LINKAGES OF ECONOMIC ACTIVITY, STOCK PRICE AND MONETARY POLICY: THE CASE OF MALAYSIA

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ABSTRACT

A simple model is formulated to show that real economic activities, stock prices, real interest rates and real money balances are linked in the long run. An empirical analysis is then conducted for the case of Malaysia based on two sub-periods. The first sub-period is before the implementation of selective capital controls by the authority and the second sub-period is since the adoption of this regime. Long-run cointegration is found among the variables, supporting the theory. Before the controls, both money supply and interest rates are effective in leading the real economic activities. Given its endogeneity, the money supply cannot be used as a monetary tool under a fixed exchange rate regime, and the interest rate has an active rule to play in this case. Its effect in leading the real economic activities, however, is limited rendering the conduct of monetary policy more difficult since the implementation of capital controls. Thus, the source of adjustments to deviations from the long-run relationships in the system mainly stems from the asset market during the second sub-period. When the stock market is performing well generally, the level of real economic activities do not seem to lead stock price movements and the stock prices do not lag behind interest rate changes. Some elements of self fulfilling bubbles exist in the first sub-period. However, the stock market is found to be a leading indicator of the level of economic activities when the market is generally bullish.

Keywords: capital controls, cointegration, monetary policy, stock market

I. INTRODUCTION

Economic theory suggests that stock prices should reflect expectations about future corporate performance. Meanwhile, corporate profits generally may reflect the level of economic activities. If stock prices accurately reflect the underlying fundamentals, then the stock prices should be employed as leading indicators of future economic activity. Therefore, the causal relations and dynamic interactions among macroeconomic variables and stock prices are important in the formulation of the nation's macroeconomic policy.

As for the effect of macroeconomic variables such as money supply and interest rate on stock prices, the efficient market hypothesis (EMH) suggests that competition among the profit-maximizing investors in an efficient market will ensure that all the relevant information currently known about changes in macroeconomic variables are fully reflected in current stock prices, so that investors will not be able to earn abnormal profit through prediction of the future stock market movements.

The relationships among money supply, interest rate and real activity can be explained by the transmission mechanisms of monetary policy under the traditional Keynesian approach. For instance, an expansionary monetary policy by increasing money supply leads to a fall in interest rate which in turn reduces the cost of capital, causing a rise in investment spending and subsequently inducing a rise in real output. This links back to stock prices again if the stock market performance reflect the expected level of economy activities.

This paper aims to study the linkages among the stock prices and three key macroeconomic variables, namely, real interest rate, real economic activity and real money balances. A major contribution of this paper is that a monetarism-based theoretical model is proposed to show that these variables are linked together in the long run. Another new attempt in this paper is to examine the effects of the regime of selective capital controls and the pegging of ringgit adopted since September 1998 by the authority on the linkages of these variables. As the regime has profound implication on the conduct of monetary policy, the dynamic interactions among these variables are expected to be different before and after the adoption of this regime. The empirical investigation of this paper is therefore based on a comparative analysis on two sub-periods, one before the implementation of the capital controls, and the other since these control measures have been in place.

The paper is organized as follows. Section II reviews the relevant literature. The proposed theoretical model is outlined in Section III. Section IV describes the data and methodology used in this study. Section V presents the results and the findings are discussed in Section VI. Section VII provides the conclusion to the paper.

II. LITERATURE REVIEW

Sims (1972) studied the causality between money and income for United States (US) post-war period from 1947 to 1969, and found a unidirectional causality from money to income. The hypothesis that the causality was unidirectional from income to money was rejected, and there was no feedback causality. Serletis and King (1994) investigated the effects of deterministic trend in money growth towards money-output causality by using US and Canadian data. They found that money growth was Granger-causing real output, and the outcomes were not significantly affected after dropping the deterministic trend.

Several previous studies examined the causal relationship between stock return and economic activity. Fama (1990), Schwert (1990) and Lee (1992) reported that the US stock market acted as signal to changes in real economic activity. However, Binswanger's (2000) study revealed that stock variation did not lead real activity in US any longer since the occurrence of the stock market boom in early 1980s. Thornton's (1993) work emphasized the importance of stock prices on real output in United Kingdom (UK). Aylward and Glen (2000) conducted an international empirical study on stock prices as leading indicators of economic activity for twenty three markets, including the G7 countries, Australia and 15 emerging countries. The evidence that stock price changes lead gross domestic product (GDP), consumption and investment in most of the countries was found. Bittlingmayer (1998) showed that the current and past increases in stock volatility were associated with output decline in Germany, consistent with the US experience. The political issues emerged clearly as the source of volatility. Apart from the stock return and real activity relations, Lee (1992) also investigated the causal relations and dynamic interactions among the asset returns, inflation and real interest rate for US in the postwar period. Stock returns did not Granger-cause inflation. Real interest rate explained a substantial fraction of the forecast error variance in inflation while inflation did not have significant explanatory power for growth in industrial production in the presence of stock returns and interest rate.

Some works on the money and stock market relations were conducted by Serletis (1993) for the case of US and Thornton (1993) for the case of UK. Thornton's study revealed that the stock prices tend to lead money supply while Serletis's finding supported the EMH in the US stock market. Muradoglu, Metin and Argac (2001) examined the long-run relationship between stock returns and three monetary variables (overnight interest rate, money supply and foreign exchange rate) in Turkey. They pointed out that the whole sample period (1988-1995) showed no cointegrating relationship between stock prices and any of the monetary variables. This is also true only for the first sub-sample (1988-1989) but all the variables were cointegrated with stock prices for the second (1990-1992) and third sub-samples (1993-1995).

Most researches on Malaysia focused on the relationship between the stock market and macroeconomic variables in order to examine the EMH. Ibrahim (1999) investigated the dynamic interactions between stock prices (represented by the Kuala Lumpur Stock Exchange (KLSE) Composite Index) and seven macroeconomic variables (industrial production index, money supply M1 and M2, consumer price index, foreign reserves, credit aggregates and exchange rate). Monthly data series for the period January 1977 to June 1996 were used. Both augmented Dickey-Fuller and Phillips-Perron unit root tests were implemented. He employed both the bivariate and multivariate cointegration and causality tests. The results from the bivariate analysis revealed that the stock market was informationally inefficient with respect to consumer prices, official reserves and credit aggregates since they are cointegrated. In addition, the stock prices were Granger-caused by reserves. The multivariate analysis was in compliance with the bivariate analysis in which the changes in stock prices were Granger-caused by the changes in official reserves. Furthermore, changes in exchange rate also led stock prices. In conclusion, the bivariate and multivariate analyses proved that the Malaysian stock market was informationally inefficient.

Habibullah et al. (2000) examined the lead-lag relationship between stock prices and five macroeconomic variables, namely, interest rate, price level, national income, money supply and real effective exchange rate. Stock prices were measured by the KLSE Composite Index, national income measured by GNP, and the three-month Treasury bill rate and Consumer Price Index were used as the proxy for interest rate and price level, respectively. They utilized the Phillips-Perron unit root test to determine the order of integration for each variable. They also employed the Toda-Yamamoto long-run Granger causality test for determining the association between integrated series without having to worry about the order of integration or cointegrating rank in the vector autoregression system. This method guaranteed the asymptotic distribution of the MWald statistic. The results suggested that the stock prices led national income, price level and exchange rate, which also meant that stock market acted as a leading indicator for many macroeconomic variables. At the same time, money supply and interest rate were found to lead stock prices.

This review shows that studies on relationships among stock prices and macroeconomic variables in Malaysia are relatively scarce compared to the developed economies. It is hoped that this paper can contribute to bridge the gap.

III. THEORETICAL BACKGROUND

A simple model is formulated within the monetary framework in this section to show that the stock prices, economic activity, interest rate and real money balances are linked in the long run. Olesen (2000) derived a model that explains the long-run movements in stock prices by the general price level, real production and the real discount rate. At the company level, the stock price should reflect its corporate performance. Assuming a constant profit margin η, and output price P_t and real output level Q_t that grow at constant rates, Olesen showed that

$$S_t = \eta P_t Q_t / i_t \qquad (1)$$

where S_t is the stock price and i_t is the discount rate adjusted for expected inflation and growth. The stock price is therefore related to the level of economic activity and expected performance of the economy at the macro level.

The growth-adjusted discount rate could be explained using the interest rate equation in a typical macro model with monetarism's features (see, e.g., Meyer 2001). This equation is stated as:

$$R_t = r^* + E_t(\hat{P}_{t+1}) + a_1(\hat{Q}_t - \hat{Q}^*) + a_2(\hat{P}_t - \hat{P}^*) \qquad (2)$$

where R_t is the nominal interest rate, r^* is the equilibrium real interest rate, $\hat{Q}_t$ is the output growth, $\hat{Q}^*$ is the potential output growth, $\hat{P}_t$ is the inflation rate and $\hat{P}^*$ is the inflation target. This equation relates the monetary instrument R_t to the output gap and the difference between the actual inflation rate and the central bank's inflation target. For simplicity, assume that $\hat{Q}^*$ and $\hat{P}^*$ are constant, and

$$r^* = r_t + \varepsilon_{rt}$$

$$E_t(\hat{Q}_{t+1}) = \hat{Q}_t + \varepsilon_{qt}$$

where r_t is the real interest rate, and ε_{rt} and ε_{qt} are random errors. These two equations suggest naïve forecasts in the equilibrium real exchange rate and output. By definition, $i_t = R_t - E_t(\hat{P}_{t+1}) - E_t(\hat{Q}_{t+1})$. Following this, equation (2) becomes

$$i_t = A + r_t + (a_1 - 1)\hat{Q}_t + a_2 \hat{P}_t + \varepsilon_t \qquad (3)$$

where $A = -(a_1 \hat{Q}^* + a_2 \hat{P}^*)$ and $\varepsilon_t = \varepsilon_{rt} - \varepsilon_{qt}$. Equation (3) then suggests that i_t is directly related to the real interest rate, and from (1), the stock price is inversely related to the real interest rate.

The level of economic activity is linked to the money stock via the quantity theory of money. The more money people hold in relation to their income, the lower is the income velocity of money. The higher the interest rate, less money will be demanded relative to income, and this increases the velocity of money. The velocity of money is thus closely related to the demand for money. When the real money balances are equal to the stock of money, the equilibrium is achieved in the long run. In equilibrium, the real demand for money is given by:

$$m_t = M_t/P_t = b_0 + b_1\, y_t + b_2\, R_t \qquad (4)$$

where M_t is the stock of money and $y_t = P_tQ_t$ represents the level of economic activity. Using this same set up, Fama (1981) assumed that real activity, money and the interest rate are exogenous and that prices the only endogenous variable in order to explain the relation between real activity and inflation. However, as the aim of this study is to investigate the linkages among the economic activity, stock price, interest rate and money stock, no assumption of endogeneity or exogeneity of the variable will be made in the ensuing discussion.

Given that $r_t = R_t - \hat{P}_t$, substituting equations (1) and (3) into (4) yields:

$$m_t = c_0 + [b_1 + c_1/S_t]\, y_t + c_2\, r_t + c_3\, \hat{Q}_t + u_t \qquad (5)$$

where the coefficients c_0, c_1, c_2 and c_3 are functions of A, a_1, a_2, b_0, b_1, b_2 and η, and $u_t = -(b_2/a_2)\varepsilon_t$. In the long run, the potential output growth is realized such that $\hat{Q}_t = \hat{Q}^*$. Equation (5) can then be stated as

$$m_t = C_0 + [b_1 + c_1/S_t]\, y_t + c_2\, r_t + u_t \qquad (6)$$

where $C_0 = c_0 + c_3\, \hat{Q}^*$. This equation shows that the real balances that economic agents hold, stock prices, real economic activity and real interest rate are linked in the long run.

IV. DATA AND METHODOLOGY

Monthly data series for the period from January 1987 to December 2001 are used in this study. The entire sample period is then divided into two sub-periods. The first sub-period is from January 1987 to August 1998 and the second sub-period is from September 1998 to December 2001. The first sub-period is characterized by free flow of capitals whereas the second sub-period is characterized by more restrictive capital flows as the selective capital controls regime was adopted since 1 September 1998.

To measure the general stock price level S_t, we use the end-of-month values of KLSE Composite Index, which are obtained from the Public Information Centre in KLSE, Kuala Lumpur. The real economic activity (y_t) is measured by the index of industrial production (IIP). This is consistent with the approach of many other studies surveyed in Section II. The IIP is compiled from various issues of the Monthly Statistical Bulletin published by Bank Negara Malaysia (BNM). The IIP series is seasonally adjusted using an additive time series component model. The nominal average lending rate by commercial banks is used as the proxy for interest rate. The real interest rate (r_t) is the nominal interest rate adjusted by the monthly inflation rate computed using the Consumer Price Index (CPI). Real money balances (m_t) refer to the money stock adjusted by the price level (CPI). The broader definition of money M2 is used for this series. The data of average lending rate, CPI and M2 are also obtained from Monthly Statistical Bulletin published by BNM. The data series of y_t, S_t and m_t are expressed in logarithmic forms for the analysis. The same is not done for r_t because taking logarithmic transformation of a series that contains negative values is not possible. This approach is also standard as transformation of the r_t series which is expressed in percentage into logarithms will add complications to the interpretation.

In order to establish the order of integration of the series ln y_t, ln S_t, r_t and ln m_t, the augmented Dickey-Fuller (ADF) unit root test is conducted. The ADF test makes a parametric correction for higher order correlation by assuming that the series follows an AR(m) process. The test regression is:

$$\Delta x_t = \mu + \beta t + \gamma x_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta x_{t-i} + \varepsilon_t \tag{7}$$

where x_t is the series under investigation, t = 1,2,…..n and n is the sample size. The model with a drift and t is used to account for the possibility of non-zero means the presence of a deterministic trend. The null hypothesis of H_0: $\gamma = 0$ is tested against H_1: $\gamma < 0$. As the t-statistic under the null hypothesis does not follow the conventional t-distribution, the critical values tabulated by MacKinnon (1991) are used. The test regression was run by using m = 1, 3 and 6 to ensure that the results are robust to different lag lengths.

The standard ADF test does not allow for the existence of a structural break in the time series. We consider the unit root test with a structural break in the series proposed by Perron (1989) whereby the breakpoint is treated as exogenous. He employed an adjusted ADF-type unit root test strategy to conduct the test with a break in trend occurring at the Great Crash of 1929 and oil-price shock in 1973. As we wish to conduct a comparative analysis of the period before and after the implementation of capital controls, this method is relevant. Given a change in the trend of each data series that occurred in the third quarter of 1998, we denote August 1998 as the breakpoint (T_B). We consider possible changes in both the intercept and slope in the trend function and the regression equation to test for a unit root is as below:

$$x_t = \mu + \beta t + \theta_1 DU_t + \theta_2 DT_t + \gamma x_{t-1} + \sum_{i=1}^{m} \phi_i \Delta x_{t-i} + \varepsilon_t \tag{8}$$

where $DU_t = 1$ if $t > T_B$, 0 otherwise, and $DT_t = t$ if $t > T_B$, 0 otherwise. The asymptotic distribution of the t-statistic for testing H_0: $\gamma = 0$ in equation (8) is given by Perron (1989). To find the percentage points from the distribution, the value of break fraction is defined to be T_B/n.

Equation (6) suggests a relationship that binds y_t, S_t, r_t and m_t together in the long run. The Johansen's (1991) framework is adopted to investigate if long-run linkages exist among these variables. Consider the vector error correction model of the following form:

$$\Delta z_t = \mu + \pi z_{t-1} + \sum_{k=1}^{p} \Gamma_k \Delta z_{t-k} + \varepsilon_t \tag{9}$$

where z_t = (ln y_t, ln S_t, r_t, ln m_t)', μ is the 4x1 column vector of constants, π is a 4x4 matrix of coefficients, Γ_k is the 4x4 matrix of coefficients for k = 1, 2, ..., p and $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, ..., \varepsilon_{4t})$ is the 4x1 column vector of disturbance terms such that $E(\varepsilon_{it}) = 0$, $E(\varepsilon_{is,}\ \varepsilon_{it}) = 0$ for $s \neq t$, $E(\varepsilon_{it,}\ \varepsilon_{jt}) = \sigma_{ij}$ and $E(\varepsilon_i^2) = \sigma_i^2$. The vector error correction model restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relations while allowing for short-run dynamic adjustments.

The Granger representation theorem asserts that if the coefficient matrix π has reduced rank r < 4, where r refers to the number of cointegrating relations, then there exist 4xr matrices α and β each with rank r, such that $\pi = \alpha\beta'$ and $\beta' z_t$ is I(0). Each column of β is the cointegrating vector while elements of α are the adjustment parameters. Thus, the rank of the π matrix gives the number of cointegrating vectors. In the case where r cointegrating relations are found, $\pi = \alpha\beta'$ where

$$\alpha = \begin{bmatrix} \alpha_{11} & \cdots & \alpha_{1r} \\ \vdots & & \vdots \\ \alpha_{41} & \cdots & \alpha_{4r} \end{bmatrix} \quad \text{and} \quad \beta = \begin{bmatrix} \beta_{11} & \cdots & \beta_{1r} \\ \vdots & & \vdots \\ \beta_{41} & \cdots & \beta_{4r} \end{bmatrix}$$

The error correction terms in (9), i.e., $\beta' z_{t-1}$ represent deviations from the long-run equilibrium relationships among the four variables.

Johansen's method is based on estimating the π matrix in an unrestricted form, and then testing whether the restrictions implied by the reduced rank of π can be rejected. This is achieved by testing the null hypothesis of at least r cointegrating vectors against a general alternative hypothesis of more than r cointegrating vectors, based on the likelihood ratio test statistic given by:

$$Q_r = -n \sum_{k=r+1}^{4} \log(1 - \lambda_k)$$

where λ_k is the k-th largest eigenvalue defined in Johansen (1991). The critical values for the test are obtained from Osterwald-Lenum (1992). The model in (9) is fitted for both the sub-periods using p = 1, 2, …, 6. The lag length that minimizes the Bayesian Schwarz criterion (BIC) is then used for further analysis. The BIC is preferable because both the Akaike information and final prediction error criteria overestimate the order of an autoregressive process asymptotically. To avoid this overestimation, a stronger penalty term as that included in the BIC is needed.[1]

In the presence of long-run relations among the four variables, the vector error correction model in (9) can be employed to establish the Granger causal direction. To investigate if variable-i Granger causes variable j, the null hypothesis to be tested is

$$H_0:\ \Gamma_{ji,k} = 0\ \forall\ k,\ \alpha_{j1} = 0 \text{ if } \beta_{i1} \neq 0,\ \alpha_{j2} = 0 \text{ if } \beta_{i2} \neq 0, \ldots\ \alpha_{jr} = 0 \text{ if } \beta_{ir} \neq 0$$

[1] See Engle and White (1999) for details.

where $\Gamma_{ji,k}$ is the (j,i) element in Γ_k, against a general alternative of at least one restriction is not zero. The F-test is used for this purpose.

It would also be useful to know which are the variables that adjust in response to long-run disequilibrium in order to restore the long-run relation. We test whether variable-i adjusts to disequilibrium by using the F-test for the null hypothesis of

$$H_0: \alpha_{i1} = ... = \alpha_{ir} = 0.$$

against a general alternative of at least one restriction is not zero.

V. RESULTS

We first conduct the ADF unit root test to establish the order of integration for the real economic activity, stock price, real interest rate and money stock series. Table 1 shows the results of the test for presence of a unit root in levels and first differences for both the sub-periods. Except for a case in the second sub-period, the results of the ADF test do not provide evidence against the unit root in the levels. Meanwhile, the test for a unit root in the first difference series indicates strong rejection of the null hypothesis in almost all the cases. As a result, these data series can be characterized as I(1) for both the sub-periods of analysis.

Table 1: Augmented Dickey-Fuller Test for Unit Root

Variable	Lag	Levels		First Differences	
		First Sub-period	Second Sub-period	First Sub-period	Second Sub-period
$\ln y_t$	1	-2.3578	-0.7582	-13.7571**	-5.2433**
	3	-0.6978	-0.8572	-8.2742**	-4.5265**
	6	-0.0222	-1.3776	-4.7613**	-0.8256
$\ln S_t$	1	0.9064	-3.0403	-6.0257**	-4.3931**
	3	0.6803	-1.9600	-5.6857**	-3.7949*
	6	1.9835	-3.2955	-4.4900**	-1.5897
r_t	1	-3.0788	-2.6885	-7.0773**	-5.5111**
	3	-2.5669	-3.6224*	-7.2593**	-4.8873**
	6	-2.8116	-1.7154	-4.9472**	-4.7687**
$\ln m_t$	1	-3.4380	-2.2063	-7.5508**	-5.0340**
	3	-2.9974	-1.3984	-6.0136**	-3.6692*
	6	-2.9092	-1.4859	-4.5771**	-3.1630

Notes: ** and * denote significance at the 1% and 5% levels, respectively.

The Perron's procedure where the breakpoint is taken to be exogenous is used to further analyze the time-series properties of these series. The break fraction (λ) is about 0.8. The unit root test with a breakpoint is conducted for all the variables in their levels and the results are reported in Table 2. The test statistic is not significant for all the data in levels at 5 per cent. For the test with the first differences of the data series, the results suggest that all the variables are stationary after first difference. In general, all the variables are non-stationary in levels, and hence are integrated of order one.

Table 2: Unit Root Test with a Structural Break

Levels			First Differences		
Variable	Lag	Test Statistic	Variable	Lag	Test Statistic
$\ln y_t$	1	-2.1797	$\ln y_t$	1	-14.6581**
	3	-1.0880		3	-8.6524**
	6	-1.3724		6	-4.8591**
$\ln S_t$	1	-0.5275	$\ln S_t$	1	-8.2875**
	3	-0.1069		3	-8.4687**
	6	1.0535		6	-5.7744**
r_t	1	-3.7704	r_t	1	-8.2960**
	3	-3.3856		3	-7.9834**
	6	-3.5943		6	-5.6600**
$\ln m_t$	1	-3.8605	$\ln m_t$	1	-8.7422**
	3	-3.3725		3	-6.8228**
	6	-3.2988		6	-5.2594**

Notes: ** and * denote significance at the 1% and 5% levels, respectively. Under the null hypothesis, the 1% and 5% critical values of the unit root test (for $\lambda = 0.8$) are -4.70 and -4.04, respectively (Perron 1989).

The Johansen cointegration test is conducted for both the sub-periods. The BIC indicates that lag length of one is optimal for the vector error correction model of both the sub-periods. This finding is consistent with our cointegration results in which the model with one lag is free from the problem of full rank in the π matrix. The results of the Johansen cointegration test are reported in Table 3. Three cointegrating vectors are found for the first sub-period while a unique cointegrating vector exists for the second sub-period. The results provide support to the theoretical analysis in Section 3 that the real economic activities, stock price, real interest rate and real money balances are linked in the long run. This link is in fact a lot stronger in the first sub-period.

Table 3: Johansen Cointegration Test for the First and Second Sub-Periods

Number of Cointegrating Relations (r)	Likelihood Ratio Test Statistic	
	First Sub-Period	Second Sub-Period
0	66.8136*	58.3862*
1	36.1499*	28.3337
2	18.3477*	13.0236
3	2.6947	4.0128

Notes: * Significant at the 5% level.

Table 4: The Vector Error Correction Model for the First Sub-Period

Independent Variable	Dependent Variable			
	$\Delta \ln y_t$	$\Delta \ln S_t$	Δr_t	$\Delta \ln m_t$
Constant	0.0114** (3.3701)	0.0024 (0.2776)	-0.0085 (-0.2211)	0.0090** (5.4984)
$\Delta \ln y_{t-1}$	-0.4424** (-5.1795)	-0.1114 (-0.5135)	1.2445 (1.2767)	-0.0120 (-0.2898)
$\Delta \ln S_{t-1}$	-0.0792* (-2.1218)	0.0946 (0.9978)	-0.4712 (-1.1060)	0.0052 (0.2873)
Δr_{t-1}	0.0117 (1.5826)	-0.0090 (-0.4786)	0.0685 (0.8145)	-0.0026 (-0.7289)
$\Delta \ln m_{t-1}$	-0.0060 (-0.0326)	-0.2905 (-0.6182)	-2.7692 (-1.3115)	-0.0056 (-0.0625)
$e_{1,t-1}$	-0.2449** (-2.9405)	0.5441* (2.5731)	-1.1052 (-1.1631)	0.0851* (2.1168)
$e_{2,t-1}$	0.0368** (4.1102)	0.0289 (1.2727)	0.0387 (0.3785)	0.0021 (0.4950)
$e_{3,t-1}$	-0.0051* (-2.0359)	0.0115 (1.8079)	-0.1002** (-3.5040)	-0.0001 (-0.0778)

Notes: The numbers in parentheses are t-ratios. ** and * denote significance at the 1% and 5% levels, respectively. The error correction terms are:

$e_{1,t-1} = 3.5050 + \ln y_t - 0.7870 \ln m_t$
$e_{2,t-1} = 9.7671 + \ln S_t - 1.4426 \ln m_t$
$e_{3,t-1} = 17.0471 + r_t - 2.0858 \ln m_t$

Table 5: The Vector Error Correction Model for the Second Sub-Period

Independent Variable	Dependent Variable			
	$\Delta\ln y_t$	$\Delta\ln S_t$	Δr_t	$\Delta \ln m_t$
Constant	0.0116* (2.1232)	-0.0000 (-0.0012)	0.0293 (0.4429)	0.0049 (2.6966)
$\Delta\ln y_{t-1}$	-0.3527* (-2.0382)	-0.3084 (-0.7198)	-2.4648 (-1.1738)	-0.0306 (-0.5268)
$\Delta\ln S_{t-1}$	0.0100 (0.1759)	0.2951* (2.0996)	-1.0736 (-1.5583)	0.04160* (2.1813)
Δr_{t-1}	0.0279* (2.2070)	-0.0533 (-1.7018)	0.0533 (0.3472)	-0.0007 (-0.1750)
$\Delta\ln m_{t-1}$	-0.6942 (-1.3136)	2.7953* (2.1362)	3.7057 (0.5778)	-0.0961 (-0.5413)
e_{t-1}	-0.0471 (-1.1975)	0.4460** (4.5785)	-1.6207** (-3.3946)	0.0154 (1.1644)

Notes: The numbers in parentheses are t-ratios. ** and * denote significance at the 1% and 5% levels, respectively. The error correction term is

$$e_{t-1} = 20.7694 + \ln y_t - 0.8474 \ln S_t + 0.2739 r_t - 1.8905 \ln m_t$$

Since all the variables for the two sub-periods are cointegrated, the vector error correction model can be established. The estimated models are reported in Tables 4 and 5 for the first and second sub-periods, respectively. The results clearly show significant error correction terms for all the variables in the first sub-period. The most striking finding is that the growth in real economic activity adjusts to disequilibrium from all the three long-run relationships, while the other variables make adjustment to only a single source of disequilibrium. In the second sub-period, however, the real economic activity no longer responds to deviations from the long-run relationship. The error correction term is significant only in the case of stock price and real interest rate.

The F-test is conducted to examine adjustments to disequilibrium in the vector error correction models. The results in Table 6 show that all the variables adjust significantly to disequilibrium in the first sub-period compared to only two in the second sub-period. The significant adjustment in the second sub-period comes from the stock price and real interest rate. There is no evidence to show adjustments to disequilibrium in the case of industrial production or money stock after the implementation of selective capital controls.

Table 6: F-Test for Adjustments to Disequilibrium

Variable	p-value	
	First Sub-Period	Second Sub-Period
Real economic activity	0.0000	0.2400
Stock price	0.0140	0.0000
Real interest rate	0.0020	0.0020
Real money stock	0.0140	0.2530

The Granger causality test is performed to investigate the lead-lag relationship between the variables before and after the implementation of capital controls. The results are presented in Table 7. In the first sub-period, the real economic activity is Granger-caused by all the variables including its own lag. This suggests that the stock price and the monetary variables play an importance role in influencing the level of economic activity. However, in the second sub-period, the real economic activity is not Granger-caused by any of the other variables. It is only marginally (at 10 per cent level) led by the real interest rate.

In the first sub-period, the real interest rate is only Granger-caused by changes in real money balances. However, in the second sub-period, it is Granger-caused by all the other variables. The stock price is led by real economic activities and real money balances in the first sub-period, but is also led by the real interest rate in the second sub-period. Real money balances are not Granger-caused by any other variables in both the sub-periods.

Table 7: Granger Causality Test

Causal Variable	Dependent Variable			
	y_t	S_t	r_t	m_t
First Sub-Period				
y_t	33.377**	3.688*	1.003	2.617
S_t	8.668**	2.046	0.612	0.249
r_t	3.075*	1.688	6.275**	0.275
m_t	5.080**	2.867*	4.174**	2.791*
Second Sub-Period				
y_t	4.306*	11.051**	9.226**	0.683
S_t	0.782	11.491**	6.318**	2.734
r_t	2.682	10.693**	5.867**	0.683
m_t	1.234	10.868**	7.043**	1.089

Notes: F-statistics are reported in the table. ** and * denote significance at the 1% and 5% levels, respectively.

VI. DISCUSSIONS OF FINDINGS

All the variables adjust to restore equilibriums in the first sub-period, but only the real interest rate and stock prices make such adjustments in the second sub-period. This suggests that adjustment in the macroeconomic system mainly stems from the asset market, but not the real sector in the second sub-period.

Real money balances do not respond to disequilibrium since the adoption of selective capital controls regime. The active role in monetary policy seems to have been replaced by interest rate. This is an interesting observation that can be explained by using the IS-LM framework. Since September 1998, the ringgit is made inconvertible in the world currency market and at the same time it is pegged to the US dollar. Under the fixed exchange rate regime, money supply is not exogenous. Domestic money supply may change either as a result of a change in the volume of bank lending or as a result of a change in the foreign currency reserves or both. Since the monetary authority cannot directly control the change in the reserves, neither can the change in the domestic money stock be controlled. As a result, the money supply cannot be regarded as a policy instrument.

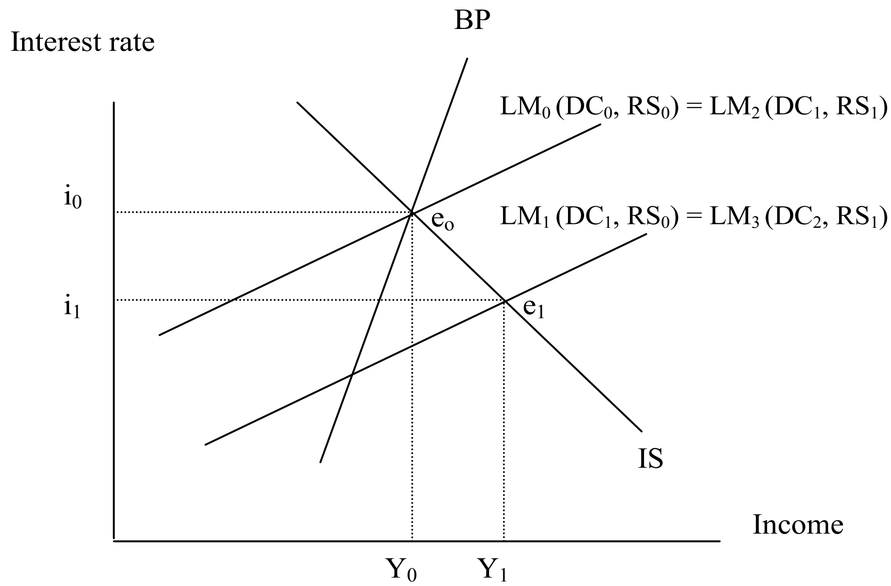
Money supply (M) is equal to the sum of the domestic credit (DC) generated by the banking system plus the country's reserves of gold and foreign currencies held at the central bank (RS). This can be stated as:

$$M = RS + DC$$

The effectiveness of the monetary policy under a fixed exchange rate regime can be analyzed using Figure 1. The BP schedule refers to a set of income and interest rate combinations that maintain a zero balance of payments. When capital mobility is low, this schedule is relatively steep.

A monetary expansion or more precisely, an expansion of domestic credit from DC_0 to DC_1 will increase total money supply. This pushes LM_0 to LM_1. The initial equilibrium point is at e_0.The new equilibrium point at e_1 is the result of an increase in the DC with an unchanged quantity of foreign reserves. Expansionary monetary policy causes a rise in real income. This leads to an increase in imports and a consequent trade deficit.

Figure 1
Expansionary Monetary Policy under Fixed Exchange Rate Regime



Although the fall in interest rate from i_0 to i_1 may worsen the capital account balance but the effect is relatively insignificant due to the control of capital movements. The overall balance of payments deficit and the excess supply of ringgit mean that the fixed exchange rate can only be preserved by running the reserves down. The outcome is a gradual reduction in the foreign currency of the monetary base. If the central bank does not sterilize the outflows of foreign exchange reserves, the assets will decline. To keep the exchange rate fixed, the central bank will sell the exchange reserves and the money stock starts to decrease until the original level before the monetary expansion is reached (LM_2). The only difference is in the composition of the money stock, with a lower fraction of foreign currency (RS_1 instead of RS_0) and a greater fraction of domestic credit (DC_1 instead of DC_0). In the new equilibrium condition, interest rate, real income and balance of payment return to the initial level.

Suppose the central bank conducts a policy of sterilization in order to prevent a change in the foreign exchange reserves from affecting the money stock by further expanding domestic credit (DC_1 to DC_2). The central bank has to add sufficient domestic assets, such as government bonds, to prevent the total assets from falling. This policy will induce the equilibrium point at e_1, with higher real income and lower interest rate. Nevertheless, the policy of continuous sterilization has drawn a great deal of debate. Each expansion of domestic credit will prolong the reserve loss and hence generate the need for further credit creation. The domestic credit component of the money stock will become larger and the reserves component become smaller. Furthermore, this will come to a stage where the foreign reserves are reduced to a critical level before exhaustion. As a result, the usefulness of sterilization is likely to be limited.

An additional observation that supports this evidence is that since September 1998, the real money balances are no longer Granger-caused by its own lags. This means that monetary targetting on the money stock is not pursued any longer. Real interest rate was not led by industrial production in the first sub-period, but the causal relation from industrial production to real interest rate is very strong after September 1998. The real interest rate now tracks behind the level of industrial production, revealing that interest rate has become an active monetary tool in the second sub-period for controlling the economic activity. On the contrary, the real money balances led industrial production in the first but not second sub-period. This suggests monetary targetting was used to affect economic activity before the fixed exchange rate regime.

The industrial production was led by real interest rate and money stock in the first sub-period but it only responds very weakly to movements in the real interest rate in the second sub-period. Thus, the monetary policy is a lot more effective in affecting the level of real economic activities before the implementation of capital controls and pegging of the ringgit.

There was a prolonged period of stock market boom (1993-97) in the first sub-period. Consequently, the existence of speculative bubbles or fads have caused the stock prices to be less influenced by the fundamental economic conditions. This is probably why the level of economic activities exerts a stronger influence on the stock price in the second sub-period than the first. The stock market fads have in fact caused the stock price to be unresponsive to real interest rate movements. Only the credit availability manifested through real money stock affects the stock price. In the second sub-period, the stock price behaviour is more in conformity to expectation where it depends strongly on the level of real economic activities, real interest rate and also real money balances. In addition, the stock price is found to lead the industrial production in the first sub-period but not the second sub-period. This shows that stock market is only a leading indicator for future real economic activity only when the stock market is performing well generally.

The presence of cointegration among stock prices and the other variables implies that the stock exchange is not informationally efficient with respect to industrial production, real interest rate and real money balances. Furthermore, the stock price is strongly led by all these variables in the second sub-period. Thus, it may be able to predict future stock prices by exploiting the long-run relationships with these variables.

VII. CONCLUSION

This study shows that stock prices, economic activities, real interest rates and real money balances are linked together in the long run using a simple theoretical model formulated based on the monetary approach. An analysis is performed based on two sub-periods, one before the implementation of capital controls and the other after this regime is adopted. Empirical results concurred with the underpinnings of model where cointegration is found among all these variables in both sub-periods. More long-run relationships exist in the first sub-period compared to the second sub-period. In the first sub-period, all the variables tend to adjust to disequilibrium, but only stock prices and real interest rate respond to disequilibrium in the second sub-period. This suggests that the source of adjustments to restore equilibrium is mainly from the asset market in the second sub-period.

The industrial production is led by stock prices, real interest rate and real money balances in the first sub-period. Meanwhile, there is no evidence for such a relation during the second sub-period. The lack of responsiveness to money stock is not surprising as this variable cannot be used as a monetary tool under a fixed exchange rate regime. Interest rate is the active monetary tool in the second sub-period. However, the lack of responsiveness to interest rate indicates that interest rate targetting alone may be limited in its effectiveness on the level of real economic activities. Management of the economy via monetary policy has become a more difficult task since the implementation of capital controls and pegging of the ringgit.

In the first sub-period, industrial production and real money balances tend to lead stock prices. Real money stock as the leading indicator of stock market may reflect the importance of money supply on credit availability. All variables tend to lead stock prices and real interest rate in the second sub-period. The impact of real economic activities is a lot stronger in this case. When the performance of the stock market was generally well, there seems to be considerable self-fulfilling bubbles rendering the level of economic activities less important in affecting the market performance and negating the impact of interest rate on the asset market. When the market is bullish in general, the stock price is a leading indicator of the real economic activities.

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