Chapter 3: Research Methodology

3.1 Data Collection

Daily data for Kuala Lumpur Composite Index (KLCI), the most widely adopted stock market index for Kuala Lumpur Stock Exchange index, was selected as proxy for stock market performance. The market capitalization weighted based stock index KLCI, and the currency exchange rate of Ringgit Malaysia against US Dollar were both obtained from Bloomberg Terminal. The four year data for the period before pegging of Ringgit Malaysia was collected from 5 September 1994 to 2 September 1998, while for the period after the depegging of Ringgit Malaysia, data was collected starting 22 July 2005, immediately after the deppeging of Ringgit Malaysia, till 5 July 2009, for a period of approximately 4 years to suit the timing of the proposed research being carried out. The periods of before pegging of Ringgit Malaysia and after depegging of Ringgit Malaysia under research are shown as follows:

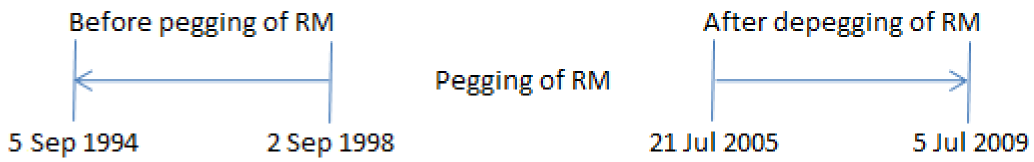

Figure 3.1.1 The periods of before pegging of Ringgit Malaysia and after depegging of Ringgit Malaysia under research

The data for post-pegging period collected up to 3 July 2009, about half a month short of full four year period up to 21 July 2009, was intended to maintain the consistency of the data as there was significant restructuring of the stock index KLCI on 6 July 2009 where the variable under study, KLCI which had one hundred (100) component stocks (eighty three (83) component stocks until it was increased to 100 stocks on 18 April 1995 to accommodate the listing of stock index futures) was retired and replaced by free-float adjusted and liquidity-screened FTSE Bursa Malaysia KLCI comprises thirty (30) largest eligible Main Board companies and computed using FTSE's global index methodology. It should also be noted that the KLCI had discontinued the practice of adjusting index base for dividends starting 25 May 2005.

As highlighted by Jun (2001), daily data which is also known as high frequency data is used so that noneconomic fundamental such expectations of investors, herding behavior, contagion and pulse of the trading in these two markets and noise factor can be included in identifying the statistical significance and relationship between the movements of currency exchange rate and stock market index. This was supported by Ooi and others (2009) who used daily data to better reflect the effect of capital movement which is intrinsically a short-run occurrence, and might not be able to be captured by monthly data. Besides, Ong & Izan (1999) and Azman-Sani, Habibullah & Law (2007) suggested the significance of the results between stocks and currencies could possible be improved by using daily data as it might better capture the dynamics of equity and exchange rate market interrelationships as the significance of interaction between the two variables might have been 'diluted' using data with lower frequency.

In this study, there are altogether 986 sets of data entry for the period before pegging of Ringgit Malaysia and 977 sets of data entry for period after depegging of Ringgit Malaysia. However, it should be noted that the data for 3 July 2008 whereby it was a trading day at Kuala Lumpur Stock Exchange but the trading was suspended one full day due to multi hardware failure in core trading system of Bursa Malaysia Berhad. The previous closing figure of Kuala Lumpur Composite Index on 2 July 2008 was used as the closing figure for 3 July 2008[12].

From casual observation of the stock price and currency exchange rate movement as shown in Figure 1.1.1 and Figure 1.1.2, it appears that the strength of Ringgit Malaysia has certain extent of positive co-movement with stock price. This was more obvious during the volatile periods such as the fall in both stock price and value of Ringgit Malaysia during the Asian financial crisis before pegging of Ringgit Malaysia, and also the period after depegging of Ringgit Malaysia where there were co-movements of stock price and value of Ringgit Malaysia during the bullish uptrend starting last quarter of year 2006 in tandem with the bullish sentiment in major stock markets, and subsequently followed by decline in both stock price and value of Ringgit Malaysia due to global financial crisis erupted in year 2008.

3.2 Unit Root Test

In econometrics, a unit root test tests whether a time series variable is stationary using an autoregressive model. A stochastic process is said to be stationary if the mean and variance are constant over time and the covariance between the two time periods depends only on the distance or lag between two time periods and not on the actual time.

In order for two variables to be described as being cointegrated, the variables shall be integrated at the same order and the residuals from

[12] Source: Media releases by Bursa Malaysia Berhad dated 3 July 2008

regressions of the two variables are *I*(0) or stationary. Therefore, before test on cointegration is being carried out, unit root tests shall be performed on the variables and the residuals.

The Augmented Dickey-Fuller test, a popular unit root test[13] and improved version of Dickey-Fuller test that had been modified to overcome the problem of autocorrelation in the basic Dickey-Fuller test, will be applied to analyze the order of stationary for the time series variables for stock price, currency exchange rate and the residuals from the regression of stock price and currency. Dickey-Fuller/ Augmented Dickey-Fuller test was used by researchers to test the stationary of time series variable such as by Pan, Fok, & Liu (2007), Ooi, Syed Khalid Wafa, Lajuni, & Ghazali (2009) and Baharumshah, M. Masih, & Azali (2002). The test is applied here serving as preliminary test to cointegration test to determine whether the time series for stock price and Ringgit Malaysia exchange rate are stationary at the same order.

Regression form of $\Delta Y_t = \delta Y_{t-1} + \mu_t$ is selected as from the graphs of the time series variables, they appear to be plots of random walk series without trend and intercept. Using E-view, automatic selection of lap length is picked based on Schwarz Info Criterion with maximum default lags of 21.

3.3 Cointegration

In time series, two variables are cointegrated when they have long-term, equilibrium relationship between them. A long-term relationship exists when the variables are cointegrated and move together over time and the

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[13] According to Wikipedia, http://en.wikipedia.org/wiki/Unit_root_test, Augmented Dickey-Fuller test is the most popular unit root test.

difference between them is constant. The linear combination of a non-stationary time-series and another non-stationary time series cancels out the stochastic trends in the two series and the error term becomes stationary.

Cointegration of non-stationary time-series variables is important in traditional regression methodology (including the *t* test and *F* test). Provided the variables are cointegrated, the traditional regression methodology is applicable to non-stationary time series. As highlighted by Granger (1986), " A test for cointegration can be thought of as a pre-test to avoid 'spurious regression' situations."

As cointegration necessitates that the variables be integrated in the same order, unit root tests were performed as a pre-requisite on the time-series variables to see if the criteria was fulfilled. If the two variables were found to be non-stationary at level and stationary at same order, usually at first difference for non-stationary data, we will proceed to test the cointegration between stock price and currency exchange rate using Augmented Engle-Granger (AEG) Test. According to (Granger, Huang, & Chin, 1998), majority of researchers still apply the widely use model of Engle-Granger test.

The test of cointegration is carried out by performing ordinary least squares regression on the variables, followed by Augmented Dickey-Fuller test on the residual obtained from the regression. The time series are cointegrated if the residual is stationary which arrives due to cancelling out of each other in the non-stationary time series.

In Dickey-Fuller or Augmented Dickey-Fuller test for cointegration, the unit root test is performed not on series of raw data but the residuals of a model which are constructed from a set of coefficient estimates, and as such, the sampling estimation error in these coefficients will alter the distribution of the test statistic. Engle and Granger (1987) had then derived a new set of critical values for the stationary test on the residuals. Meanwhile, Engle and Yoo (1987) had come out with a new set of critical values that are greater in magnitude (more negative) than the Dickey-Fuller critical values.

In fact, there are at least three methods that could be used to test cointegration of time series variables. They are Engle-Granger method, Engle-Yoo method and Johansen method.

Engle-Granger method is selected for the purpose of this study as according to Brooks (2008), Engle and Yoo method, an updated version of Engle-Granger method, is algebraically technical, still carries all of the remaining weaknesses of the Engle-Granger approach, and rarely used in empirical applications while Johansen method is said to lack testability of hypothesis concerning the cointegrating relationship.

3.4 Granger Causality Test

Before discussing on Granger Causality Test, the term "causality" itself had attracted much discussion as some authors highlighted the term "causality" was somewhat misleading. The existence of a relationship between variables does not imply causality of one variable on other variable(s). The term "causality" means a correlation between the existing value of a variable to the past value of other variables, or chronological ordering of movements in the series, and not the movement in a variable causing movement of other variable(s). This happens when we include past or lagged values of A and it significantly improves the prediction of B, A granger causes B.

As Koop (2000) put it, "… time does not run backward. That is, if event A happens before event B, then it is possible that A is causing B. However, it is not possible that B is causing A. In other words, events in the past can cause events to happen today. Future events cannot. (Emphasis added.)"

To avoid confusion, some econometrician used different words such as "precedence" and "predictive causality" to better reflect the lead-lag relationship between variables.

In this study, we will carry out this test to see if stock price "causes" movement in currency exchange rate, or the other way round, or there was bilateral causal relationship between them, or they are independent for the two periods under study.

To test the above relationship, it involves estimating the pair of regressions below which postulate one of the bivariate variable is related to the past values of itself and that of another variable.

$KLCI_t = \alpha_i CURRENCY_{t-i} + \beta_i KLCI_{t-j} + u_{1t}$ and,

$CURRENCY_t = \lambda_i CURRENCY_{t-i} + \delta_i KLCI_{t-j} + u_{2t}$

with assumption that the disturbances u_{1t} and u_{2t} are uncorrelated.

The steps involve in Granger Causality Test are as follows:

i) Regress current KLCI on all lagged KLCI to form restricted regression in order to obtained the restricted residual sum of squares, $RSS_{R.}$

ii) Run another regression by including the lagged CURRENCY term to form unrestricted residual sum of squares, RSS_{UR}.

iii) Form null hypothesis, H_0: $\alpha_i = 0$, i.e. lagged CURRENCY terms is not significant in the regression.

iv) Carry out F test.

v) If the calculated F value is greater than critical F value, null hypothesis is rejected, implying that CURRENCY does Granger cause KLCI.

vi) To test whether KLCI Granger cause CURRENCY, the regression for second equation is to be carried out. Repeat steps i) to v) to obtain the results.

Various researchers had applied Granger causality test to determine the causal relationship between stock price and currency exchange rate such as in Pan, Fok, & Liu (2007), Jun (2001) and Granger, Huang, & Chin (1998).

However, when performing Granger Causality Test, it should be noted that:

i) Both the time series shall be stationary. In the event the variables are not stationary, take the differences of the variable to make them stationary.

ii) The number of lagged terms is important in Granger Causality Test. Akaike Information Criterion or Schwarz information criterion can be used as reference to decide on the lagged term.

iii) Assuming that the error terms in the causality test are uncorrelated.

It should be noted that some variables can be very sensitive to the selected number of lags in the analysis and therefore the reasonable lag length shall be carefully selected. Data with longer interval such as annual or monthly data generally use shorter lag length compared with weekly or daily data. For the purpose of this study, analysis will be carried out for lap length of 1 day to 24 days.

3.5 Coefficient of Correlation and Coefficient of Determination

A correlation coefficient (represented by letter 'r') is to quantify the degree of association of a linear relationship between two quantifiable variables. Correlation coefficient falls between -1 and +1. The value of +1 indicate a perfect positive correlation, two variables are exactly related. When the value of one variable increases, the value of the other variable increases too. On the other hand, the value of -1 shows perfect negative correlation. The two variables are still exactly related but the movements of the values of the two variables are exactly in opposite direction. The variables are statistically independent when the value is 0. While the positive or negative sign shows the direction of relationship between the variables, the magnitude of the coefficient reveals the strength of correlation as below:

Value	Correlation
-1	Perfect negative
-0.7	Strong negative
-0.3	Weak negative
0	Perfect independence
+0.3	Weak positive
+0.7	Strong positive
+1	Perfect positive

Table 3.5.1: Values and the strength of correlation[14]

Subsequently, the coefficient of determination (represented by r^2) which has value between 0 and 1, will be obtained to consider the goodness of fit of the regression line for the set of data. It explains how much the proportion of

[14] Interpretation of the correlation strength abstracted from Figure 12.14, page 451 of Research Methods for Business Students by Mark Saunders, Philip Lewis, Adrian Thornhill, 4th edition.

the variation in a dependent variable can be explained by the independent variable but does not imply any cause-and-effect relationship between the variables. Similar method had been applied by (Yahya, 1998) in the study of the relationship between the returns on KLSE indices and the returns on US Dollar foreign exchange for 1997.

The collected data for these two different periods (before pegging and after depegging) will be regressed separately by the extensively used method of ordinary least squares (OLS) using EViews, a program for statistical and econometrics analysis and forecasting to estimate the parameter of β_1 in the econometric model as below:

$$KLCI = \beta_1(CURRENCY) + u$$

where KLCI = Kuala Lumpur Composite Index

CURRENCY = US Dollar per Ringgit Malaysia exchange rate

β_1 = slope co-efficient for the rate of change of KLCI per unit change of USDRM

u = combination of measurement error, inherent randomness, omitted explanatory variables and many small factors that do not systematically affect the analysis

From the regression result, it will be checked whether the estimate is statistically significant. The sign and magnitude of the correlation coefficient obtained are then interpreted to determine the relationship between the performance of Kuala Lumpur Composite Index and RM/ US Dollar currency exchange rate. From the coefficient of determination, it can be seen to what extend the performance of the stock index could be explained by the movement of currency exchange rate.

In order to find out the relative change in the currency rate for a relative change in stock price, and the mechanical interpretation of intercept for KLCI-RM/USD linear regression may not make sense, log-linear (log-log) model is generated for both periods. The coefficient obtained from regression of this log-linear model is the elasticity of stock price with respect to change in the currency, i.e., measuring the percentage of change in the stock price for every one percent change in the currency.

After the data has been regressed and analysed to obtain the coefficient of correlation as described above, it was found that strong positive serial correlations existed in all the four regressions as summarized below:

Variables	Period (year)	Durbin-Watson Statistics
KLCI and CURRENCY	5 September 1994 to 2 September 1998	0.032793
ln(KLCI) and ln(currency)	5 September 1994 to 2 September 1998	0.030689
KLCI and CURRENCY	21 July 2005 to 5 July 2009	0.011495
ln(KLCI) and ln(currency)	21 July 2005 to 5 July 2009	0.011052

Table 3.5.2: Durbin-Watson Statistics for each regression

To rectify the problem that arose from serial correlation, the following remedy was performed after first round of data analysis had been performed and this section is inserted here for ease and continuity of reading.

The situation of serial correlation, lag correlation between two different series showing inter-correlation between successive data in order of time, is common for data with short interval such as daily data. The likely reason behind the existence of serial correlation here is due to inertia, as it is a known feature of most economic time series to have the characteristic of inertia or sluggishness. It is usual to see the time series move up or down for several periods in succession, such as stock market indices, gross domestic product, employment rate, mirroring the economic situation of a country. For example, when financial crisis happens, a country turns into recession. The above economic indicators turn from growing into declining and then dip further into negative territory. There is momentum built into the time series and the trend continues until there is measures taken to slow down the movement and turn them around. In economic time series, successive data are often inter-correlated.

Generally there are four options of remedy when serial-correlation exists. They are:

i) Instead of pure serial-correlation, to find out whether the model has been mis-specified with some important variables being omitted and re-specify the model.

ii) In the case of pure serial-correlation, the original model can be transformed into a model that does not have pure serial-correlation problem by generalized least-squared (GLS) method.

iii) If the sample is large, Newey-West method can be used to obtain standard error or ordinary least square estimators corrected for serial correlation.

iv) Continue to use ordinary least square method as in the case of small sample and the coefficient of correlation, ρ is less than 0.3, as the results using remedy of feasible generalized least square

(FGLS) and heteroscedasticity and autocorrelation consistent (HAC) methods may be worse off in small sample.

In the case of this study, the existence of serial correlation is likely due to combination of economic series which have the nature of autocorrelation and exclusion of some other important variable such as gross domestic product and interest rate. For the purpose of this study, it may not be appropriate to include gross domestic product data as there are small amount of observations with only 18 readings for the quarterly released gross domestic product since depegging of Rinngit Malaysia.

For the reasons above, the third option using Newey-West method is selected. This method produces the same estimators and coefficients of determinations, R^2. The difference is the standard errors using Newey-West method is much larger and therefore the *t* values are much smaller than the *t* values obtained using ordinary least square. Even though the Durbin-Watson statistics are still the same, this method has addressed the problem by correcting the standard errors in ordinary least square method.