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ALTERNATIVE APPROACH TO DETERMINATION OF MALAYSIAN ECONOMIC BEHAVIOUR

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Abstract

This study documents significant findings on the determination of Malaysian economic behaviour in relation to its close trading partners. The data series for this study were from Malaysia, the USA, and China, over a 25-year period. The test procedure incorporated a fully specified Auto Regressive Distributed Lag (ARDL) model with optimum lags being identified from high R-Squared value and the absence of serial correlation. The gross domestic product and industrial production indices were accounted for to re-examine a macroeconomic modelling approach to determination of the Malaysian economy. The results affirmed evidence of significant explanatory role of American and Chinese lagged GDP and IPI in determining the Malaysian economy. Our test results further identified a significant long-run interdependence between Malaysian economy and its major trading partners. In our view, these findings, given the appropriate econometric methodology, suggested significant policy implications concerning the timing and accuracy of risk management practices in preventing economic crisis to occur in Malaysia.

Keywords: Economic Behaviour, Structural Breaks, ARDL, Cointegration, Error Correction Mechanism
JEL Classification: N15, E17, O11, C40

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1. Introduction

Being recognised as the third largest economy in South East Asia, Malaysia has gone through several stages of structural changes, witnessing recessions, crises, resilience, rapid growth, and development, ever since its independence from the United Kingdom in 1957. The country is now classified as an upper-middle-income country by the World Bank with per capita income of US $10760 as of 2014 year-end, and an average annual growth of 7% over and above Thailand and Indonesia. Nevertheless, the economy has been highly dependent on favourable external terms of trade to stimulate its growth. This study investigated the Malaysian economic behaviour triggered from its interdependency on its major trading partners, specifically the USA and China, over a 25-year period from 1990 to 2014.

The strand of literature on economic forecasting suggested development of several sophisticated econometric techniques, including survey forecasts and reduced-form equations for an appropriate theory-based economic behaviour modelling and determination, as the mainstream practices applied in practical policy decision making by several policy institutions and banks around the world. However, there is not a unanimous clue as to whether these forecasting techniques are opportune or promising. It is further noted that imposing simple theory-based cointegrating restriction can lead to more reliable outputs when dealing with long-forecast horizons(Giacomini, 2014). Hence this study applied a simple modelling approach using an appropriate and robust econometric methodology to revisit the issue of Malaysian economic forecasting concerning its relationship with its trading partners.

As a pre-estimation, this study implemented a test on structural break of the Malaysian GDP and IPI. A review of behaviour of the series revealed the fact that there is evidence of multiple significant changes or breakpoints being identified from a recent test developed by Bai and Perron (2003). This study further implemented an ARDL bound test of Pesaran, Shin, and Smith (2001) to reexamine the effect of gross domestic products (GDP) and industrial production index (IPI) as two fundamental variables representing Malaysian economic growth, earnings, and income. The aim was to establish a simple, parsimonious modeling technique with all the timeseries properties being fulfilled and verified. New findings were reported pertaining to high dependency of the Malaysian economy on its trading partners, with its behavior being determined within a year-prior-impact. Also identified was new evidence of a long-run relationship between Malaysian economic factors and those of its trading partners. This would suggest crucial implications corroborating to the prediction of the Malaysian economic behaviour within a year ahead of its occurrence from the information obtained on economic factors of its closely linked trading partners. The test procedure applied in this study incorporated a fully specified model with optimum lags - after performing a large number of iterations of regression equations to be verified from high R-Squared statistics and the absence of serial correlation. To the best of our knowledge, this is by far the most precise estimation method for identification of appropriate lag parameters of the explanatory variables.

In the remainder of this paper, in Section 2, a brief review of the literature on this topic is presented, before describing the hypothesis and model development in Section 3. Findings are presented and discussed in Section 4 and the conclusion is in Section 5.

2. Literature Review

Numerous studies investigated evidence of macroeconomic and business cycle interdependency and/or co-movements of trading partners. This strand of literature suggested significant implications arising from cross-country correlation analyses using parsimonious principles of variable and model specifications. In other words, many scholars found that inclusion of additional explanatory variables in a model is found to have no marginal effect on the estimation output (Blonigen, Piger, & Sly, 2014). The very preliminary study of such type was conducted by Frankel and Rose (1998) to demonstrate a significant strong correlation among trading partners being determined solely from their real GDP behaviour. Similarly, Clark and Van Wincoop (2001) documented evidence of significant correlations between US regions. A rather contrary relationship was found to hold true among European nations, as in Bayoumi and Eichengreen (1993), and Fatás (1997). Such mixed findings are partly associated with different methodological applications. The so-called univariate and multivariate approaches for economic determination are applied very commonly. In spite of several sophisticated statistical and econometric applications to economic forecasting, the simple univariate and bivariate approaches are found to be often more reliable benchmarks, against which to assess the performance of those multivariate models (Stock, 2001). There are also several studies examining the degree of interdependence of financial markets and trade sectors of different countries. Yang, Cai, Zhang, and Hamori (2016) documented evidence of significant interdependence between exchange rate markets of European zone and a rather modest contagion between Japanese Yen and British Pound, especially during the crisis times. Similarly, a recent study by Shahzad, Kumar, Ali, and Ameer (2016) reported new findings on the interdependence of Greek stock market with that of European zone. Daniel, Surugiu, and Surugiu (2015) elaborated on the effect of international trade activities in transport and ICT sectors on development and growth of economies that are substantially interdependent on each other.

The very first version of univariate modelling is known as the exponential weighted moving average (EWMA) method, which uses a parameter $\alpha\alpha$ determined by the forecaster or estimated by nonlinear least squares using historical data (Stock & Watson, 2001). The model however is not very accurate or reliable, given its broad range of applications in practice. The auto-regressive moving average (ARMA) model however represents more accuracy and reliability in presence of serially uncorrelated residuals and imposition of lag polynomials of orders p and q for a univariate regression equation, as:

$$y_t = \varphi_1 y_{t-1} + \varphi_1 y_{t-2} + \cdots + \varphi_p y_{t-p} + u_t + \vartheta_1 u_{t-1} + \vartheta_2 u_{t-2} + \cdots + \vartheta_q u_{t-q} \quad (1)$$

or

$$y_t = \sum \varphi_i y_{t-i} + u_t + \sum \vartheta_j u_{t-j}$$

where y_t is determined by (i) its own values y_{t-i} in the preceding period and φ_i is restricted to be stationary, provided $|\varphi| < 1$, and (ii) the value of the immediate past error u_{t-j} is subject to an invertible process, provided $|\vartheta| < 1$. Hence, an important condition for ARMA to be met is stationarity of time series which is not the case in most economic time series. Another deficiency of ARMA is biased estimation in presence of large roots of moving average processes (Davis & Dunsmuir, 1996; Stock, 1994). A study by Meese and Geweke (1984) found that the special cases of ARMA using purely autoregressive models with lag orders p (*AR(p)*) are more accurate, when optimum lags are identified by information criteria (e.g., AIC and BIC). It is therefore suggested that using OLS with distributed lags would result in more consistent outputs from what is obtained when testing ARMA models. The question to an appropriate lag specification leading to a fully-specified regression equation however is still unsolved; we tend to solve this issue using latest econometric techniques. Other (notably univariate) forecasting approaches use models to be estimated on a nonlinear basis, with relatively substantial estimation errors and technical problems, although extensively developed over time. Examples are smooth transition auto-regressions (STAR) by Teräsvirta (1994), and artificial neural networks (NN) by McCulloch and Pitts (1943), which are widely applied to economic time series. The fundamentals of these two methods are identical with the linear autoregressive approach, in which inputs are lagged values to estimate future values as outputs. However, STAR uses a nonlinear function of past data that switches between lag polynomial regimes, and NN uses an index model formulation with nonlinear transformation. Further explanation about these approaches can be found in Granger and Terasvirta (1993), and Swanson and White (1997), respectively.

The literature on economic time-series forecasting is also extended to include multivariate approaches likely to improve forecasting precision. There are four broad categories to multivariate forecasting, namely structural econometric models, small linear time-series models, small nonlinear time-series models, and forecasts based on leading economic indicators. The structural econometric models generally rely on estimation of a large number of simultaneous equations known as a system with large numbers of factors being identified on the basis of economic theory. This approach is found to have poor out-of-sample performance. The small linear time-series models however are found to be more precise. Early versions of such models are known as vector auto-regressions (VARs) proposed by Sims (1980), as follows:

$$Y_t = \mu_t + A(L)Y_{t-1} + \epsilon_t \quad (3)$$

where Y_t represents $n \times 1$ vector time series, ϵ_t is a $n \times 1$ is a serially uncorrelated disturbance term, *A(L)* is a p-th order lag polynomial matrix, and μ_t denotes a $n \times 1$ vector of deterministic terms. Using VAR method, the parameters can be estimated efficiently subject to presence of no parameter restrictions. It is important to note that the selection of series to be included in Y_t and the choice of lag order *p* play a very crucial role to satisfy the preliminary conditions to appropriate forecasting. Likewise the univariate methods, the choice of lag orders can be achieved using information criteria. There has been a wide array of applications of VARs in empirical economic and finance literature. Examples are studies by Bates and Granger (1969), Granger and Newbold (2014), Stock and Watson (2004), Clark and McCracken (2005), and Smith and Wallis (2009). Nevertheless, there still exist some limitations in the VAR approach pertaining to distortions in impulse responses resulting from the effects of omitted variables and measurement errors, or misspecifications being embedded in the residuals, leading to misinterpretation of the results. Furthermore, the VAR models are a-theoretic, that is they are not based on any economic theory, given there is no restrictions on any of the parameters under estimation.

A very important issue related to the poor performance of VAR and other stated equivalent models is anchored in formal misspecifications such as spurious relationship between variables, resulting from the *so-called* non-stationary processes, as in Clements and Hendry (1998). Accordingly, the issue of variable stationarity and cointegration analysis has been extensively investigated since early 1980s by many scholars including Granger (1981), Granger and Weiss (1983), Granger (1986), Engle and Granger (1987), Johansen (1988), Johansen, Douglas, and Nonaka (1985), Banerjee, Dolado, and Mestre (1998), and Harris, McInish, Shoesmith, and Wood (1995). Given the non-stationary property of most economic time series as can be verified from their stochastic trend behaviour, investigation of a genuine long-run relationship in their trended behaviour plays a significant role. This approach calls for determination of the validity of the cointegrating series by investigating the order of integration of variables, which by definition should be similar. In other words, one may assume an equilibrium long-run relationship to exist between variables if the variables are integrated of the same order. There are numbers of possible alternatives on cointegration testing. Broadly speaking, Engle and Granger (1987) developed an OLS framework to estimate the static version of cointegration model (SOLS). Another approach was proposed by Johansen (1988) in which the necessary information on the cointegrating property of variables will be provided while estimating the long-run relationship. As a pre-condition, all variables must be integrated of order 1 (i.e., I(1)) to be estimated in the model.Alternatively, the *so-called* Autoregressive distributed lag (ARDL) bound testing by Pesaran, Shin, and Smith (1999), and Pesaran et al. (2001) employs a single equation setup wherein a combination of I(0) and I(1) series can be taken into consideration.

Furthermore, different variables can be assigned different lag-lengths as they enter into the model. An ARDL (p, q) regression model takes the following form:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \cdots + \beta_k y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \cdots + \alpha_q x_{t-q} + \varepsilon_t \quad (4)$$

where ε_t is a random "disturbance" term. The model follows an auto regressive representation where y_t is explained by lagged values of itself and employs distributed successive lags of the x_t explanatory variable. Using this approach, the time series properties concerning serial correlation of residuals and dynamic stability of the model will be controlled. The presence of significant long-run relationship between variables can be verified using the *so-called* bound testing approach. Hence the model is more appropriate than conventional cointegration techniques. The ARDL has been extensively used in empirical economics and finance literature by many scholars, reasons being more applicability and flexibility of test modelling for economic time-series forecasting. Examples are studies by Narayan (2005), Duasa (2007), Rapach and Strauss (2010), and Barhoumi, Darné, Ferrara, and Pluyaud (2012). In the next section, the data and methodology applied in this study are discussed.

3. Research Design, Data, And Methodology

This research was designed to investigate whether the Malaysian economic behaviour is dependent on that of its major trade partners. The data series on variables (Gross Domestic Product and Industrial Production) were from Malaysia, China, and the US, where a long period quarterly data series over 1991-2014 were employed. The major sources of data were from: *The International Financial Statistics* (IFS) CD-ROM, and *Thomson Reuters DataStream*. "What determines the Malaysian time-series economic behaviour" was the research question. Two test models were developed specifying Malaysian GDP and IPI as dependent variables, with distributed lag structure of GDP and IPI from China and the US being the independent variables within bivariate and multivariate regression equations, respectively.

It is believed that this approach has yielded new insights on how (i) the Malaysian economic behaviour can be determined concerning its (ii) interdependence on major trading partners' past economic behaviour in an attempt to (iii) introduce an alternative and reliable approach to Malaysian economic forecasting.

3.1 Methodology and Modelling

As a pre-estimation, this study applied Bai and Perron (2003) tests to investigate structural changes by identifying parameter instability locations in Malaysian quarterly GDP and IPI data set over 1991-2014, which is a long time series. The test constitutes an efficient algorithm based on dynamic programming method to obtain global minimisers of the sum of squared residuals in a simple regression test model under a very general framework that allows for both pure and partial structural changes. By imposing a common structure, the test controls for different serial correlations, data distributions, and the errors across segments. The data series were quarter-end observations on each currency: Eviews 9 was used. The analysis was conducted to identify multiple breakpoints in the Malaysian economic time series. The aim was to show statistical support on significant breakpoints associated with the fluctuating behaviour of Malaysian economy. The estimation procedure for identification of structural breaks was based on a simple regression equation under a least square specification; with the Malaysian GDP and IPI playing the role of dependent variable regressed against a single (constant) regressor. The modelling therefore can be represented as:

$$MYGDP_t = constant + \varepsilon_t \tag{5}$$

$$MYIP_t = constant + \varepsilon_t \tag{6}$$

In order to allow for serial correlation in the errors, a quadratic spectral kernel was specified based on HAC covariance estimation with the use of pre-whitened residuals, whereby the kernel bandwidth was determined using the Andrews AR(1) method. In examining multiple breakpoint tests, three different methods were considered. As *a priori* requirement for all three methods, the distributions of errors were allowed to differ across breaks which in turn satisfied the heterogeneity of errors. The default method for investigation of multiple structural changes as outlined in the studies of Bai (1997) and Bai and Perron (1998), is known as sequential testing of $l + 1$ versus l breaks. At the second stage, the global Bai-Perron break method was applied, which was meant to examine the alternative hypothesis of l globally optimised breaks (as two lines above) against the null of no structural breaks, along with the corresponding *UDmax* and *WDmax* tests, which were interpreted later on in discussing the findings. Finally, at the third stage, the method of global information criteria was applied, which did not require computation of coefficient covariance as compared to previous two methods of break selection criteria.This study applied the global information criteria to estimate breakpoints using global minimisers of the sum of squared residuals. The LWZ criteria were chosen as a selection criterion for optimum number of breaks after initial testing. The selection of optimum number of breaks was based on three different selection criteria, namely sequential, Bayesian Information Criterion (BIC), and a modified Schwarz Criterion (LWZ). According to Bai and Perron (2003), LWZ performs better compared to the other two criteria under the no-break null hypothesis.

The discussion of the procedure indicates that it is feasible to adopt this as a pre-screening procedure in the on-going research on monetary theory testing, as in Ariff and Zarei (2016). Results pertaining to structural break test reported in the next section. Additionally, in order to ascertain the presence of a long-run relationship (cointegration), a bound test was conducted. Using this approach, the simultaneous modelling of long-run and short-run dynamics in a conditional ARDL-ECM framework can be examined. This study used the critical values proposed by Pesaran *et al.* (2001) by comparing the calculated F-statistics from the pre-determined lower and upper bound measures to verify the cointegrating relationship between variables. Finding the two series to be cointegrated in the long-run would indicate that there is error-correction (ECM) and convergence of the series in the long-run. The ECM estimate would therefore indicate the long-run dependence of the two series. Consistent with the discussions provided in Section 2, the modelling approach is based on a single equation with distributed optimum lagged variables identified using selection criteria. The following ARDL equations were used to test the basic relationship among the variables.

$$\begin{aligned} MYGDP_t = \beta_0 + \beta_1 MYGDP_{t-1} + \cdots + \beta_p MYGDP_{t-p} \\ + \alpha_0 USGDP_t + \alpha_1 USGDP_{t-1} \\ + \alpha_2 USGDP_{t-2} + \cdots + \alpha_q USGDP_{t-q} \\ + \theta_0 CHGDP_t + \theta_1 CHGDP_{t-1} + \theta_2 CHGDP_{t-2} \\ + \theta_r CHGDP_{t-r} + \varepsilon_t \end{aligned} \tag{7}$$

$$\begin{aligned} MYIP_t = \beta_0 + \beta_1 MYIP_{t-1} + \cdots + \beta_p MYIP_{t-p} + \alpha_0 USIP_t \\ + \alpha_1 USIP_{t-1} + \theta_2 USIP_{t-2} + \cdots \\ + \alpha_q USIP_{t-q} + \theta_0 CHIP_t + \theta_1 CHIP_{t-1} \\ + \theta_2 CHIP_{t-2} \ldots + \alpha_r CHIP_{t-r} + \varepsilon_t \end{aligned} \tag{8}$$

wherere *MYGDP* presents the Malaysian *GDP*, *USGDP* denotes the US GDP, and *CHGDP* is the Chinese GDP. Likewise, *MYIP, USIP* and *CHIP* are proxies for Malaysian, the US, and Chinese Industrial productions, respectively. This paper also reports results on bivariate regression equations having Malaysian GDP and IPI regressed on those of the US and China, separately.

4. Findings

The central research question was: What determines the behaviour of Malaysian economic time-series? To examine the normality assumption of data, a summary of descriptive statistics is provided in Table 1. The data used for this analysis were over the whole sample period. The variables were transformed into natural logarithmic form.

Table 1: Descriptive Statistics on Macroeconomic series of Four Countries

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Observations
MYGDP	25.342	25.321	0.616	-0.115	1.887	93
USGDP	30.014	30.033	0.314	-0.286	1.791	93
CHGDP	10.260	10.243	0.985	-0.230	2.257	93
MYIPI	4.315	4.398	0.362	-0.703	2.263	93
USIPI	4.537	4.595	0.154	-0.918	2.541	93
CHIPI	4.730	4.732	0.039	-0.949	6.191	93

The measure of dispersion, standard deviation in GDP for China is larger than other relevant metrics in view of high economic fluctuations in China, whereas the Chinese industrial production is the least fluctuating series. The statistics on skewedness and kurtosis fulfil the assumption of normal distribution of data. In order to confirm the order of integration of the time series, this study conducted two unit root tests using the augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979, 1981), and the Phillips and Perron (1988) (PP) tests. The ADF model can be very useful in identifying higher order serial correlations in conjunction with higher order lags. The PP test allows for relatively weak assumptions regarding the distribution of residuals in the equation. The results reported in Table 2 suggest that most of the series are integrated of order one and the degree of integration of all of the series are not identical. Examining the results in Panel B, it was observed that all tests showed stationarity of the series. The levels data were not stationary or at best, this findings were mixed. Hence these series, to be used for ARDL, satisfies the necessary condition for reliable test results, given that all series are integrated at order zero or one.

Table 2 reports the statistics on stationarity of data series. The statistics suggested that most of the data were stationary at first difference, which were judged by the respective ADF and PP tests of unit root.

4.1 Findings from Structural Breakpoint Test

A time-series analysis regarding multiple structural breakpoints is first described so as to facilitate the interpretation of results presented in this section. Results for each economic series using quarterly observations are reported in Table 3, which reports test statistics along with the associated break dates.

Table 2: Results on data transformation (Unit-root tests)

	Augmented Dickey Fuller (ADF)		Phillips Perron (PP)	
Panel A	Level			
Variables	Constant Without Trend	Constant With Trend	Constant Without Trend	Constant With Trend
MYGDP	-1.27 (9)	-2.54 (5)	-3.09** [91]	-3.36 [10]
USGDP	-2.36 (1)	-0.19 (1)	-3.06** [5]	-1.19 [5]
CHGDP	-1.81 (5)	-3.49** (5)	-1.98 (14)	-6.02 (3)
MYIPI	-3.16** (6)	-1.31 (6)	-3.20** [10]	-1.50 [8]
USIPI	-1.77 (2)	-1.90 (2)	-1.99 [5]	-1.69 [5]
CHIPI	-5.19*** (0)	-5.17*** (0)	-5.23*** [3]	-5.19*** [3]
Panel B	First Difference			
MYGDP	-4.24*** (8)	-4.39*** (14)	-10.50*** [47]	-12.31*** [39]
USGDP	-3.88*** (1)	-7.39*** (0)	-7.00*** [7]	-7.55*** [3]
CHGDP	-5.27***(5)	-3.50** (4)	-22.73*** [16]	-26.78*** [15]
MYIPI	-4.75*** (5)	-5.72*** (5)	-8.30*** [9]	-9.56*** [14]
USIPI	-4.26*** (1)	-4.35*** (1)	-3.48** [0]	-3.56** [0]
CHIPI	-11.52*** (0)	-11.60*** (0)	-12.22*** [6]	-12.43*** [6]

Note: *** and ** denotes significant at 1%, and 5% significance level, respectively. The figure in parenthesis (…) represents optimum lag length selected based on Akaike Info Criterion. The figure in bracket […] represents the Bandwidth used in the KPSS test selected based on Newey-West Bandwidth criterion.

Table 3: Multiple Structural Break Points

	$\hat{\delta}_1$	$\hat{\delta}_2$	$\hat{\delta}_3$	$\hat{\delta}_4$	$\hat{\delta}_5$	$\hat{T}_1$	$\hat{T}_2$	$\hat{T}_3$	$\hat{T}_4$	$\hat{T}_5$
MYGDP	24.38 (0.12)	24.88 (0.08)	25.25 (0.09)	25.65 (0.09)	25.95 (0.04)	Q2 1993	Q2 1998	Q1 2003	Q2 2006	Q3 2009
MYIPI	3.66 (0.08)	4.06 (0.06)	4.35 (0.04)	-	-	Q2 1993	Q2 1998	Q3 2002	-	-

The test applied three break-selection criteria to identify optimum number of breaks. The final choice was made based on the LWZ criteria by Liu, Wu, and Zidek (1997), which is robust to serial correlation problems, and the test performed relatively well. The statistics revealed that there is evidence of three structural breaks in the Malaysian economic series which are in line with several up-turns ever since 1990, given that the coefficients reported are all positive (the up-turn behaviour of GDP and IPI can also be verified from Figures 1 and 2). Although the Malaysian economy witnessed a negative average nominal GDP growth rate of minus 11% as of 1985-1986 due to the collapse of commodity prices leading to the country's recession since its independence, the country has been growing steadily and substantially at the rate of 8% on average, in line with its extensive foreign and domestic investment and manufactured goods export activities. The first break date (1993Q2) reported in Table 3 was associated with the introduction of a number of significant tariff and fiscal policy changes that took effect immediately leading to the growth of the economy. In mid-1997 the Asian Financial crisis led to severe deteriorations in the performance of Malaysian financial markets, leading to a decline in GDP growth rate of minus 9% until the second quarter of 1998, mainly due to substantial credit squeeze and mounting debts in the corporate sector. However, after the second quarter of 1998, the GDP and IPI began growing in line with the introduction of exchange control measures, as of September 1998.

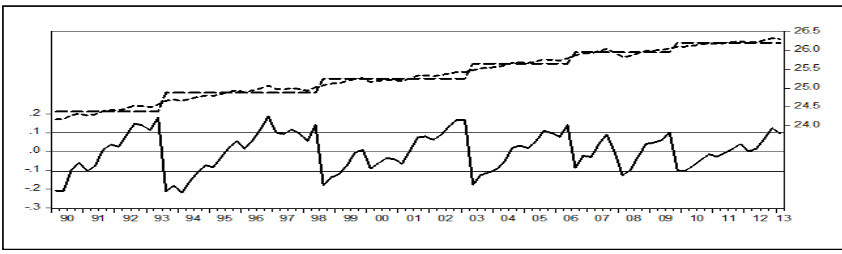

Figure 1: Structural Breakpoints in Malaysian GDP (1990-2014)

In 2002, the Malaysian economy strengthened its GDP growth by 4.2%, due to strong domestic demand and improved export performance. Furthermore, the low interest rate policy stimulated higher access to financing and significant improvement in commodity prices leading to a considerable growth in the private sector. The Malaysian economic performance also grew in 2006 with its nominal domestic product expanding by 6% in line with the positive global economic environment that led to a strong demand for electronics and primary commodities, triggering private consumption growth and private investment expansion to meet these demands. Following the advent of global financial crisis in 2007-08, in the first half of 2009, the global economy experienced a sharp contraction leading to the credit crunch in the private sectors, low household consumption, declining employment rate, production cut by mainstream businesses, and the associated collapse of world trade. Accordingly, the Malaysian economy faced an economic downturn with its GDP declining by 6.2% in the first half of the year, while experiencing an accelerated recovery in the second half due to the implementation of fiscal stimulus measures, aggressive easing of monetary policy, and continued access to financing, there by leading to a revival of the private sector sentiment and improvement of labour market conditions and the resulting expanded private consumption. In view of such fluctuations in the Malaysian economy (as is evident from Figures 1 and 2), the question of its economic interdependency on its major trading partners needs some detailed investigation and testing to verify an alternative approach for the determination of Malaysian economy.

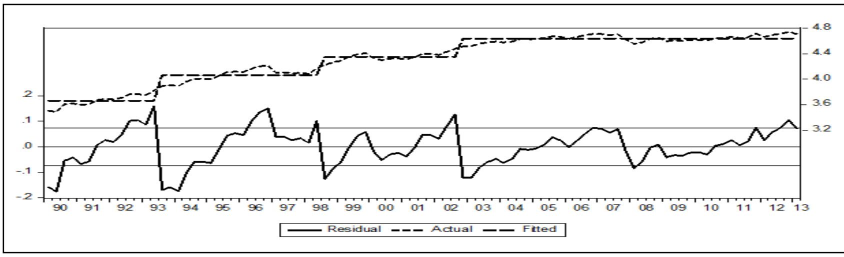

Figure 2: Structural Breakpoints in Malaysian IPI (1990-2014)

Hence, there is a need to develop a model that could establish linkages between the Malaysian economy and those of its trading partners. In the next section, this paper reports and discusses the findings associated with the determination of Malaysian economy arising from its relationship with its trading partners, particularly USA and China.

4.2 Findings from the ARDL test results

This section presents and discusses the results associated with the ARDL test. Table 4 reports statistics on the ARDL test from the regression Equation 7 on pair-sampled-country equations; having the Malaysian GDP regressed on the US and Chinese GDP, separately, as in the first and second columns and on both countries' GDP series, as in the third column. The empirical results were based on the reparameterisation of different estimated ARDL models reported in the upper panel of the table. The test procedure applied a large number of model iterations (72 and 648) to produce fully specific models with lagged parameters being identified appropriately in presence of no serial correlation problem. The results affirmed evidence of a significant contemporaneous and lagged impact of the US GDP on Malaysian GDP at four quarters or a year ahead from the actual Malaysian GDP growth. Similarly, the Chinese GDP determined the behaviour of Malaysian GDP contemporaneously and a year ahead, when taken into consideration jointly with the US GDP. However, the information on the Chinese GDP in isolation can only have a contemporaneous impact on the Malaysian GDP, with coefficient size being very negligible (0.045) and significant at 10%. Results from Table 5 is also evident of the fact that Malaysian IPI was determined mainly by the US contemporaneous and one-quarter lagged IPI, when taken in isolation and jointly with the Chinese IPI.

The Chinese IPI however was found to have no impact on the Malaysian IPI, even when estimated jointly with the US IPI. Hence, the role of China in determination of the Malaysian IPI as a proxy for earnings and income was not significant. The contemporaneous impact of the US IPI on that of Malaysia was positive while the one-quarter lagged impact was negative with relatively lower magnitude.

Table 4: ARDL Regression Equation for GDP

MYGDP = f (USGDP) ARDL (2,4)		MYGDP = f (CHGDP) ARDL (2,0)		MYGDP = f (USGDP, CHGDP) ARDL (2,4,4)	
Dependent Variables = MYGDP					
Intercept	-2.401 (-1.97)**	Intercept	1.471 (1.77)	Intercept	-3.271 (-2.48)**
MYGDP (-1)	1.219 (11.89)***	MYGDP (-1)	1.257 (12.29)***	MYGDP (-1)	1.109 (10.94)***
MYGDP (-2)	-0.291 (-2.81)***	MYGDP (-2)	-0.334 (-3.21)***	MYGDP (-2)	-0.352 (-3.34)***
USGDP	1.264 (2.57)**	CHGDP	0.045 (1.65)*	USGDP	1.447 (3.00)**
UDGDP (-1)	-0.038 (-0.04)	-	-	UDGDP (-1)	-0.151 (-0.18)
UDGDP (-2)	-1.277 (-1.52)	-	-	UDGDP (-2)	-1.022 (-1.27)
UDGDP (-3)	-1.105 (-1.42)	-	-	UDGDP (-3)	-1.023 (-1.30)
UDGDP (-4)	1.294 (2.97)***	-	-	UDGDP (-4)	1.038 (2.24)**
-	-	-	-	CHGDP	0.208 (3.28)***
-	-	-	-	CHGDP (-1)	0.016 (0.33)
-	-	-	-	CHGDP (-2)	-0.014 (-0.31)
-	-	-	-	CHGDP (-3)	0.030 (0.67)
-	-	-	-	CHGDP (-4)	-0.173 (-3.32)***
Obs.	89	Obs.	91	Obs.	91
# of Models Evaluated	72	# of Models Evaluated	72	# of Models Evaluated	648
Adjusted R-Squared	0.99	Adjusted R-Squared	0.99	Adjusted R-Squared	0.99

Table 5: ARDL Regression Equation for IPI

Equation 4 ARDL (1,2)		Equation 5 ARDL (2,0)		Equation 6 ARDL (1,2,0)	
Dependent Variables = MYIPI					
Intercept	-0.207 (-1.18)	Intercept	0.525 (1.28)	Intercept	-0.199 (-0.37)
MYIPI (-1)	0.942 (35.82)***	MYIPI (-1)	1.141 (10.99)***	MYIPI (-1)	0.942 (35.03)***
USIPI	1.200 (3.55)***	MYIPI (-2)	-0.165 (-1.62)	USIPI	1.199 (3.47)***
USIPI (-1)	-1.608 (-2.59)**	CHIPI	-0.094 (-1.09)	USIPI (-1)	-1.607 (-2.56)**
USIPI (-2)	0.502 (1.49)	-	-	USIPI (-2)	0.502 (1.47)
-	-	-	-	CHIPI	-0.001 (-0.01)
Obs.	89	Obs.	91	Obs.	91
# of Models Evaluated	72	# of Models Evaluated	72	# of Models Evaluated	648
Adjusted R-Squared	0.99	Adjusted R-Squared	0.99	Adjusted R-Squared	0.99

Tables 6.1 and 6.2 report statistics on bound tests of Pesaran et al. (2001) to verify presence of long-run relationship between Malaysian GDP and IPI, and those of its trading partners. The results were indicative of presence of significant long-run (cointegrating) relationship for all six model types discussed in previous sections. The computed F-value, the likelihood ratio, and Lagrange multiplier were used for testing the long-run relationship. Pesaran et al. (2001) provided critical values for the bound tests.

Table 6.1: Results of Bound Tests (GDP)

MYGDP = f (USGDP)		F-Statistics	(1,89) = 9.465***
MYGDP = f (CHGDP)		F-Statistics	(1,91) = 10.79***
MYGDP = f (USGDP, CHGDP)		F-Statistics	(2,89) = 7.476***
Pesaran*et. al* (2001) Critical Value		Lower Bound I(0)	Upper Bound I(1)
	99% Level	4.94	5.58
	95% Level	3.62	4.16
	90% Level	3.02	3.51

(continued)

Pesaran*et. al* (2001) Critical Value		Lower Bound I(0)	Upper Bound I(1)
	99% Level	4.13	5.00
	95% Level	3.10	3.87
	90% Level	2.63	3.35

In Table 6.1, k was the number of variables; the maximum lag identified was 2; the tests is identified the upper and lower bounds at three levels of is significance.

The calculated F-statistics (e.g., F (1, 89) = 9.465 for the first equation), was greater than upper bound at 1 percent degree of significance. Results reported in Table 6.2 also verify presence of significant long-run relationship between Malaysian IPI and that of US and China, given that the associated F-statistics was bigger than the upper bound of all three relevant models.

Table 6.2: Results of Bound Tests (IPI)

MYIPI = f (USIPI)		F-Statistics	(1,91) = 10.77***
MYIPI = f (CHIPI)		F-Statistics	(1,91) = 8.630***
MYIPI = f (USIPI, CHIPI)		F-Statistics	(2,91) = 7.984***
Pesaran*et. al* (2001) Critical Value		Lower Bound I(0)	Upper Bound I(1)
	99% Level	4.94	5.58
	95% Level	3.62	4.16
	90% Level	3.02	3.51
Pesaran*et. al* (2001) Critical Value		Lower Bound I(0)	Upper Bound I(1)
	99% Level	4.13	5.00
	95% Level	3.10	3.87
	90% Level	2.63	3.35

In Table 6.2, k was the number of variables; the maximum lag identified was 2; the tests is identified the upper and lower bounds at three levels of is significance.

Table 7 and 8 summarise the results from the ARDL long-run relationship tests for GDP and IPI, respectively. Results from Equation 1 revealed that 1 unit increase in the US GDP will lead to an increase of 1.94 units in the Malaysian GDP over the long-run. Similarly, a 1 unit increase in Chinese GDP will lead to an increase of 0.59 unit in the Chinese GDP when considering a long-run relationship.

Results from the joint model (i.e., Equation 3 in Table 7) also showed that there is a relatively larger impact of the US GDP than that of China on the Malaysian GDP over the long-run. On a similar basis, the results reported in Table 8 showed that US IPI played a more contributing role in determination of

Malaysian IPI over the long-run compared to the IPI of China, which was very negligible when estimated jointly with the US IPI.

Table 7: Cointegrating Equation (GDP)

GDP			
Cointegration Equation 1 = MYGDP - (1.9432*USGDP) - 33.4908)			
	[13.58***]	[-7.64***]	
Cointegration Equation 2 = MYGDP - (0.5908*CHGDP) + 18.8947)			
	[12.32***]	[43.98***]	
Cointegration Equation 3 = MYGDP - (1.1913*USGDP + 0.2746*CHGDP) - 13.5037)			
	[5.60***]	[4.04***]	[-2.35**]

Table 8: Cointegrating Equation (GDP)

IPI			
Cointegration Equation 1 = MYIPI - (1.6459*USIPI) - 3.5895)			
	[3.89***]	[-1.99**]	
Cointegration Equation 2 = MYIPI - (0.5908*CHIPI) + 18.8947)			
	[12.32***]	[43.98***]	
Cointegration Equation 3 = MYIPI - (1.6433*USIPI – 0.0257*CHIPI) - 3.4572)			
	[3.60***]	[-0.01]	[-0.42]

Finally, the results from the Error Correction model are reported, to identify the speed of adjustment or convergence of the variables to the long-run (cointegrating) equilibrium. A necessary condition for the verification of the presence of long-run equation is to have an error correction term (ECT) to be negative and significant at 5% or lower degree of significance. In other words, this test will identify the time to revert to the equilibrium, provided the coefficient is negative and significant. Tables 9 and 10 report results on the six error correction models in line with the results obtained from previous sections. It was found that the condition was met for all six equations. The US and Chinese GDPs were found to have an almost identical speed of adjustment (0.071, 0.076), implying that the disequilibrium between Malaysian GDP and the US GDP, as well as Malaysian GDP, and Chinese GDP can be corrected by 7% within each period (i.e. per quarter).

In other words, it takes approximately 3.5 years (14 quarters) for the total equilibrium to be adjusted; while considering both countries GDP jointly, the speed of adjustment will tend to be 1 year (4 quarters = 100 % / 24.2 %). The statistics in Table 10 also revealed evidence of significant error correction terms

Table 9: The Error Correction Representation for the Chosen ARDL Model (GDP)

ECM 1: MYGDP = f (USGDP)				
MYGDP	D(MYGDP(-1))	D(USGDP)	D(USGDP(-1))	D(USGDP(-2))
	0.291	1.264	1.087	-0.189
	(2.86)***	(2.75)***	(2.06)**	(-0.36)**
D(USGDP(-3))	ECT(-1)			
-1.294	-0.071			
(-3.19)***	(-2.16)**			
ECM 2: MYGDP = f (CHGDP)				
MYGDP	D(MYGDP(-1))	D(CHGDP)	ECT(-1)	
	0.333	0.052	-0.076	
	(3.60)***	(0.17)	(-4.37)***	
ECM 3: MYGDP = f (USGDP, CHGDP)				
MYGDP	D(MYGDP(-1))	D(MYGDP(-2))	D(USGDP(-1))	D(USGDP(-2))
	0.352	1.447	1.007	-0.015
	(3.58)***	(3.36)***	(2.03)**	(-0.03)
D(USGDP(-3))	D(CHGDP)	D(CHGDP(-1))	D(CHGDP(-2))	D(CHGDP(-3))
-1.038	0.208	0.157	0.143	0.173
(-2.41)**	(3.73)***	(3.27)***	(2.97)***	(3.73)***
ECT(-1)				
-0.242				
(-4.07)***				

for both countries separately and when considered jointly. The speed of adjustment was found to be slower compared to the results obtained in Table 9. For example, the disequilibrium between the Malaysian IPI and that of the US would be corrected over almost 4.5 years. Likewise, the disequilibrium between Malaysian IPI and Chinese IPI would be corrected over a longer period of approximately 10 years. Hence, although the results showed presence of significant long-run relationship between the sampled countries' IPIs, they tended to be cointegrated on a relatively slower pace than GDP.

A reason can be due to the fact that countries have certain comparative advantages over each other, being relatively distinct in different sectors. For example, China has higher degrees of comparative advantage in agricultural products than Malaysia, while Malaysia's economic activities in industrial sector are higher. China's manufacturing growth rate is ranked 7^{th} while that of Malaysia is 87^{th} with relatively divergent trend behaviour.

Likewise, the rate of growth in industrial value added products and services such as manufacturing, construction, electricity, water, and gas was almost two times higher than that of the US. Furthermore, US and Malaysia have a record of dissimilar manufacturing growth rates, and production of car, machinery and transport equipment; with Malaysian growth rate being higher.

Table 10: The Error Correction Representation for the Chosen ARDL Model (IPI)

ECM 1: MYIPI = f (USIPI)				
MYIPI	D(USIPI)	D(USIPI(-1))	ECT(-1)	
	1.201	-0.502	-0.057	
	(3.75)***	(-1.53)	(-4.09)**	
ECM 2: MYIPI = f (CHIPI)				
MYIPI	D(MYIPI(-1))	D(CHIPI)	ECT(-1)	
	0.170	-0.139	-0.023	
	(1.69)*	(-1.10)	(-4.55)***	
ECM 2: MYIPI = f (USIPI, CHIPI)				
MYIPI	D(USIPI)	D(USIPI(-1))	D(CHIPI)	ECT(-1)
	1.195	-0.498	-0.018	-0.057
	(3.69)***	(-1.51)	(-0.15)	(-4.06)***

5. Conclusion

This paper conceived an alternative approach with novelty in application compared to previous studies to examine the interrelationship between Malaysian economic time series behaviour and those of its trading partners (USA and China). This study applied new and more appropriate econometric approaches; namely (i) the structural break test of Bai and Perron (2003) to identify the structural breakpoints in the behaviour of Malaysian GDP and IPI, and (ii) the ARDL cointegration approach of Pesaran et al. (2001) to estimate the interdependency of the Malaysian economy on its trading partners. The Malaysian, the US, and Chinese data were used since long-length data are available for these economies readily. The ARDL bound testing was used, which satisfies the long-length equilibrium on paired-country as well as multi-country testswherein Malaysian GDP and IPI is regressed on the US and Chinese GDP and IPI.

The results revealed that both the GDP and IPIof Malaysia are strongly cointegrated with those of the US and China. The US GDP and IPI as proxies for economic growth and earnings were found to have contemporaneous and 1-year lagged impact on those of Malaysia, while the Chinese GDP has a lagged impact only when estimated jointly with the US. Although there was evidence of long-run relationship between Malaysian IPI and the US and Chinese IPIs, the speed of adjustment was found to range between 4.5 to 10 years, which, in our view, is due to relatively distinct behaviour of countries in their industrial production activities concerning the manufacturing, construction, electricity, and water and gas sectors, as well as production of cars and other machineries.The econometric tests conducted in this study, in our view, made these results reliable and robust compared to earlier studies, given the controls for the number of lag parameters are provided in presence of no serial correlation leading to high model fitness and model specification. Hence, this study has certain implications on how the Malaysian economy is likely to behave based on past information obtained from the US and Chinese economic time series. Perhaps the research process followed in this study can provide a new approach, which may be useful to study other economies to reveal if the same relationship between key fundamental economic time-series hold in more economies than in Malaysia.

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