried different exchange rate regimes starting with an open capital account and a managed float system by imposing limit on selective capital accounts and on the fixed exchange rate regime during Asian financial crises. This step improved the capital inflows and steadily it control the capital was lifted in 2000 and reinstated the managed floating system to deal with the considerable inflow of capital (Lim & Goh, 2011).

In the last three decades, the Malaysian economy experienced volatile and surged economic situations. In the early 1990s, the economy experienced growth in capital inflows and vibrant economic activities; however, and then came the adverse advent of 1997- 98 Asian economic crises. Consequently, speculative issues arose in the currency market and volatile capital outflows occurred. Again in the early 2000's, reviving after the Asian financial crisis, the economy again experienced surge in economic activities and huge inflows leading to a current account surplus. To attain certain policy goals, it is very essential to understand the key forces in place in that context. For example, to curtail exchange rate fluctuations, its determinants are targeted, which includes inflation and interest rate among many others (Madura, 2007). To devise proper policy therefore requires the proper understanding of the way these variables interacts with exchange rate and how exchange rate relates with these variables.

The exposure to the nexus among the key variables (e.g. exchange rate, interest rate, inflation) is very important especially in the context of Malaysia where volatile situations are quite often. Malaysia has been a successful emerging country in Asia and is forging ahead to become a developed nation in its own shape. The country has been transforming its economic model from agriculture economy based into diversified economy based. According to the World Bank, manufacturing sector has much grown in recent years and it is contributing high Gross Domestic Product (GDP) which is 25 per cent and more than 60 per cent of export in total export, service sector has become the largest sector which accounting of 54 per cent of GDP. Besides mining and quarrying are contributing of 9 per cent of GDP, GDP growth has always been treated as current issue studied by many researchers (Aziz & Azmi, 2017). Inconsistency growth of GDP per capita within a country will lead to higher incidence of poverty as well as hinder the progress in health, education and eventually the economic growth. The factors towards GDP growth are relatively important to prevent occurrence of socio-political instability.

There is an association between macroeconomic variable such as interest rate, GDP, exchange rate, inflation and stock market, obviously regardless of causal direction. They are integrated and they could influence stock prices especially in the developed countries. Interest rate and the macroeconomic variables are the most popular significant factors in explaining the stock market movement. Nominal interest rate, interest rate and effective interest rate are the measure of macroeconomic level in a country. This study explores the interaction between selected macroeconomic variables such as exchange rate, interest rate, inflation rate, GDP and composite index. Understanding the impact of the interest rate, GDP, exchange rate and inflation on stock market is important for policy development due to the dynamic global economic condition.

Literature Review

Stock market return refers to return from stock market particularly stocks listed in Bursa Malaysia and the main index used as the market return indicator is Bursa Malaysia KLCI which comprises 30 largest companies by full market capitalization (FTSE, n.d.). KLCI is calculated from the prices of the 30 largest companies using the market capitalization weighted method and the return is often determined by index variation from time to time (Bursa Malaysia, n.d.).

According to Ferrer, Bolós and Benıtez (2014), interest rate influences the stock market in two ways. First, the discount rate can be affected by the changes in interest rate, in most of the modern valuation techniques. Additionally, it alters the cost of borrowing, which in turn affecting the anticipated cash flow of a firm. Malaysia stock market return is negatively related to interest rate which is found in the prior research (Kadir et al., 2011; Vejzagic & Zarafat, 2013; Heng et al., 2013). Conversely, study done by Yakob et al (2014) failed to show any statistically significant return in days before and immidiately after the announcement of changes in interest rate which is aligned with the research of Bernanke and Kuttner (2005) who observed that stock market only respond to unanticipated announcements. The negative relationship does not apply to certain industries and sectors, Khan and Mahmood (2013) also found the positive relationship for financial institutions and insurance companies in Karachi Stock Exchange, KSE (Kadir et al., 2011; Khan & Mahmood, 2013; Vejzagic & Zarafat, 2013); and insignificant by the others (Ab Rahman et al., 2013; Yakob et al., 2014).

The volatility in exchange rate impacted on firms' competitiveness and profitability where exporters expected to benefit from depreciation of local currency and vice versa for importers (Tsagkanos & Siriopoulos, 2013). Generally, currency depreciation is a popular monetary tool among the central banks as it can be implemented easily. However, majority of the studies failed to show that poor implementation this policy will result in great repercussion to global economy such as during the beggar-thy-neighbour policy in 1930. Ayub and Masih (2013) on the other hand found that the relationship is dynamic and varying in both long term and short term in the Islamic stock indices. They showed that relationship between exchange rate and all FTSE Bursa Malaysia index have negative significant correlation at different time scales, however the relationship is not fixed. The positive relationship in Japan may be distorted due to their unique economic environment as they have been hit by deflation for 20 years which is also known as the notorious The Lost Decades.

Laopodis (2006) examined the dynamic interaction among the equity market, economic activity, inflation and concerning the role of monetary policy. Advance econometrics using cointegration, causality and error methods using bivariate and multivariate Vector Autoregressive (VAR) or multivariate Vector Error Correction (VEC) models, with bivariate results, they found that the negative correlation between stock market and inflation; meanwhile stock market can hedge against inflation.

One of the most contentious issues in economics is whether the stock market is able to serve as a key indicator for the future economic growth and vice versa (Choong et al., 2003; Mun et al., 2008). Many believe that large increases or decreases in stock prices may be reflective of future economic growth or recession respectively (Mun et al., 2008).

Arestis and Demetraides (1997) conducted a study to find out the cointegration relationship between financial development and economic growth, using the Johansen cointegration method on the macro data of the USA and Germany. They found that there is a positive correlation between banking system development and real GDP per capita in Germany. However, a negative relationship was stated between stock market volatility and GDP. They suggested that the stock market might have some effects on economic growth. Arestis et al (2001) conducted a study utilizing time series data of five developed economies (Japan, USA, Germany, France, and UK) to examine the relationship between stock market development and economic growth controlling the effects of the banking system and stock market volatility. They suggested that there was likelihood that economic growth is promoted by both banks and stock markets; however, the effects of banks were more powerful. Kwon and Shin (1999) carried out a study on the relationship between the stock market index, output index, trade balance and money supply, exchange rate and economic growth. They found that stock price indices were integrated with a set of macroeconomic variables, and there was a direct long run balanced relationship with every stock price index. Stock prices were signaled in changes; however, it was not the leading variable of economic fluctuation, they stated.

Regarding the Malaysia construct, macroeconomic variables were selected to examine the determinants of stock market tend to differ slightly across studies by Ibrahim and Aziz (2003); Booth and Booth (1997); Wongbangpo and Sharma (2002); Chen (2003); Chen et al (2005); Maysami and Koh (2000); Mukherjee and Naka (1995) reveal that the rate of inflation, money growth, interest rates, industrial production, reserves, and exchange rates are the most popular significant factors in explaining the stock market movement.

Many studies used Cointegration and Granger causality methods used to conduct empirical studies in the area of relationship between macroeconomic variables and stock market. In our research, we use Cointegration, Granger causality methods and VEC model to examine the relationship between the selected macroeconomic variables and stock market composite index of Malaysia.

Research Modelling

The identified based line model in this study comprises five variables which hypothesise that stock market composite index is a function of the selected macroeconomic variables; the model is stated as below (equation 1).

$$\Delta CI_t = f(\Delta GDP_t, \Delta EXR_t, \Delta RIR_t, \Delta INR_t) \quad (1)$$

Where, *EXR* represents annual exchange rate in Malaysia, RIR represents annual real interest rate, INF represents inflation rate where *t*-sign represents time trend. All variables are measured the changes percentages throughout the period from 1988 to 2019. The data were obtained from World Data bank and Yahoo Finance websites. All data were being converted into log-log equation for time series processing. Thus, the coefficient can be interpreted as elasticity.

Stationarity and Cointegration Tests

Stationarity of a series is an important phenomenon because it can influence the data behaviour. The basic principle of the stationarity test could be explained as if x and y series are non-stationary random processes (integrated), then modelling the x and y relationship as a simple OLS relationship as in equation (2) will only generate a spurious regression.

$$Y_t = \propto + \beta X_t + \epsilon_t \qquad (2)$$

Time series stationarity is the statistical characteristics of a series such as its mean and variance, both are constant over time. Then, the series is said to be a stationary process which is not a random walk or has no unit root. Otherwise, the series is described as being a non-stationary process which is a random walk or has unit root. Differencing operations of a series produce other sets of observations such as the first-differenced values, the second-differenced values and so on. It can be explained as equation (3).

x level x_t; x 1^{st} differenced value $x_t - x_{t-1}$; x 2^{nd} differenced value $x_t - x_{t-2}$ (3)

If a series is stationary without any differencing it is denoted by I (0), or integrated of order 0. On the other hand, a series that has stationary first differences is designated I (1), or integrated of order one (1). The Augmented Dickey-Fuller test (Dickey &. Fuller, 1979) and the Phillips-Perron test (Phillips & Perron, 1988) are used to test the stationarity of the series of variables.

Johansen and Juselius Cointegration Test (Johansen & Juselius, 1990) process uses two types of tests to determine the number of cointegration vectors: the Maximum Eigenvalue test and the Trace test. The Maximum Eigenvalue statistic tests the null hypothesis of r cointegrating relations against the alternative of r+1 cointegrating relations for r = 0, 1, 2…n-1. The test of the maximum eigenvalue is a Likelihood Ratio (LR_{max}) test. This test statistic is computed as equation (4):

$$LR_{max}(r, r+1) = -T * \ln\left(1 - \hat{\lambda}_i\right) \qquad (4)$$

Where LR (r, r + 1) is the likelihood ratio test statistic for testing whether rank (r) = 0 versus the alternative hypothesis that rank r = 0+ 1. For example, the hypothesis that rank (r)= 0 versus the alternative that rank (r) = 0+1 is tested by the likelihood ratio test statistics is stated as follow.

$$LR_{max}(0, 1) = -T * \ln(1 - \lambda_1)$$

Where λ is the largest Maximum Eigenvalue and *T* is the sample size.

Trace statistics examines the null hypothesis of *r* cointegrating relations against the alternative of *n* cointegrating relations, where *n* is the number of variables in the system for *r* = 0, 1, 2…*n*-1. Its equation is computed according to the following formula:

$$LR_{tr}(r, n) = -T * \sum_{i=r+1}^{n} \log\left(1 - \hat{\lambda}_i\right) \qquad (5)$$

In some cases, Trace and Maximum Eigenvalue statistics may yield different results (Alexander, 2001). In our study the both tests are applied and findings are presented in Table (3).

Vector Error Correction Model (VECM)

If cointegration has been detected between series, there exists a long-term equilibrium relationship between the series; therefore we apply VECM in order to evaluate the short run properties of the cointegrated series. In case of no cointegration, VECM is no longer required and we directly precede to Granger causality tests to establish causal links between variables. The regression equation form for VECM is stated as follows (equation 6):

$\Delta Y_t = \alpha_1 + p_1 e_1 + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta Z_{t-i} + \sum_{i=0}^{n} \theta_i \Delta G_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta F_{t-i}$

$\Delta X_t = \alpha_2 + p_2 e_{i-1} + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta Z_{t-i} + \sum_{i=0}^{n} \theta_i \Delta G_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta F_{t-i}$ (6)

In VECM the cointegration rank shows the number of cointegrating vectors. For instance, a rank of four indicates that four linearly independent combinations of the non-stationary variables will be stationary. A negative and significant coefficient of the ECM (i.e. e_i-1 in the above equations) indicates that any short-term fluctuations between the independent variables and the dependant variable will give rise to a stable long run relationship between the variables.

Granger-Causality Test

A general specification of the Granger causality test in a bivariate (*X*, *Y*) context can be expressed as:

$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \dots + \alpha_i Y_{t-i} + \beta_1 X_{t-1} + \dots + \beta_i X_{t-i} + \varepsilon$ (7)

$X_t = \alpha_0 + \alpha_1 X_{t-1} + \dots + \alpha_i X_{t-i} + \beta_1 Y_{t-1} + \dots + \beta_i Y_{t-i} + \varepsilon$ (8)

In the model, the subscripts denote time periods and ε is a white noise error. The constant parameter 0 represents the constant growth rate of *Y* in the equation (7) and *X* in the equation (8) and thus the trend in these variables can be interpreted as general movements of cointegration between *X* and *Y* that follows the unit root process. We can obtain two tests from this analysis: the first examines the null hypothesis that the *X* does not Granger-cause *Y* and the second test examines the null hypothesis that the *Y* does not Granger-cause *X*. If we fail to reject the former null hypothesis and reject the latter, then we conclude that *X* changes are Granger-caused by a change in *Y* (Gul & Ekinc, 2006). Unidirectional causality will occur between two variables if either null hypothesis of equation (7) or (8) is rejected. Bidirectional causality exists if both null hypotheses are rejected and no causality exists if neither null hypothesis of equation (7) nor (8) is rejected (Duasa, 2007).

Results, Stationarity Test and Cointegration

The null hypothesis of no unit roots for all the time series are rejected at both level and first difference since the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test statistic values are less than the critical values at 1% levels of significances. Thus, the variables are stationary and integrated of same order, i.e., I (0) and I (1). However, the application of the ADF and PP tests revealed that all variables are stationary in both their levels and their first differences (see in Table 1).

Table (1)
The results of ADF and PP unit root tests

Series	ADF Test		PP Test	
	Level	First difference	Level	First difference
	Intercept		Intercept	
EXR	-4.414713***	-7.510289***	-4.358690***	-20.52511***
CI	-5.157817***	-5.527904***	-7.174874***	-25.68076***
GDP	-5.393964***	-6.949449***	-5.393964***	-22.24915***
INFR	-4.560674***	-6.728918***	-4.707647***	-10.46778***
RIR	-5.787961***	-8.929990***	-5.899485***	-16.93562***

Note: Asterisks (***) indicate significant at 1% level. Exchange rate, stock market composite index, gross domestic product, inflation rate and real interest rate are denoted by EXR, CI, GDP, INFR and RIR.

Cointegration Test

Cointegration rank (rank of matrix) is estimated using Johansen methodology. Johansen's approach derives two likelihood estimators for the cointegration rank: a maximum Eigen value test and a trace test.

Table 3
Results of co-integration tests

Null	Alternative	$k = 1$			
		λ-max		Trace	
		Unadjusted	95% C.V.	Unadjusted	95% C.V.
$r = 0$	$r = 1$	49.25143**	33.87687	96.57134**	69.81889
$r \leq 1$	$r = 2$	24.55524	27.58434	47.31991	47.85613
$r \leq 2$	$r = 3$	11.44379	21.13162	22.76467	29.79707
$r \leq 3$	$r = 4$	7.829240	14.26460	11.32088	15.49471
$r \leq 4$	$r = 5$	3.491645	3.841466	3.491645	3.841466

Notes: r is the cointegration vector. Asterisks (**) indicate significant at 5% level.

Table (3) indicates the results of the cointegration rank (r) tested with the maximum Eigen value and trace statistics. If the tests reject the null hypothesis of no cointegration among the variables, the alternative hypothesis of cointegration among the variables will be accepted. If the tests do not reject the null hypothesis, there is no cointegration relation between the variables. In our study, testing of hypothesis H_0: r = 0 is rejected because Maximum Eigen value (λ-max) is greater than critical value (CV) at 5% level (49.25143 > 33.87687); and value of trace statistics is greater than critical value (CV) at 5 % level (96.57134 > 69.81889). In other words, the tests results reject the null hypothesis; therefore, these variables (stock market composite index, exchange rate, real interest rate, inflation rate and GDP) are cointegrated. We will proceed to estimate the VECM model.

Table 4
Vector Error Correction Model

Cointegration Equation	Normalized [*t*-statistics]	Standard Error
Constant	2.748374	
CI	-1.000000	
EXR	2.000603 [-5.34567]**	0.37425
GDP	0.006293 [0.78890]	0.00798
INFR	-0.012118 [-0.41942]	0.02889
RIR	0.028277 [2.52038]**	0.01122

Notes: The estimated coefficients were obtained by normalizing the independent variables with respect to their respective dependent variable (CI). Asterisks (**) indicate statistically significant at 5 percent level.

Vector Error Correction Model

The presence of cointegration between variables suggests a long term relationship among the variables. Then, the VEC model can be applied. The long run relationship between stock market composite index, exchange rate, real interest rate, inflation rate and GDP for one cointegrating vector for Malaysia in the period 1988-2019 is stated as follows (t-statistics are displayed in parenthesis).

$$CI = 2.748374 + \underset{[-5.34567]}{2.000603\,EXR} + \underset{[0.78890]}{0.006293\,GDP} - \underset{[-0.41942]}{0.012118\,INFR} + \underset{[2.52038]}{0.028277\,RIR} \quad (9)$$

In the above Table 4, the coefficients of exchange rate (EXR) and real interest rate (RIR) are significant at 1% level of significance. According to the 5 variables in logarithms and one cointegrating vector is estimated, the coefficients can be interpreted as long run elasticities. The appreciation of the composite index (CI) is related to increasing exchange rate, real interest rate, inflation rate and GDP, the estimated model is able to produce a consistent result. Thus, 1% appreciation of the exchange rate is likely to increase composite index by 2.000603%, 1% appreciation of GDP is likely to increase composite index by 0.006293% and 1% appreciation of interest rate is likely to increase composite index by 0.028277%; and these estimates were significant. In the long run, inflation is to be detrimental to composite index changes. For 1% increase in inflation, composite index is reduced by 0.012118%, this coefficient was significant at 1% level of significance.

As a general conclusion, Malaysia with a consistently lower inflation rate exhibits a rising composite index; higher exchange, GDP and real interest rate exhibit a rising composite during the study period.

Granger Causality Test

Cointegration between the variables does not specify the direction of a causal relationship. Granger Causality can specify in at least one direction (Order & Fisher, 1993). We verify the direction of Granger Causality between CI, EXR, RIR, INFR and GDP. Estimation results for granger causality between the very variables are presented in Table 5.

The study by Gul & Ekinc (2006) used chi-square statistics and probability to measure causality between the variables. Chi-Square statistics and probability values constructed under the null hypothesis of non-causality show that there is a causal relationship between those variables.

Table 5
Granger Causality Results (VECM)

Dependent Variable	Δ CI	Δ EXR	Δ GDP	Δ INFR	Δ RIR	ECT	
	χ^2-statistics (*p*-value)					Coefficient	t-statistics
Δ CI	-	6.380702 (0.0115)**	1.824346 (0.1768)	0.021236 (0.8841)	0.266213 (0.6059)	-1.078761	- 3.79161**
Δ EXR	33.48972 (0.0000)**	-	2.200528 (0.1380)	3.094300 (0.0786)	0.931293 (0.3345)	-0.477964	-7.13001
Δ GDP	0.303681 (0.5816)	13.91014 (0.0002)**	-	0.806681 (0.3691)	0.389271 (0.5327)	-5.742027	-1.40987
Δ INFR	2.739301 (0.0979)	1.358444 (0.2438)	2.382128 (0.1227)	-	2.343037 (0.1258)	-1.035601	-0.93293
Δ RIR	2.127035 (0.1447)	0.983436 (0.3214)	1.069275 (1.069275)	7.342052 (0.0067)**	-	0.725203	0.25741

Notes: The χ^2-statistic tests the joint significance of the lagged values of the independent variables, and the significance of the error correction term(s). Δ is the first different operator. Figures in parentheses are the *p* values. Asterisks (**) indicate statistically significant at 5% level.

Table 5 provides the results of pair wise analyses. Significant probability values denote rejection of the null hypothesis. This study reject the null hypothesis if the probability value is less than 1% otherwise do not reject the null hypothesis if the probability value is more than 1%. It is found that EXR Gringer causes CI unidirectional at the 1% significance level (Chi square statistics is 6.381, p value is 0.012), implying that any changes in exchange rate will affect the changes of stock market composite index. There is bidirectional causality for the CI and EXR at the 1% significance level (Chi square statistics is 33.490, p value is 0.000); the finding explains that EXR and CI are mutually influential or they have vice vasa effects over the study period in Malaysia. EXR Granger causes GDP unidirectional at the 1% significant level (Chi square statistics is 7.910, p value is 0.000); any changes of exchange rate can positively predict the changes of gross domestic product.

There is no causality in either direction between the series of INFR and the other series. However, INFR Gringer causes RIR unidirectional causality at the 1% significance level (Chi square statistics is 7.342, p value is 0.007); the changes of INFR can positively cause the changes of RIR. In other words, there are unidirectional causalities running from INFR to RIR, implying that past values of inflation rate have a predictive ability in determining the present values of real interest rate. This finding can be explained by the changes in the short term INFR and it can reflect on the changes of RIR movement.

Conclusion

It can be concluded that increasing the EXR significantly affects the changes of CI and vice vasa. Besides, improvement of EXR also positively concerns with changes of GDP. The changes of INFR significantly determine the changes of RIR. The contribution of the study highlights that the movement of EXR positively significant influence to cause the changes of stock market composite index and gross domestic product, therefore this finding provides message to focus managing EXR which is related to both stock market as well as economy of Malaysia. Further study should focus on the period which could not cover in this study.

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