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EXCHANGE RATES, MONETARY AGGREGATES, INDUSTRIAL PRODUCTION AND SHOCK ADJUSTMENTS IN MALAYSIA AFTER THE CAPITAL CONTROL

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ABSTRACT

Malaysia imposed capital control and fixed exchange rate during 1999-2005 due to Asia financial crisis 1997/98. The capital control was liberalized and the pegged ringgit was lifted in July 2005. This study examines the dynamic relationship among macroeconomic stability and industrial performance in the post-capital control era with de-pegged regime. Macro variables such as industrial production (Y), exchange rate (RM/USD), monetary aggregates (M3) and interest rate (R) were being analyzed. The long- and short-run relationships were discovered among the variables at different signs and magnitudes. By VECM specification, the production function was bearing most of the short-run adjustments towards the long-run equilibrium but the adjustments were slow (> 6 years), in respond to shocks in the system. The impulse response function and variance decomposition analyses reveal that changes in macroeconomic variables have led to similar patterns of behavior with significant effects differing mainly in terms of shock adjustment. Dynamic causal effects were also being detected among the variables to justify the export led-growth strategy but the monetary effects were less prominent. In brief, monitoring the macro stability and foreign exchange shocks are essential in sustaining the industrial performance of Malaysia.

Keywords: Small and open economy (SOE); Macro stability; Industrial performance; Foreign exchange policy; Shock adjustments

1. INTRODUCTION

Assessment of industrial or economic performance and the contributory factors has been skyrocketed over the past decade globally. However, theories and empirical evidences are still far from getting consensus in the literature. Different findings are found in the past studies that diversity in culture, macro stability, trade openness and export strategy, central bank's monetary rules and foreign exchange policy, and the extent of financial integration, have played some important roles in the economic performance of one country (see Chan and Baharumshah, 2013;

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Chan, et al., 2014; Garcia and Gonzalez, 2014; Hooy, et al., 2015; Ghosh et al., 2016; Chan, 2017; among others).

Among all, the case of small and open economy (SOE) is of special interest but was less being investigated. Surviving in global competition is hard for SOE due to the small-scale economy and disadvantage in technology advancement that requires substantial capital investment. In that sense, export strategy and foreign exchange policy are important for SOE to compete with the large and developed nations such as the US, China, Japan and German, etc (Hooy, et al., 2015; Chan, 2017). But, trade openness and foreign exchange exposures are always risky for the SOE. For instance, currency depreciations may lead to imported inflation and financial instability, whereas exchange rate appreciations can prompt to an unpleasant loss of competitive edge in foreign markets, exposing minor exports and economic doings. There is also general worry that exchange rate appreciation can weaken economies' attraction to fresh foreign direct investment.

Malaysia appears as an interesting study case. The country had experienced various exchange rate regimes and financial crises in the past three decades but survived well in the wave of globalization and export competition. In Malaysia, the central bank has two fundamental monetary policy objectives – foreign exchange stability and low inflation. However, these two objectives can on occasion clash with each other (Amato, et al., 2005). The corresponding clash has regularly happened amongst developing economies but policymakers only pay attention to the objective of steady inflation. Exchange rate stability can clash with the objective of steady and low inflation on the off chance that either it prompts the improper situation of interest rate policy or the exchange rate straightforwardly handovers foreign currency in an inflationary or recession trend. On the off chance that the domestic exchange rate is steadiness, a solid currency may have threatened by recession, flattening, and weak currency. Conversely, with solidness in an efficient exchange rate regime, successions in the real exchange rates have a tendency to face lesser aggregate deflationary or inflationary constraints. In addition, Malaysia has been promoting export-led-growth policy with some extend of undervalued exchange rate in the past decades (Chan, et al., 2014). This may result in imported inflation when imports increase during the exchange rate depreciations.

Earlier studies on Malaysia have focused more on monetary variables (M1, M2, M3) to assess the dynamics of monetary policy and aggregate output. Simply, prior to the mid-1990s, the Malaysian authority was monetary oriented than interest- or inflation-targeting, in line with the financial liberalization since 1980s. Government first started focused targeting with M1 and shifted to focus on M3 when the financial liberalization and innovation has rendered M1 less reliable for policy targeting. Tan and Baharumshah (1999), for instance, revealed that M1 and M3 appear to have significant effect on output and prices using VECM but not in M2. This contradicts with Azali and Matthews (1996) who found evidences of causality between M2 and output in the post-liberalization period. Ooi and Bahmana (2011) tried to extend the study. Their findings settled with the classical economist that money is non-neutral and M2 is confirmed as an output indicator, but the influence of price changes is unclear. In addition, interest rate was found to be another important intermediate target in the monetary policy transmission mechanism. All in all, studies conducted had covered the pre- and post-liberalization and the Asia financial crisis periods, but no further details for the unpegged regime that correlated with the subprime crisis (2008/09), oil shock (since 2008) and recent exchange rate depreciation – more than 35% from 2014 to 2018.

Putting the paragraphs together, we find the need to reassess the macro stability and economic performance in Malaysia, with special focus given to the recent managed floating era, 2005-2018. Due to speculative attacks in the currency market during the Asia financial crisis 1997/98, Malaysia imposed capital control and fixed exchange rate from 1999 to 2005. Malaysian central bank unpegged the fixed regime in 21 July 2005, hours after China adjusted the Chinese yuan against US dollar. Malaysian central bank monitors the exchange rate against a currency basket (trade-weighted) to ensure that the ringgit remains close to its fair value by economic fundamentals. To capture the dynamic changes in the post-capital control regime, our analysis focuses on recent period of 2005M8-2018M8. In this study, a series of econometric tests have been employed to assess the interrelationship among the industrial production, interest rate, foreign exchange rate (RM/USD) and monetary aggregates (M3).

The rest of the paper is organized as follows: in Section 2, literature review is briefly discussed; Section 3 then elaborates the data and methodology; Section 4 reports the empirical results and finally in Section 5, we conclude.

2. LITERATURE REVIEW

A significant part of the collected works on SOEs' monetary policy has put attentions on the reaction of central banks against the exchange rate volatility. The confirmation acquired from practical reviews designates which numerous countries consist of exchange rate in their own policy response equation. Ball (1999), Svensson (2000), and Batini et al (2003) discover that comprising exchange rate slightly enhances the corresponded central banks' macroeconomic performance (Ball, 1999; Svensson, 2000; Batini, Harrison, & Millard, 2003).

Alphada et al. (2010), in addition, have fabricated New Keynesian DSGE model in SOE for South Africa alike SMS model. Their hypothesis included exchange rate data for forsaking presumption of comprehensive threat distributing among countries economy, and presenting a country possibility shock by takes consideration into the variances from revealed interest rate correspondence. SMS model accepts which the domestic interest rate is equivalent with the sum of a demand risk major shock and rate of policy of the two separate economies. SMS model defined as a no investment open economy, and their uncovered interest rate correspondence condition likens the predictable depreciation rate with each household in every country, as opposed to the variances of the interest rate established via particular central banks in the policy rates. This hypothesis is, to some degree prohibitive, due to the fact that it joins domestic and foreign demands shock with predicted depreciations. In consequence, the influence of demand shocks is reduced in the model (Alpanda, Kotzé, & Woglom, 2010).

Garcia and Gonzalez (2014), on the other hand, have concentrated on monetary policy reactions based on a delegate sampling from SOEs. These selected SOEs are export-oriented and practice inflation targeting. Their finding revealed that monetary policy in these SOEs responds similarly to those of closed economies to demand shocks, productivity shocks, and markup shocks. Nevertheless, Garcia and Gonzalez (2014) point out that these SOEs confront a bigger number of difficulties compared to closed economies in positions of policy creation as well as engagement. Ghosh et al. (2016), in addition, argued that inflation targeting is appropriate for open market that are shortage of other significance protection (for example, a formal peg). However, such policy is ought to be supported by reasonable foreign exchange rate intervention, particularly withstanding unpredictable capital flows. This type of intervention may appear inconsistent with the traditional way of thinking about inflation targeting.

In regards to advanced economies, Masson et al. (1997) found that Sweden, United Kingdom, and New Zealand that initially adopted interest rate targeting need a high elastic exchange rate to sustain inflation-targeting. But the highly elastic exchange rates may pressure on domestic prices through the foreign export sectors and imported inflation. This will weaken the integrity of interest rate targeting policy (Mishkin & Savastano, 2001). Foreign exchange rate intervention is not practical which neither desirable in general nor feasible. For the reason that exchange rate variations, price differentials and interest rate parity condition are to hold (Benes, et al., 2012), open markets have motives to address the appropriateness of monetary model macroeconomic policy collectively. None of these policies can stand alone to work effectively.

3. DATA AND METHODOLOGY

For analysis purpose, the present study relies on monthly data from 2005 August to 2018 August. These include exchange rate (E, RM/USD), interest rate (R, overnight interbank rate), Monetary aggregates (M3) and Industrial Production Index (IPI, 2015=100). Due to unavailability of monthly series for GDP, IPI is taken as proxy for economic performance (Y). All data are sourced from the Datastream, and crosschecked with the Department of Statistics Malaysia (DOSM) and Bank Negara Malaysia (BNM). The data are transformed into natural logarithm prior to the analysis. In addition, seasonal adjustment was also applied to IPI series using the census X-13 method built in the E-views software. The theoretical model is hypothesized in such way that Y is a function of interest rate, monetary aggregates and exchange rate.

$$Y = f(R_t, M_t, E_t) \tag{1}$$

where Y represents economic performance, R represents monthly interest rate, M represents monetary aggregates, and E represents exchange rate of Malaysian Ringgit against the US dollar.

3.1. Unit Root and Cointegration Tests

First, we rely on the ADF unit root test of stationarity to examine the data properties. The Modified Akaike Information Criteria (MAIC) proposed by Ng and Perron (2011) is used in the selection of optimal lags. Second, we compute the cointegration tests. Cointegration allows to incorporate both long-run expectations (corrections to equilibrium) and short-term dynamics (deviations from equilibrium). Standard regression analysis fails when dealing with non-stationary variables, leading to spurious regressions that suggest relationships even when there are none. Johansen-Juselius (1990) procedure is employed in this study to examine the multivariate (system-based) long-run relationship among economic variables within different models. Johansen-Juselius's methodology starts with vector autoregression (VAR) of order p given by

$$y_t = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t, \tag{2}$$

where, y_t = $nx1$ vector of variables that are integrated of order one I (1), ε_t = $nx1$ vector of innovations. VAR also can write as

$$\Delta y_t = \mu + \pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, y_{t-i} + \varepsilon_t, \tag{3}$$

where $\pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$.

When coefficient matrix, π has reduced rank $r < n$, nxr matrices α and β each exist with rank r. r = the number of co-integrating relationships, α = the adjustment parameters in the vector error correction model (VECM), β = co-integrating vector. Johansen proposes two tests statistics for cointegration, namely the trace test and maximum eigenvalue test, as shown below:

Trace test: $$J_{trace\,(r)} = -T \sum_{i=r+1}^{n} ln(1 - x_i) \tag{4}$$
Maximum eigenvalue test: $$J_{max\,(r,r+1)} = -T ln\,(1 - x_{r+1}) \tag{5}$$

where, T = the sample size, x = the i^{th} largest canonical correlation. The trace test tests the null hypothesis of the number of distinct co-integrating vector, r against a general alternative of n co-integrating vectors. The maximum eigenvalue test tests the null hypothesis of r co-integrating vectors against the alternative of r+1 co-integrating vectors (Johansen, 2000). Maximum eigenvalue test is more preferable since it gives results of exactly r co-integrating vectors. Critical values for both tests are tabulated by Osterwald-Lenum (1992) and the p-values are sourced from MacKinnon-Haug-Michelis (1999).

3.2. Granger Causality Test

Next, the study also aims to evaluate causal interrelationship (either unidirectional or bidirectional) between the macroeconomic variables. According to theory, if two or more time-series are co-integrated, Granger causality must exist in either one-way or in both directions between them but not apply for the converse. The identification of causal relationships is an essential part for understanding the consequences when moving from empirical findings to actions. Granger causality demonstrates the likelihood of causation or the lack of causation more forcefully than does simple contemporaneous correlation, which is same to causation in the classical philosophical sense (Geweke, 1984). Granger causality in its original formulation is a bivariate concept, based on the temporal ordering of two time series. The temporal causation is tested statistically, so that it does not necessarily imply true causality. In general, the bivariate regressions take the form:

$$y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, y_{t-i} + \sum_{i=1}^{n} \beta_i \, x_{t-i} + \varepsilon_t \tag{6}$$
$$x_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, x_{t-i} + \sum_{i=1}^{n} \beta_i \, y_{t-i} + \mu_t \tag{7}$$

where t denotes the time period dimension for all possible pairs of (x, y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis, when

$$\beta_1 = \beta_2 = \cdots = \beta_i = 0$$

for each equation (Granger, 1969). The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression.

3.3. Impulse Response Function (IRF)

Granger-causality does not have a complete overview about the interactions among the variables in a system. In macroeconomic modeling, Impulse response function (IRF) tracks the evolution of the variable of interest across a specified time horizon interact with exogenous impulse (shock) in a given moment which also affects other dependent variables in existing system via the dynamic structure (Enders, 2014). Impulse response function, y_i, with reflect by a shock in ε_j, where variable, i is response to shock, j at time horizon, t. IRF can be clearly interpreted with a vector moving average (VMA) in condition, y_t is covariance stationary. Formally, VMA can be represented by the following:

$$y_t = \mu + \varepsilon_t + \Xi_1 \varepsilon_{t-1} + \Xi_2 \varepsilon_{t-2} + \cdots \tag{8}$$
$$y_t = \sum_{i=0}^{\infty} \Xi_i \varepsilon_{t-i} + \mu \tag{9}$$

By using this VMA, the impulse response y_i with respect to a shock in ε_j can be expressed as

$$y_{t+n} = \sum_{i=0}^{\infty} \Xi_i \varepsilon_{t+n-i} \tag{10}$$
$$\{\Xi_n\}_{i,j} = \partial y_{i,t+n} \Big/ \partial \varepsilon_{j,t} \quad , \qquad \forall j \geq 0 \tag{11}$$

The equations are created through converting vector autoregressive (VAR) model into the vector moving average representation. It is an essential tool in empirical causal analysis and policy effectiveness analysis especially studying specific economic problems (Lütkepohl, 2008). However, IRF is interpreted by assumed all of the other shocks are constant. Thus, structural information must be used to specify meaningful shocks. The Cholesky decomposition is suggested in order to identify the underlying shock (Hatemi, 2014).

3.4. Variance Decompositions

One of the objectives for statistical analysis of multi-dimensional data sets is to determine whether there is any relationship exists among the dimensions. Variance decomposition splits up overall variation in a dependent variable into the component shocks in the system. Thus, variance decomposition delivers the relative significance facts for every random shocks which impact the variables. Cholesky uses the inverse of the Cholesky factor of the residual covariance matrix to orthogonalize the impulses. This imposes an ordering of the variables in the system and attributes all of the effect of any common component to the variable that comes first in the system. Cholesky decomposition, also named Cholesky factorization, is a decomposition of a Hermitian, which positive-definite matrix, $A \in L^{n\,x\,n}$ factored into the product of L, a unique lower triangular matrix with positive diagonal elements and its conjugate transpose L^T.

$$A = LL^T \tag{12}$$

where L is the Cholesky factor of A. Partition A and L as

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ a_{31} & a_{32} & \cdots & a_{3n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} = \begin{bmatrix} l_{11} & 0 & \cdots & 0 \\ l_{21} & l_{22} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ l_{n1} & l_{n2} & \cdots & l_{nn} \end{bmatrix} \begin{bmatrix} l_{11} & l_{21} & \cdots & l_{n1} \\ 0 & l_{22} & \cdots & l_{n2} \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & l_{nn} \end{bmatrix} \quad (13)$$

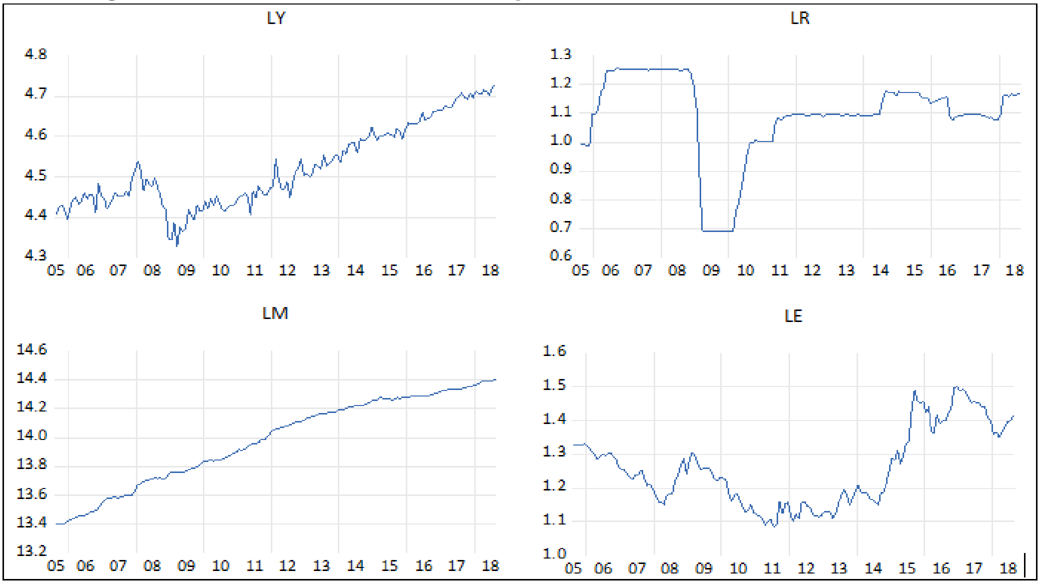
In short, Cholesky decomposition deconstructs any n x n positive definite covariance matrix into an n x n triangular matrix, post multiplied by its transpose.

4. EMPIRICAL FINDINGS

This study adopts a standard macro model to assess the economic performance in Malaysia in the post-capital control and de-pegged regime, during 2005M8-2018M08. The analysis includes industrial production index, exchange rates (RM/USD), monetary aggregates (M3) and overnight lending rates. Unlike earlier studies, the price variable was excluded from the analysis due to possible multicollinearity problem. A pre-test shows that prices were highly correlated with M3. Besides, M3 is being used in our analysis, instead of M1 and M2, because it offers a more accurate depiction of the actual size of a country's working money supply (Pospisil, 2017).

The recent trend and movement of the macroeconomic series are presented in Figure 1. Industrial production and monetary aggregates have generally shown an upward trend over the past 13 years. The industrial production indexes have been seasonal adjusted using the Census X-13 analysis. The X-13 removes seasonal patterns, such as weather fluctuations or holiday effects, from time series. It uses the X-13-ARIMA-SEATS program from the US Census Bureau, which is presently the most common method for seasonal adjustment. On the other hand, the exchange rate series have been fluctuating, while interest rates are quite stagnant. Overall, there have been market adjustments in 2008/09 due to the US subprime crash that end up with global financial crisis.

Figure 1: Industrial Production, Exchange rates, Interest rates and M3, 2005-2018



Source: Datastream, Bank Negara Malaysia.

Notes: LY = natural logarithm of industrial production index, LE = natural logarithm of RM/USD, LR = natural logarithm of average overnight lending rates, LM = natural logarithm of monetary aggregates (M3).

In Table 1, the data properties of the variables used for analysis are presented. Among the descriptive statistics, the mean, median, maximum and minimum values are shown to verify the consistency and reliability of the data. Based on the skewness and kurtosis measurements, all series are unlikely to be normally distributed, but is common for time series. For each variable, the sample size is n = 157, which is sufficient for time series analysis.

Table 1: Data Properties

	Descriptive Statistics								Unit Root Test: ADF t-stat			
	N	**Mean**	**Median**	**Max**	**Min**	**Std Dev**	**Skewness**	**Kurtosis**	**Level**	**Lag**	**1st Diff**	**lag**
LY	157	4.52	4.5	4.73	4.33	0.1	0.43	2.04	-0.16	2	-11.52*	1
LE	157	1.26	1.24	1.5	1.08	0.11	0.48	2.12	-0.93	0	-4.99*	6
LM	157	13.98	14.06	14.4	13.4	0.3	-0.37	1.82	-2.53	1	-6.80*	0
LR	157	1.09	1.1	1.26	0.69	0.15	-1.49	4.94	-2.56	2	-6.20*	2

Note: *MacKinnon (1996) one-sided p-values significant at 5% level.

The Augmented Dickey-Fuller (ADF) test is carried out to examine the data properties of all variables with individual intercept. The appropriate lag lengths are determined by the Akaike Information Criteria (AIC). Table 1 shows that at level, the null hypothesis of unit root fail to be rejected for all variables (LY, LE, LM, LR). This reveals that variables in the level stage contain unit roots and are non-stationary. However, after first-differencing, the variables depict stationary pattern. The null of unit root is being rejected at 5% significance level for all variables. In other word, all the four variables appear to be integrated of order one, I (1). This fulfills the requirement for co-integration test.

4.1. Cointegration Test and Long-Run Estimation

Next, we proceed with the Johansen and Juselius (1990) co-integration test results, as shown in Table 2. The trace- and max-eigen test statistics are reported at 58.5993 and 37.6639, which are higher than the respective 95% critical value (47.8561, 27.5843). Hence, the null hypothesis of none co-integrating vector is rejected for both tests. Statistically, there is at least 1 co-integrating vector at the lag length 2. This would suggest that four variables (LY, LE, LM, LR) share a common long-run and equilibrium relationship. The result at present stage is in line with earlier literature. Asari et al. (2011) and Saymeh and Orabi (2013), for instance, also established similar macro relationship among the variables.

Table 2: Cointegration Tests

Hypothesized	Test statistics		Critical Values	
No. of CE (s)	**Trace**	**Max-Eigen**	**Trace**	**Max-Eigen**
None *	58.5993	37.6639	47.8561	27.5843
At most 1	20.9354	11.9228	29.7971	21.1316
At most 2	9.0126	7.6259	15.4947	14.2646
At most 3	1.3867	1.3867	3.84147	3.8415

Notes: * denotes rejection of the hypothesis at the 0.05 level. Trace and Max-Eigen tests indicate one cointegrating relationship based on the MacKinnon-Haug-Michelis (1999) p-values.

The normalized cointegrating equation is originated by the use of the ratio of every cointegrating vector via the negative cointegrating vector of Y. The outcome demonstrates that null hypothesis of the related variables coefficient equal to zero is rejected, as indicated by the t-statistics reported in the parentheses. As a result, a significant long-run interrelationship exists amongst Y, E, M and R and the long-run estimation with respective coefficients are presented below:

$$\begin{array}{l} Y = 0.34 + 0.39E^{*} + 0.25M^{*} + 0.22R^{*} \\ \qquad\qquad\quad (9.69) \quad (16.81) \quad (7.06) \end{array}$$

The normalized co-integrating equation indicates that exchange rate (E) has a positive and significant long-run effect on the economic performance of Malaysia. The impact is larger (coefficient = 0.39) than that of monetary aggregate and interest rate. Given the way we code the exchange rate (E) as RM/USD, a positive (upward) movement implies depreciation of domestic ringgit whereas a negative (downward) movement implies appreciation of ringgit. An appreciation will destruct the growth of industrial production while a depreciation will boost the economy. The depreciation impacts the export-import ratio and improves the trade balance, which hence stimulates economic growth. The finding is in fact in line with Malaysia's global competition policy over the years as export promotion has been pushed through an undervalued foreign exchange against the USD. In such vein, the export-led-growth hypothesis is being supported.

Meanwhile, monetary aggregates and interest rate are also contributed significantly to industrial performance. To some extent, this implies that the monetary policy has been fruitful in the post-capital control period. Central bank uses money aggregates as a metric for how open-market operations – such as trading in Treasury bills or changing the discount rate (now overnight policy rate) – affect the economy and it worked by showing a positive sign of contribution to the industrial performance. The long run coefficient of 0.25 is moderate, which may suggest that financial stability and inflation were of major concerns in promoting growth strategy.

On the other hand, the log-run impact of interest rate (0.22) on the Malaysian industrial production is positive though minor. This contradicts the conventional wisdom that lower interest rates boost investment and hence stimulating the economy, whereas higher interest rates tighten the capital flows. The finding implication is not supported by literaure that investment risk portflio is reated closely to the interest rate offered (Montiel, 1996; Banerjee & Adhikary, 2009).

However, the positive link of interest-industrial growth has its support in the literature. According to Shaw (1973) and McKinnon (2010), interest rates are positively related to economic growth rates. When executes a ceiling on deposit, the financial constraints get up which relieve financial restrictions and allowing market powers control interest rates contribute to higher interest rates. The higher rates of return contribute to higher levels of savings, thus followed by stimulus economic growth and development in the long run. In addition, the present finding could also attributable to the policy respond on foreign investments and to defend Malaysian ringgit from further depreciation during the de-pegged regime. However, more comprehensive analysis in the next sections is needed before any conclusion can be drawn.

4.2. Vector Error Correction Model (VECM) and Causality

Error correction term (ECT) for the DLY equations in the VAR model is significant with negative signs (-0.131), as reported by Table 3. Though not reported here, the ECT for other equations (LE, LR, LM) are inconsistent in signs and significant level[1]. This would suggest that the LY bears most of the short-run adjustments towards the long-run equilibrium. About 1.3% of disequilibrium is 'corrected' each month by changes in the industrial production equation. A simple calculation would suggest that the adjustments are slow and will need 76 months (or, > 6 years) to complete, following a shock in the system.

Table 3: Vector Error Correction Model for DLY

	C	ECT(-1)	DLY(-1)	DLY(-2)	DLM(-1)	DLM(-2)	DLR(-1)	DLR(-2)	DLE(-1)	DLE(-2)
β	0.0030	-0.131*	-0.285*	-0.060	0.094	-0.098	0.057	-0.016	-0.080	-0.222*
t-stat	[1.246]	[-2.118]	[-3.064]	[-0.683]	[0.482]	[-0.485]	[0.860]	[-0.261]	[-1.040]	[-2.926]

Note**:** * denotes significant at 5% level.

In addition, the short run coefficients demonstrate that only the lagged DLY and DLE are significant. DLY has not responded significantly to the monetary variables like DLM and DLR in the short run. In other word, stability of the industrial production and exchange rates are of major policy concern in the short-run. The monetary mechanism has not effectively channeled to the industrial performance, and the finance-led growth theorem is not being supported in our analysis. However, one should be careful with the interpretation. Money in the form of capital, which brings product and further revenue, income, wages and taxes into the state budget has a completely

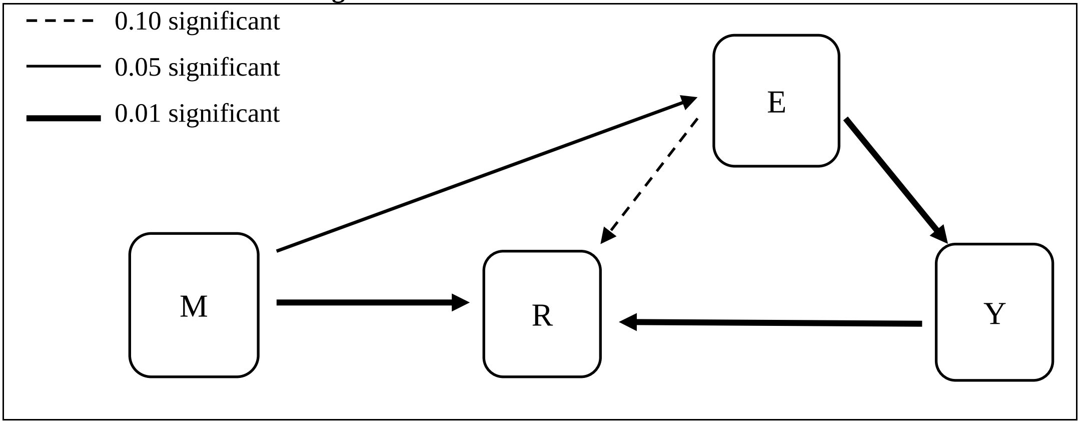
[1] Full results of VECM is available upon request from the author.

different function in monetary circulation than money in the form of money in circulation which only enables the exchange and consumption of the goods produced. Both are money of the aggregate but with completely different monetary functions and consequences (Pospisil, 2017).

Proofs of cointegration and error corrections amongst entirely macroeconomic variables have precluded the ‘spurious’ likelihood correlations as well as the Granger non-causality probability that consecutively point toward as a minimum a sole channel of Granger causality is present, which can be whether unidirectional or bidirectional. One can reject the null hypothesis at the 5% significance level. The cointegrating vector amongst two variables does not stipulate the causal relation direction. Economic concept promises where Granger Causality exists in at least one direction at all times. It verifies whether any endogenous variables included in the existing VAR model could be considered as exogenous in Granger sense.

Granger causality tests within the VECM are then been conducted and the results are summarized in Figure 2. At lag length 2, Exchange rate (E) has Granger-caused the interest rate (R) and industrial production (Y) at 10 % and 1% significance level respectively. On the other hand, unidirectional causal effect is also running from Y and M to R, at high significant level. In brief, central bank has been endogenously influenced by exchange rate and economic movements when setting the interest rates. And, the industry performance is largely influenced by the exchange rate movement for a SOE like Malaysia. However, there was an absence of direct causal effect between monetary aggregates and industrial performance. The monetary mechanism works indirectly through the exchange rate towards Y. Again, such finding does not support the finance-led growth theorem for Malaysia in the post-capital control and de-pegged regime. The causal results are consistent with finding in the short run VECM that monetary effects are less prominent in explaining the industrial performance.

Figure 2: Causal Effects within the VECM



4.3. Impulse Response Function (IRF)

Even though Granger Causality test indicates the causality relationship among variables, it doesn’t reveal either the signal of the relationship or how long these impacts would last. The IRF targets to visualize the response of a particular variable to shocks from system variables. If two variables are correlated over time and there is a stable relationship between them, it is expected that a shock in one variable spreads over to the other variable. This shock is called innovation or impulse. The IRF has the advantage of not depending on the order of the functions of the VAR model. These functions allow for observing the 'dynamic' response of a determinate variable in the face of shocks or unexpected changes in any other variable, as shown by Figure 3.

Figure 3: Impulse Responses

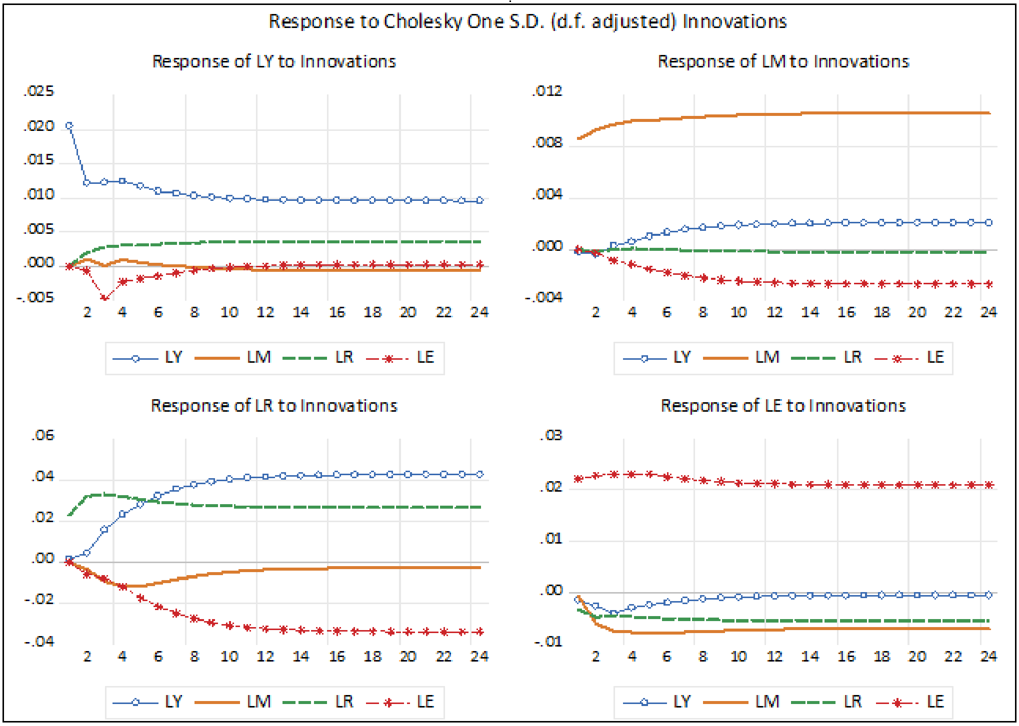


Figure 3 shows the behavior of the variables in the model to one standard deviation shock in industrial performance (LY), monetary aggregates (LM), interest rate (LR), and exchange rate (LE) respectively. An industrial shock had directly moved LY to a lower level and then stabilized after 8 months. The LY gave negative response to exchange rate (LE) and returns to its initial status no-monastically within a year. LY also responded positively to interest rates (LR) but weakly negative to monetary aggregate (LM). In addition, all variables responded weakly to monetary shock but greater to interest rate shock. On the other hand, all variables responded negatively to exchange rate shocks, whereas exchange rate responded negatively to all others excepts own innovations. In most of time, the responses decay and stabilize within a year.

4.4. Variance Decompositions

To complement the impulse-response analysis, variance decomposition is performed. Variance decomposition breakdowns variations of an endogenous variable into the component shocks to other endogenous variables in the VAR. The variance decomposition's outcome is to quantify the proportion of variance explained by a variable's own shock versus the variance explained by shock to the other variables in certain period.

Table 4: Variance Decomposition Analysis

Period	S.E.	LY	LE	LM	LR
			Variance Decomposition of LY		
1	0.02	**98.99**	0.20	0.73	0.07
4	0.03	**94.45**	2.96	0.23	2.36
8	0.04	**92.98**	2.33	0.18	4.52
12	0.04	**91.91**	1.79	0.17	6.14
24	0.06	**89.99**	1.09	0.25	8.66
			Variance Decomposition of LE		
1	0.02	0.35	**97.62**	0.06	1.97
4	0.05	1.38	**89.24**	6.26	3.12
8	0.07	0.94	**87.33**	8.03	3.70
12	0.08	0.68	**86.68**	8.48	4.17
24	0.11	0.37	**86.03**	8.79	4.81
			Variance Decomposition of LM		
1	0.01	0.04	0.00	**99.96**	0.00
4	0.02	0.18	0.62	**99.19**	0.01
8	0.03	1.07	2.16	**96.76**	0.01
12	0.04	1.79	3.29	**94.91**	0.01
24	0.05	2.62	4.62	**92.74**	0.02
			Variance Decomposition of LR		
1	0.02	0.49	0.00	0.00	**99.50**
4	0.07	16.26	4.76	4.63	**74.35**
8	0.12	34.73	15.41	3.77	**46.09**
12	0.17	41.30	21.51	2.31	**34.88**
24	0.27	46.21	27.01	1.05	**25.73**

The variance decomposition for the empirical model is presented in Table 4. In the analysis, majority of the variations in industrial production (LY) is explained by its own innovations as much as 98.9%. This strong contribution is reduced over the next 24 periods to about 89.9%, suggesting that industrial performance begins to react further parsimonious to shocks from other macroeconomic variables, but the process is slow. Influences originates from exchange rate (LE) are about 0.2%-1.09% and variances being explained by interest rate (LR) are about 0.07%-8.66%.

On the other hand, monetary aggregates (LM) makes dismal contribution of 0.73%-0.25% in explaining the variances of industrial production.

Likewise, exchange rates and monetary aggregates also exhibit similar pattern where most variances were being explained by own innovations. As for interest rates, the own contribution of innovations dropped drastically from 99.5% in the first period to 25.73% in the 24th period. Major influences came from LY and LE. The result is consistent with that of VECM that interest rates were endogenously determined.

5. CONCLUSION

Being a small and open economy, Malaysia has been liberal to global trade and foreign investment. However, capital control and fixed exchange rate were imposed during 1999-2005 owing to the Asia financial crisis 1997/98. This study examines the dynamic relationship among selected macroeconomic variables and industrial performance in the post-capital control era with de-pegged regime. A number of econometric analyses has been employed to gauge the long- and short-run of the relationship, causal effects and shock responses among the variables within a modeling system. The results have been robust and the findings are worth noting.

First, the empirical results have justified the export-led-growth strategy but have not supported the finance-led-growth theorem, which are both fundamental in the macroeconomic policy settings. Second, the monetary link with the industrial performance is somewhat weakly established which offers room for further investigation. Third, shocks adjustments are slow and the endogenous responses of macroeconomic variables within the modeling system cannot be fully justified. Fourth, policy makers are to be cautious about the impacts of external shocks via foreign exchange rates and interest rates. Undervaluing exchange rate to boost exports has been working but will not sustain without productivity growth and if imported inflation is on the rise. A continuous monitor of external shocks and foreign exchange stability is essential to achieve sustainable development.

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