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Impact of Crude Oil Price, Exchange Rates and Real GDP on Malaysia's Food Price Fluctuations: Symmetric or Asymmetric?

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ABSTRACT

In this study, we examined the impact of crude oil price, real GDP, and exchange rates on Malaysian food price fluctuation by using the quarterly data from quarter 1 of year 2000 to quarter 2 of year 2016. Considering the possibility that an asymmetric impact exists between the underlying variables, an asymmetric Unrestricted Non-linear Auto-Regressive Distributed Lag (NARDL) model was adopted. In short, the bounds test for cointegration showed that the underlying variables have a significant long-run relationship along with changes in food prices. However, only the crude oil price has a symmetric long-run effect on the food price fluctuation. On the other hand, the real GDP and exchange rates have an asymmetric long-run effect on food price movements. In the short-run, the crude oil price has an insignificant impact on food price volatility, but the growth of real GDP and exchange rates have a significant impact on food price changes. Hence, this study suggests that policymakers should be taking the exchange rate factor instead of crude oil price into consideration.

JEL Classification : C22; E31

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INTRODUCTION

In recent years, the frequency of large food price increases has accelerated around the world. This phenomenon is known as The World Food Price Crisis (Figure 1). In January 2007 to the July 2008, the global food price index increased dramatically for about 90%, from 135 to 226, in a short time period. Subsequently, the food prices plunged sharply in January 2009 peaking in 2008. After hitting this low point, the food price index again showed an upward growth and hit a second peak in June 2011, which was slightly higher than the 2008 peak.

Due to the dramatic changes in food prices, there have been numerous studies postulated that the crude oil price instability is a main determinant of the food price crises occurred in recent years (Chen *et al*., 2010; Gilbert, 2010; Ibrahim, 2015; Abdlaziz *et al*., 2016; and etc.). Theoretically, the industrial cost of production, especially in the agriculture sector, relies heavily on the crude oil price. Therefore, the increment of the pass-through of crude oil price will lead to the decrement in the supply of food and agricultural products due to the increase in the cost of fertilizers, transportation and capital, such as fuel.

The decrease of food and agricultural commodity supply will consequently lead to the increase of food price in the new market equilibrium. Hence, the global crude oil price instability can be related positively to the worldwide food price crisis (Figure 2). Additionally, the significant impact of oil price on agricultural prices was supported by the findings of Baffes (2007), Harri *et al*. (2009), Chen *et al*. (2010), Baffe and Dennis (2013), and Abdlaziz *et al*. (2016).

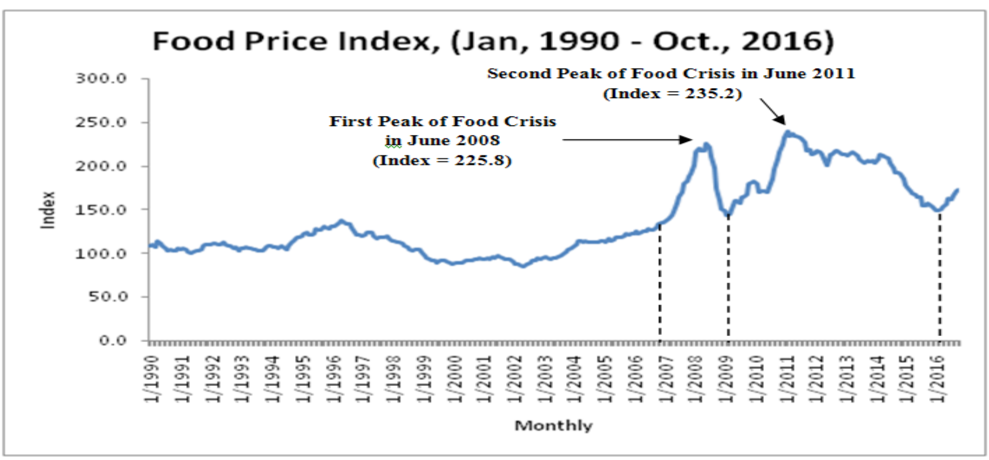


Figure 1 International Monthly Food Price Index, January 1990 – October 2016
Sources: Food and Agriculture Organization of the United Nation [1]

[1] Downloadable from: http://www.fao.org/worldfoodsituation/foodpricesindex/en/

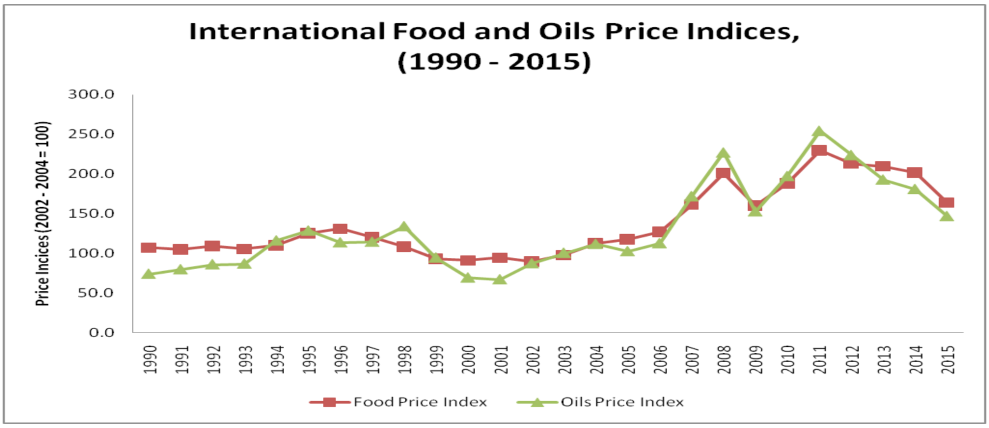


Figure 2 International Food and Oils Price Indices, 1990 – 2016
Sources: Food and Agriculture Organization of the United Nation

Several literatures suggested that one should take into account the asymmetric price behavior of crude oil price in food price fluctuation. Meyer and Cramon-Taubadel (2004) explained that the price adjustment usually has a promptly response in the upward direction due to market power. Karantininis *et al*. (2011a, b) further explained that both the long-run and the short-run price asymmetry movements relate to the interaction between cost structures of firms and market power.

However, the reasons of crude oil price has an asymmetric relationship with food price inflation can be explained by the response of food producers when the crude oil price changes. The food producers responded differently towards the increment and decrement of crude oil price. When the price of crude oil increases, the cost of production will increase, thus, and suppliers will reduce their production or increase food prices rapidly in order to reduce their loss of profit.

In contrast, food producers may not increase their production and reduce the food price when the crude oil price decreases due to three possible scenarios. Firstly, food suppliers assume the fall in the crude oil price might be temporary thus affecting the confidence of the suppliers to secure more inputs in order to produce additional output in the short term. Secondly, owing to the pessimistic or relatively conservative business expectations of the food producers, with respect to the market for future sales, the increment of food production is a time-consuming process. Finally, food and agricultural product is biological in nature, thus, it is difficult to increase the production immediately unlike durable goods[2]. Consequently, these factors will cause the food price to stick at the similar price level or remain close to the constant rate. Henceforth, no matter how large of the crude oil price reduction, food prices would not decrease in the short term.

In this study, the long-run and short-run asymmetric impact of exogenous variables, such as real income, oil price and exchange rate on Malaysian food price were analyzed by adopting the Unrestricted Nonlinear Auto-Regressive Distributed Lag (NARDL) model which was advanced recently by Shin *et al*. (2011). The new contribution of this article to the existing literatures can

[2] Therefore, the agriculture products always categorized as inelastic and as non-durable goods.

be categorized it into three main points: (i) the possibility of an asymmetric impact of other exogenous variables such as real income and exchange rates were analyzed in this study; (ii) the quarterly data instead of annual data were used in order to better capture the short-term effects; and (iii) separating the exchange rate from the crude oil price in determining the food price is reasonable in order to capture the individual asymmetric magnitude on the food price.

The rest of the paper is organized as follows. Short reviews of empirical studies about the factors that influence food price inflation were explained in Section 2.The data and outline of the model were described in Section 3. The empirical results were discussed in Section 4 and followed by the conclusion.

LITERATURE REVIEW

Food price inflation can be determined by many factors and not only because of agricultural production or demand shock (Abdlaziz *et al*., 2016). The main factors highlighted by various researchers are oil price fluctuation, exchange rates and the real GDP. According to Chen *et al*. (2010), the pass-through of oil prices will affect inflation in general and food inflation in particular, therefore affect the basic needs of consumers indirectly. However, past studies have shown different explanations regarding the effects of oil price instability on food price volatility. In general, the factors which explain the food price shock can be categorized into demand side and/or supply side effects. On the demand side, increasing population, rapid growth of economy, rising demand for processing of biofuel and ethanol and other factors lead to an increase in the aggregate demand for food as well as agricultural commodities, such as palm oil, sunflower as well as soybean, thus raises food prices (Abdlaziz *et al*., 2016). On the supply side, as mentioned in the previous section, the cost of production, the biological nature of agriculture, the pessimistic business expectations on future market sales and market power are all explanation of the supply-side.

The empirical studies about the impact of the crude oil price on food price changes can be categorized into three groups, (i) no evidence to support; (ii) weak evidence; and (iii) strong evidence. Yu *et al*. (2006), Zhang and Reed (2008), Zhang *et al*. (2010), Naglioglu and Soytas (2011) and Reboredo (2012) were unable to discover evidence representing significant contribution of the effect of crude oil price volatility to agricultural prices. Yu *et al*. (2006) examined the cointegration and causality relationship between the world vegetable oil prices and crude oil prices. However, there was no evidence to support the hypothesis. Besides that, Zhang and Reed (2008) also failed to find any evidence to support that crude oil price is related to the corn, soy meal and pork prices of China. Furthermore, Zhang (2010) reaffirmed the previous findings that there is no interconnection between crude oil price and other types of agricultural commodity prices such as corn, rice and others. Recent findings by Naglioglu and Soytas (2011) and Reboredo (2012) claimed that food prices have had no reaction to the recent oil price shock.

In contrast, Mutuc *et al*. (2010) examined the impact of oil price shock on US cotton prices and discovered a weak evidence to support the response of cotton prices to petroleum price fluctuations. Moreover, recent literatures by such as, Baffes (2007), Harri *et al*. (2009), Chen *et al*. (2010), Baffes and Dennis (2013), Ibrahim (2015) and Abdlaziz *et al*. (2016) shown that oil price fluctuations has a strong relationship on commodity prices. The Ibrahim (2015) and Abdlaziz, *et al*. (2016) studies, in which both applied the same asymmetric cointegration method which is a nonlinear Autoregression Distributed Lag (NARDL) model to investigate the long- and short-run cointegration between oil price changes and food prices in both Malaysia and Indonesia. Based on their findings, the oil price has a positive long-run impact on the food price inflation while there is no significant relationship between reductions in the long-run oil price and food prices inflation.

On the contrary, Harri *et al*. (2009) studied the relationship between oil price, exchange rates and commodity prices. In their study, a long-run cointegrated relationship between oil price, exchange rates and corn prices were found. Likewise, Kwon and Kao (2009) and Baek and Koo (2010) also provided similar findings and explained that exchange rate movements and petroleum price play a significant role in determining US food price inflation. According to Abdlaziz, *et al*. (2016), the depreciation of the US dollar was one of the important factors that influences global food prices and this was supported by the Nazlioglu and Soytas (2012) findings.

DATA AND DESCRIPTIVE STATISTICS

In the early of 2000's, Malaysian food price inflation rate constantly fluctuated although the crude oil price increased dramatically (Figure 3). However, Malaysian food price inflation increased rapidly as the price of crude oil increased in 2006. Due to the global food price and crude oil price crisis, the Malaysian food price inflation was also affected and hit a peak in June 2008 and then hit a second peak level in 2011.

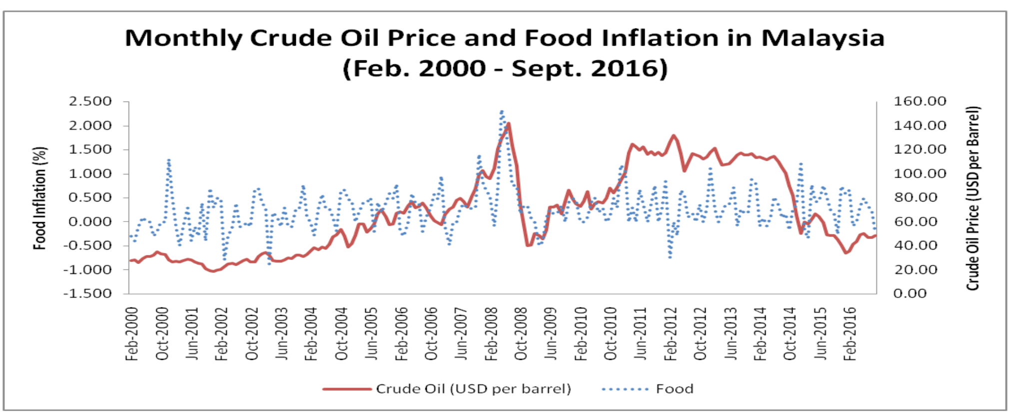


Figure 3 Monthly Crude Oil Price and Food Inflation in Malaysia, February 2000 – September 2016.
Sources: Monthly Bulletin Statistic: October 2016, Center Bank of Malaysia

After the peak in 2011, the Malaysian food price inflation rate reduced but did not follow the decreasing trend of the crude oil price. Even when the crude oil price decreased significantly in 2014, the food inflation rate in Malaysia constantly fluctuated and did not respond in a similar manner to the crude oil price. In the nutshell, the Malaysian food inflation has a fast response to the increase of crude oil price but not to the decrease of crude oil price.

In Malaysia, the crude oil price and food price inflation appear to have an asymmetric relationship and this was supported by Ibrahim (2015). According to Ibrahim (2015), the crude oil price has a significant impact on the Malaysian food price inflation only when the crude oil price increases. In contrast, there was no statistical evidence found by Ibrahim (2015) to support the theory that a decrease in crude oil price will have a significant impact on the Malaysian food price inflation.

Understanding the factors that lead to food price inflation in Malaysia is of great importance not only for making policy decisions about social welfare but also for the Malaysian food trade bills. According to the Yeong-Sheng (2008), the percentage of Malaysian household food budget across their income quartiles dropped continuously and this affects social welfare especially the lower income groups who spend the majority of their income on the food items[3]. According to Ibrahim (2015), the households at lower income quartiles will have a higher financial burden than the highest income quartiles when food price inflation increases in Malaysia. The increasing trend of food imports means that Malaysia is arguably more exposed to oil and global food crises (Ibrahim, 2015), such as the global food and oil crisis which occurred in June 2008 and June 2011.

In Figure 4, the monthly real GDP was plotted on the left-axis and the nominal food import was plotted on the right-axis, both variables were measured in million Malaysian ringgit. As shown in Figure 4, food imports increased steadily and moved in parallel with real GDP over the years. However, despite the real GDP in Malaysia having a lower growth in recent years, the food imports bill was still rising due to the impact of the Malaysian ringgit depreciation especially in the years 2014/2015 (Figure 5).

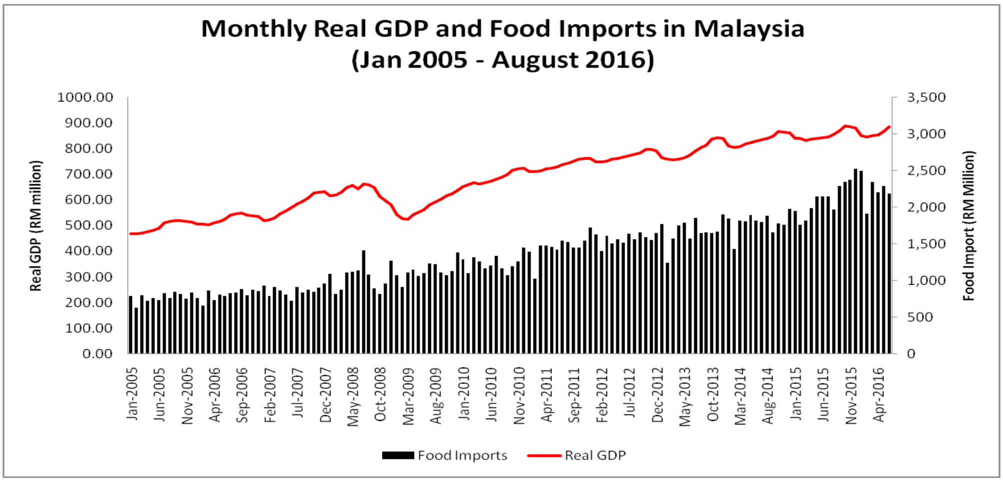


Figure 4 Monthly Real Gross Domestic Product (GDP) and Food Imports in Malaysia, January 2005 to August 2016

Sources: Monthly Bulletin Statistic: October 2016, Center Bank of Malaysia

[3] The percentage is calculated by Yeong-Sheng (2008) based on the Malaysia's Household Expenditure Survey 2004/2005 and the details of percentage are 33.03% (Quartile 1), 25.92% (Quartile 2), 21.2% (Quartile 3), and 14.63% (Quartile 4), respectively.

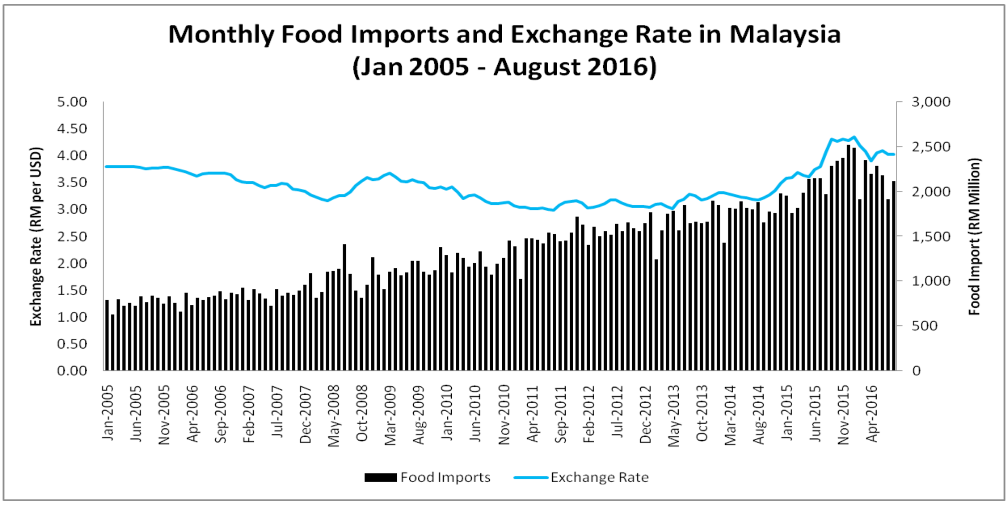


Figure 5 Monthly Food Imports and Exchange Rate in Malaysia, January 2005 to August 2016
Sources: Monthly Bulletin Statistic: October 2016, Center Bank of Malaysia

There are various factors that interconnect with food price volatility, namely oil price, national business cycle and exchange rates. However, there is no consistent empirical evidence to support that these factors have a significant impact on food price changes. For example, Yu *et al*. (2006), Zhang and Reed (2008), Nazlioglu and Soytas (2011), and Reboredo (2012) were unable to provide evidence to support that oil price has a significant impact on food or agricultural prices. Although Mutuc *et al*. (2010) found that oil prices have an impact on US cotton prices, however, the impact is relatively weak. Nonetheless, the effects of oil price on food prices have been supported by some recent studies, such asIbrahim and Said (2012), Ibrahim (2015) and Abdlaziz *et al*. (2016) which suggested that the oil price has an asymmetric impact on food prices.

METHODOLOGY

In this study, we endorsed quarterly data from 2000Q1 to 2016 Q2 to analyze the oil price impact on the Malaysian food price. The food price index (FP) is adopted to represent the Malaysian food price. The real income is proxy by the real gross domestic product (RGDP) and in millions ringgit. Furthermore, the crude oil price (COP) is proxy by the West Texas Intermediate crude oil price in US dollar per barrel and Malaysian exchange rate (MYR) measured in ringgit per US dollar. All of these variables are adopted from the *Monthly Statistical Bulletin* published by the central bank of Malaysia (*www.bnm.gov.my*).

Due to the possibilities of asymmetric impact exits between the underlying variables, the asymmetric Non-linear Unrestricted ARDL proposed by Shin *et al*. (2011) is widely used by the researchers, such as Ibrahim (2015) and Abdlaziz *et al*. (2016). The main purpose of this test was to test for the presence asymmetric effects in both long- and short-run relationships between economic time-series. Shin *et al*. (2011) applied the positive and negative partial sum decompositions to test the asymmetric effects. This asymmetric Unrestricted ARDL cointegration approach which allows the joint analysis of non-stationarity and non-linearity issues in the context of an unrestricted error correction model (ECM) (Katrakilidis *et al*., 2012).

Before developing the full representation of the NARDL model,the asymmetric long-run regression of food price was specified as shown in the following equation (Schorderet, 2003 and Shin *et al*., 2011):

$$FP_t = \alpha^* + \beta^+ RGDP_t^+ + \beta^+ RGDP_t^- + \lambda^+ COP_t^+ + \lambda^- COP_t^- + \delta^+ MYR_t^+ + \delta^- MYR_t^- + \mathcal{E}_t \quad (1)$$

where FP is food price Index, RGDP is real GDP, COP is the crude oil price, MYR denotes the Malaysian exchange rate and the parameters ($\alpha^*, \beta^+, \beta^-, \lambda^+, \lambda^-, \delta^+, \delta^-$) represent the long-run cointegration coefficients to be estimated. In equation (1), $RGDP_t^+$, $RGDP_t^-$, COP_t^+, COP_t^-, MYR_t^+ , MYR_t^- are partial sums of positive and negative changes in real GDP, crude oil price and exchange rate, respectively. The formulation of partial sums of positive and negative changes is:

$$Z_t^+ = \Sigma^{t}_{i=1} \Delta Z_i^+ = \Sigma^{t}_{i} \max\ (\Delta Z_i, 0) \quad (2)$$

and

$$Z_t^- = \Sigma^{-}_{i=1} \Delta Z_i^- = \Sigma^{-}_{i} \max\ (\Delta Z_i, 0) \quad (3)$$

where $Z_t^+ = RGDP_t^+ + COP_t^+ + MYR_t^+$ and $Z_t^- = RGDP_t^- + COP_t^- + MYR_t^-$, respectively. The parameters in equation (1), i.e. β^+, λ^+ and δ^+ capture the long-run effects between food price and its exogenous increase ($RGDP_t^+$, COP_t^+ and MYR_t^+ respectively). Besides that, β^-, λ^- and δ^- capture the long-run relation between food price and its exogenous reduction, such as $RGDP_t^-$, COP_t^- and MYR_t^-, respectively. According to Shin *et al*. (2011), the asymmetric impact of exogenous on the endogenous variable exists if the magnitude of exogenous increase has a significant different than the magnitude of exogenous reduction. Thus, if the findings show that $\beta^+ = \beta^-$, $\lambda^+ = \lambda^-$, and/or $\delta^+ = \delta^-$ then the asymmetric pass-through effects from real GDP, crude oil price and exchange rate to food price will not hold.

Based on the Shin *et al*. (2011), the equation (1) was extended in an Unrestricted Nonlinear ARDL regression in order to analyze the asymmetric long and short-run cointegration effects. To be simplified, the modified equation (1) in Unrestricted NARDL is framed as:

$$\begin{aligned}\Delta FP_t = {} & \gamma_1 + \rho FP_{t-1} + \tau_1^+ RGDP_{t-1}^+ + \tau_2^- RGDP_{t-1}^- + \tau_3^+ COP_{t-1}^+ + \tau_4^- COP_{t-1}^- + \\ & \tau_5^+ MYR_{t-1}^+ + \tau_6^- MYR_{t-1}^- + \textstyle\sum_{r=1}^{p} \pi_{t-r}\, \Delta FP_{t-r} + \\ & \textstyle\sum_{L=0}^{q^+} \varphi_L^+\ \Delta RGDP_{t-L}^+ + \sum_{L=0}^{q^-} \varphi_L^-\ \Delta RGDP_{t-L}^- + \sum_{L=0}^{r^+} \sigma_L^+\ \Delta COP_{t-L}^+ + \\ & \textstyle\sum_{L=0}^{r^-} \sigma_L^-\ \Delta COP_{t-L}^- + \sum_{L=0}^{s^+} \theta_L^+\ \Delta MYR_{t-L}^+ + \sum_{L=0}^{s^-} \theta_L^-\ \Delta MYR_{t-L}^- + v_t \end{aligned} \quad (4)$$

where all variables are described as above, and the *p, q, r* and *s* are lag orders selected based on the Hendry (1979) general-to-specific approach. The long-run coefficient of each exogenous variables asforementioned in the equation (1), can be computed as: $\beta^+ = -\tau_1^+/\rho$, $\beta^- = -\tau_2^-/\rho$, $\lambda^+ = -\tau_3^+/\rho$, $\lambda^- = -\tau_4^-/\rho$, $\delta^+ = -\tau_5^+/\rho$, and $\delta^- = -\tau_6^-/\rho$, respectively. Furthermore, the $\Sigma^p_{r=1}\pi_{t-r}$, $\Sigma_{L=0}^{q+}\varphi_L^+$, $\Sigma_{L=0}^{q-}\varphi_L^-$, $\Sigma_{L=0}^{r+}\sigma_L^+$, $\Sigma_{L=0}^{r-}\sigma_L^-$, $\Sigma_{L=0}^{s+}\theta_L^+$ *and* $\Sigma_{L=0}^{s-}\theta_L^-$ represent the short-run increase and reduction impact of real GDP, crude oil price and exchange rate, respectively. Meanwhile, the short-run asymmetric impact of changes in real GDP, oil price and exchange rate on food inflation can be measured in the equation (4).

To simplify the steps to analyze the Unrestricted NARDL, the equation (4) can be estimated as following. Firstly, the regression was estimated with a standard Ordinary Least Squares (OLS). Secondly, the optimal lag p, q^+, q^-, r^+, r^-, s^+ *and* s^- were selected based on the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and Hendry (1979) general to specific procedure. Thirdly, the long-run relationship between the levels of the underlying variables FP_t, $RGDP_t^+$, $RGDP_t^-$, COP_t^+, COP_t^-, MYR_t^+, MYR_t^- were examined using modified F-test, while using the bounds-testing procedure advanced by Pesaran *et al*. (2001) and Shin *et al*. (2011), which refers to the joint hypothesis as:

H_0: $\rho = \tau_1^+ = \tau_2^- = \tau_3^+ = \tau_4^- = \tau_5^+ = \tau_6^- = 0$ (no long run cointegration relationship)

H_1: $\rho \neq 0 \cup \tau_1^+ \neq 0 \cup \tau_2^- \neq 0 \cup \tau_3^+ \neq 0 \cup \tau_4^- \neq 0 \cup \tau_5^+ \neq 0 \cup \tau_6^- \neq 0$ (Exist long run cointegration relationship)

If the cointegration null hypothesis is rejected in third steps, then Wald test will be applied to test each asymmetric long-run coefficient as the hypothesis defined as:

H_0: $\Omega^+ = \Omega^-$ (the long-run coefficient for positive and negative is symmetric)

H_1: $\Omega^+ \neq \Omega^-$ (the long-run coefficient for positive and negative is asymmetric)

Finally, by referring to the Unrestricted NARDL as shows in the equation (4), the asymmetric cumulative dynamic multiplier effects of a unit change in exogenous variables (z^+_t and Z^-_t , respectively) were derived on endogenous variable(FP_t):

$$m_h^+ = \sum_{j=0}^{n} \frac{\partial FP_{t-j}}{\partial Z_t^+} \quad and \quad m_h^- = \sum_{j=0}^{n} \frac{\partial FP_{t-j}}{\partial Z_t^-} \quad ; \quad where\ j = 0, 1, 2, \ldots, n$$

Noted that as $n \to \infty$, then $m_h^+ \to \beta^+$, λ^+ and δ^+ respectively, and $m_h^- \to \beta^-$, λ^- and δ^- respectively.

RESULTS AND DISCUSSIONS

Before analyzing the unrestricted NARDL model as shown in the equation (4), the unit root checking of variables are the general procedure in time series analysis which to confirm that all variables are stationary at order one or *I*(1). The Augmented Dickey Fuller (ADF) and Philip-Perron (PP) tests were adopted to determine if the variables are stationary. In Table 1, the results show that all variables are stationary at order one or *I*(1) and confirm that there were no order two *I*(2) variables. Hence, we proceeded to the bounds testing procedure as stated in the methodology section.

Table 1 Augmented Dickey Fuller (ADF) and Philip-Perron (PP) Unit Root Tests

Variables	Level		1st difference	
	ADF	PP	ADF	PP
FP	-1.820	-2.889	-5.821***	-12.974***
RGDP	-2.756	-2.972	-5.292***	-5.170***
COP	-0.957	-1.095	-6.470***	-6.261***
MYR	-1.316	-0.578	-5.467***	-5.475***

Note: All variables are transformed into logarithm form. ***, and ** denotes as significant at 1% and 5% significance level, respectively. The Schwarz Info Criterion (SIC) was adopted to select the optimum lag order in ADF test and the Newey-West Bandwidth (NWB) was used to select the optimum lag order in PP test.

In Figure 3, the food price possessed the probability of containing innovational outlier or structural break. Hence, the breakpoint unit root test proposed by Perron (1989) was adopted to check the break date. Based on the breakpoint unit root test (Table 2), the different break date selection methods showed that the food price only possessed a stationary pattern at order one or *I*(1) which confirmed that the result of unit root tests presented in Table 1 was valid. Moreover, the different selection methods showed the different break date in the food price but only the break date quarter 4, 2007 chosen by the minimizing Dickey-Fuller t-statistic was statistically significant at 1% significance level.

Table 2 Summary of Innovative Outlier Unit-root Test on Food Price

Break Date Selection Methods	Level		First Difference	
	t-statistic	Break Date	t-statistic	Break Date
Dickey Fuller Min-t	-1.903	2003Q2	-6.290***	2007Q4**
	(0.987)	(0.445)	(<0.01)	(0.022)
Intercept break Min-t	0.697	2008Q3	-5.704***	2008Q3
	(0.982)	(0.976)	(<0.01)	(0.914)
Intercept break Max-t	-1.611	2009Q2	-4.906***	2009Q2
	(0.694)	(0.909)	(<0.01)	(0.665)
Intercept break max-abs-t	-1.611	2009Q2	-5.704***	2008Q3
	(0.954)	(0.909)	(<0.01)	(0.914)

Note: *** and ** denotes significant at 1% and 5% significance level, respectively. The figure in the parenthesis (…) represents the p-value.

Based on the suggestion of Hendry (1979), the general-to-specific procedure is a widely acceptable and appropriate technique to use in determining the optimum lag in a distributed lag regression. Hence, equation (4) was analyzed using this technique in order to identify the final specification of the model and the maximum lag order considered is 3. The final estimated unrestricted NARDL bounds test results were summarized in Table 3. The bounds test showed that the F-statistic of the Wald's test is 17.318, which is greater than the upper bound at a 1% significance level and rejects the null hypothesis (H0), indicating that the food price dynamic, real income, crude oil price and exchange rates have a long-run nonlinear cointegrated relationship.

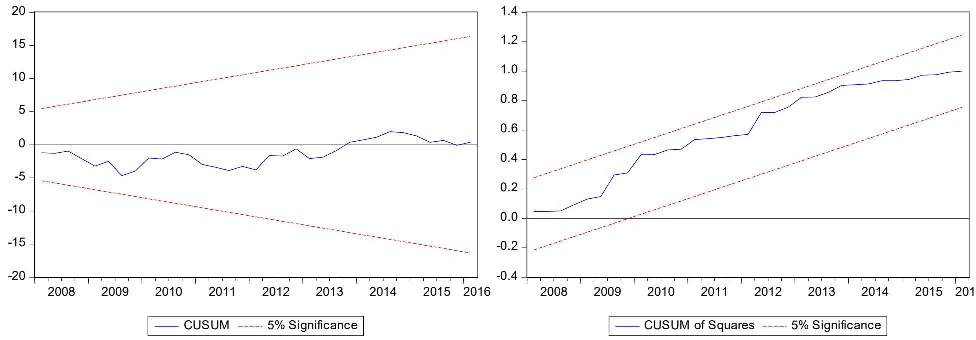
Table 3 Summarize of Unrestricted NARDL Bound test Estimation Results

Variable	Coefficient	Standard Error	t-statistic
Constant	1.966***	0.408	4.821
FP_{t-1}	-0.348***	0.069	-5.066
MYR^{+}_{t-1}	0.645***	0.094	6.877
COP^{+}_{t-1}	0.124***	0.030	4.087
$RGDP^{+}_{t-1}$	-0.804***	0.281	-2.863
MYR^{-}_{t-1}	-0.266***	0.093	-2.847
COP^{-}_{t-1}	0.125***	0.025	5.065
$RGDP^{-}_{t-1}$	-8.519***	1.648	-5.168
ΔFP_{t-2}	-0.273***	0.075	-3.653
ΔMYR^{+}_{t}	0.430**	0.176	2.436
ΔMYR^{+}_{t-3}	-0.506***	0.170	-2.976
ΔCOP^{+}_{t}	-0.024	0.042	-0.578
ΔRGDP+t	1.358***	0.418	3.247
ΔMYR^{-}_{t}	-0.687**	0.266	-2.589
ΔCOP^{-}_{t}	0.009	0.029	0.329
Dummy2007Q4	0.015	0.021	0.704
Nonlinear Cointegration Bound Testing:			
H_0: $\rho = \tau_1^{+} = \tau_2^{-} = \tau_3^{+} = \tau_4^{-} = \tau_5^{+} = \tau_6^{-} = 0$			
H_1: $\rho \neq 0 \cup \tau_1^{+} \neq 0 \cup \tau_2^{-} \neq 0 \cup \tau_3^{+} \neq 0 \cup \tau_4^{-} \neq 0 \cup \tau_5^{+} \neq 0 \cup \tau_6^{-} \neq 0$			
Wald Test:	F-statistic	1% Lower Bound	1% Upper Bound
	17.318***	3.436	5.044
Diagnostic Checking:			
R-squared	0.856	Adj. R-squared	0.808
F-statistic	17.789***		
LM (2)	2.582	LM(4)	4.759
	[0.275]		[0.313]
Jarque-Bera	1.007	ARCH (2)	2.722
	[0.604]		[0.256]

Notes: *, **, and *** denote significant at 10%, 5%, and 1% significance levels, respectively. Critical values for Bound test are cited from Narayan, P. (2005) table Case III: Unrestricted intercept and no trend for without trend models. LM (.) is the Breusch-Gofrey Serial Correlation LM test for error autocorrelation up to the lag order given in the parenthesis, Jarque-Bera test is analyze the error normally distributed, and ARCH(.) is the ARCH test for autoregressive conditional heteroskedasticity up to the lag order given in the parenthesis.

Moreover, this study adopted various diagnostic tests namely, the Breusch-Gofrey Serial Correlation LM test, Jarque-Bera (JB) test and the ARCH statistic, to check the adequacy of the specification of model. As shown in the lower panel of Table 3, the respective diagnostic checking statistics failed to reject the null hypothesis in the respective tests. This indicated that the specification model results, reported in Table 3, were adequate and the stochastic term was free from autocorrelation problems [4], it was normally distributed and has no heteroskedasticity problems, respectively. The stability diagnostic, i.e. CUSUM and CUSUM of Squares statistics (Figure 6) show that the parameters in the estimated regression were structurally stable.

[4] A Correlogram: Q-statistic test with 24 lags is adopted and confirmed that there is no evidence of autocorrelation in the model's residuals (Appendix Figure A1).



(a) (b)

Figure 6 Stability Diagnostic Test: CUSUM and CUSUM of Squares

We created the Unrestricted NARDL model specified in Table 3 to derive the asymmetric cumulative dynamic multiplier (long-run) effects of a unit change (increase and decrease) of real GDP, crude oil prices and exchange rate, respectively, on the food price (Table 4). All of the variables are shown to be statistically significant determinants of the food price in Malaysia, except the break time dummy.

Table 4 The Computed Long-run Coefficients

Variable	Coefficient	Standard Error	P-value
Constant	5.643***	0.077	0.000
Dummy2007Q4	0.042	0.059	0.484
MYR^{+}_{t}	1.852***	0.360	0.000
COP^{+}_{t}	0.355***	0.080	0.000
$RGDP^{+}_{t}$	-2.308**	1.004	0.026
MYR^{-}_{t}	-0.764**	0.339	0.029
COP^{-}_{t}	0.358***	0.077	0.000
$RGDP^{-}_{t}$	-24.449***	7.203	0.001

Note: ***, **, and * denotes significant at 1%, 5%, and 10% significance level, respectively

Firstly, the long-run crude oil price has shown to be positively related to dynamic food price movements, indicating that an increase of crude oil price will lead to a food price inflation increase and *vice-versa*. Moreover, the moderate magnitudes of long-run crude oil price increase (COP^{+}) and reduction (COP^{-}) were 0.355 and 0.358, respectively, which was in close correspondence with Baffes and Dennis (2013) [5] but greater than Ibrahim (2015). Surprisingly, there is no statistical evidence to support the theory that the crude oil price has an asymmetric impact on food price, as the Wald test statistic failed to reject the null hypothesis of symmetric relationship (Table 5).

The Malaysian Ringgit depreciation (MYR^{+}_{t}) has a positive impact on determining food price movements, however, the exchange rate has an opposite impact on food prices when the Malaysian Ringgit appreciates (MYR^{-}_{t}). Additionally, the magnitude of Malaysian Ringgit

[5] The average long-run oil price pass-through coefficient in food price from 1960 to 2012 is estimated to be 0.34 by Baffes (2007).

appreciation (-0.764) is smaller than the ringgit depreciation (1.852) impact on the food price fluctuation. This indicated that the import bills for food will increase when the Malaysian Ringgit becomes cheaper and this will consequently increase the value of import food bill then drive food prices to rise (Ibrahim, 2015). When the Malaysian Ringgit appreciates, which will cause Malaysia to import more food from the global market and this will affect the food price increases too. Hence, the asymmetric impact of the exchange rate on the food price is supported by the findings of different magnitude of the long-run coefficient and by the Wald test statistic in Table 5.

Table 5 Summary of Wald Test for Asymmetric Long-run Coefficient

Variable	Hypothesis:	t-statistic	F-statistic	Conclusion
Real GDP (RGDP)	$H_0: \tau_1^+ = \tau_2^-$	3.145***	9.889***	Reject H_0
	$H_1: \tau_1^+ \neq \tau_2^-$	[0.003]	[0.003]	Asymmetric
Crude Oil Price (COP)	$H_0: \tau_3^+ = \tau_4^-$	-0.033	0.001	Failed to Reject H_0
	$H_1: \tau_3^+ \neq \tau_4^-$	[0.974]	[0.974]	Symmetric
Exchange Rates (MYR)	$H_0: \tau_5^+ = \tau_6^-$	4.244***	18.015***	Reject H_0
	$H_1: \tau_5^+ \neq \tau_6^-$	[0.000]	[0.000]	Asymmetric

Note: ***, **, and * denotes significant at 1%, 5%, and 10% significance level, respectively.

Furthermore, the increase and reduction of real GDP were found to be negatively significant[6] to determine the food price, which the long-run magnitudes were found to be -2.308 and -24.449, respectively. Accordingly, the Wald test statistic shows that there was an asymmetric impact between real GDP and the food price. An increase in real GDP will increase the confidence of producers and investors to produce more output, hence, increasing the aggregate supply and driving the food price level to fall. In contrast, a reduction in real GDP will lead the food price increase due to a pessimistic business expectation in future sales and a decrease in aggregate supply.

In the short-run, the estimated results showed that changes of exchange rates (i.e. ΔMYR^+_t and ΔMYR^-_t) and positive growth of real GDP ($\Delta RGDP^+_{t-1}$) have a significant impact on the food price movements. However, the positive and negative changes of oil price (i.e.ΔCOP^+_t and ΔCOP^-_t) were found to be insignificant to determine the food price fluctuation in the short-run and this finding confirms the previous findings of Abdlaziz *et al*. (2016) which oil price only have a long-run cointegration in determine the food price. Besides that, the magnitude of both short-run coefficients was -0.011, indicating that there were no asymmetric short-run impact on the crude oil price to the food price volatility.

CONCLUSION AND POLICY IMPLICATION

In this study, we examined the asymmetric impact of oil price, real GDP and exchange rates in the Malaysian food price fluctuation. Firstly, the findings showed that these variables (i.e. price, real GDP, and exchange rate) have a long-run cointegration with food prices. Secondly,

[6] The negative significant impact of real GDP on food price also found by the recent study, which Abdlaziz, et al. (2016) obtained the estimated long-run real GDP coefficients to be -0.025 and -0.0688 in oil price rupiah and oil price USD specification model, respectively.

the Unrestricted NARDL model showed that real GDP and exchange rates have a significant long-run asymmetric impact on food price changes; however, the crude oil price has a long-run symmetric impact on food price movements. Even though some researchers, such as Ibrahim (2015) and Abdlaziz *et al*. (2016), have claimed that the crude oil price has an asymmetric effect on food prices, it may not be appropriate since they have not been tested the asymmetric hypothesis between the two variables specifically. Thirdly, short-run changes of oil price have an insignificant impact on changes of food prices in Malaysia, however, the short-run growth of real GDP and changes of exchange rate have a significant impact on food price fluctuation.

In the nutshell, the findings illustrated that there are two main aspects should pay further attention by the policymaker. Firstly, the evidence showed that the significant asymmetric magnitude in exchange rate related to the food price movement is likely to explain the current food market situation in Malaysia. This indicates that policy attention should be on the issues of exchange rates rather than the crude oil price when considering food price policy. Thus, stabilizes the national currency is more crucial than the oil price control as illustrated by the findings from this study. Finally, the recent oil price subsidies reduction strategy in Malaysia effectively enhanced the local food markets competitions and it is sufficient to prevent the market power control. Hence, the policymakers have to gradually reduce the subsidies in order to enhance the competition in the Malaysian food markets.

Based on these findings, the crude oil price, market business cycle and exchange rate have a long-term significant impact on determine the food price fluctuation. However, the control policy should focus on the exchange rate stability rather than the oil price in Malaysia. Since the rise and fall of oil price have a symmetric magnitude on the food price adjustment, policymakers should promote the market freedom in oil industry such as reduce the market oil price subsidies. In contrast, the asymmetric impact of exchange rate on Malaysian food price fluctuation suggested that the policymaker have to stabilize the national currency in order to maintain the movement of food price. As claimed by Abdlaziz *et al*. (2016), the long-run cointegrated relationship between oil price and food price is strong when the depreciation of a country's currency occurs. Yet, the depreciation of currency will have a huge impact to boost the Malaysian food price and caused it to be volatile. Moreover, the appreciation of exchange rate will increase the food import volumes, thus further import the inflation from international market. Hence, this indicated that the cost-push inflation may affect the food price crisis occurs if the Ringgit Malaysia last on unstable.

REFERENCES

Abdlaziz, R. A., Khalid, A. R. and Peter, A. (2016), "Oil and food prices co-integration nexus for Indonesia: A non-linear autoregressive distributed lag analysis", *International Journal of Ennergy Economics and Policy*, Vol. 6 No. 1,pp. 82 – 87.

Baffes, J. (2007), "Oil spills on other commodities", *Resource Policy*,Vol. 32 No. 3, pp.126–34.

Baffes, J., and Dennis, A. (2013), "Long-Term Drivers for Food Prices", The World Bank Policy Research Work Paper No. 6455.

Chen, S. T., Kua, H. I., and Chen, C. C. (2010), "Modelling the relationship between the oil price and global food prices", *Applied Energy*, Vol. 87 No. 7, pp. 2517–25.

Gilbert, C. L. (2010), "How to understand high food prices", *Journal of Agricultural Economics*,Vol. 61 No. 2, pp. 398 – 425.

Harri, A., Nally, L., and Hudson, D. (2009), "The relationship between oil, exchange rates, and commodity prices", *Journal of Agricultural and Applied Economics*, Vol. 41 No. 2, pp. 501–510.

Hendry, D. F. (1979), "Predictive failure and econometric modelling in macroeconomics: The transactions demand for money", in Paul, O. (Ed.), *Economic Modelling*, Heinemann, London, pp. 217 – 242.

Ibrahim, M. H. (2015), "Oil and food prices in Malaysia: A nonlinear ARDL analysis", *Agricultural and Food Economics*, Vol. 3 No. 1, pp. 1-14.

Ibrahim, M. H., and Said, R. (2012), "Disaggregated consumer prices and oil price pass-through: evidence from Malaysia", *China Agricultural Economic Review*, Vol. 4 No. 4, pp. 514–529.

Karantininis, K., Katrakylidis, K., and Persson, M. (2011a), "Price transmission in the Swedish pork chain: Asymmetric nonlinear ARDL", EAAE 2011 Congress, Zurich, Switzerland.

Karantininis, K., Kostas, K., and Persson, M. (2011b), "Price transmission in the Swedish pork chain: Asymmetric nonlinear ARDL". Paper presented at the EAAE 2011 Congress: Challenges and Uncertainty, September 2, 2011, Zurich, Switzerland

Katrakilidis, C., and Trachanas, E. (2012), "What drives housing price dynamics in Greece: New evidence from asymmetric ARDL cointegration", *Economic Modelling,* Vol. 29, pp. 1064–1069.

Meyer,J., and Cramon-Taubadel, S. (2004), "Asymmetric price transmission: a survey", *Journal of Agricultural Economics,* Vol. 55 No. 3, pp. 581–611.

Mutuc, M., Pan, S., and Hudson, D. (2010), "Response of cotton to oil price shock". Paper Presented at the Southern Agricultural Economics Association Annual Meeting. Orlando, FL, February 6-9, 2010.

Narayan, P. K. (2005), "The saving and investment Nexus for China: Evidence from cointegration tests", *Applied Economics*, Vol. 37, pp. 1979-1990.

Nazlioglu, S., and Soytas, U. (2011), "World oil prices and agricultural commodity prices: evidence from an emerging market", *Energy Economics*, Vol. 33 No. 3, pp. 488–496.

Nazlioglu, S., and Soytas, U. (2012), "Oil price, agricultural commodity prices, and the dollar: A panel cointegration and causality analysis", *Energy Economics*, Vol. 34 No. 4, pp. 1098 – 1104.

Pesaran, M.H., Shin, Y., and Smith, R. (2001), "Bound testing approaches to the analysis of level relationship", *Journal of Applied Econometrics,* Vol. 16, pp. 289-326.

Reboredo, J. C. (2012),"Do food and oil prices co-move?"E*nergy Policy*, Vol. 49, pp. 456–467.

Shin, Y., Byungchul, Y., and Greenwood-Nimmo, M. (2011), "Modelling asymmetric cointegration and dynamic multiplier in a nonlinear ARDL framework", In Sicles, R. C. and Horrace, W. C. (Eds.), *Festschrift in Honor of Peter Schmidt: Econometric Methods and Application,* Springer, pp. 281 – 314.

Yeong-Sheng, T. (2008), "Household expenditure on food at home in Malaysia", MPRA Paper, No. 15031.

Yu , T. H. (Edward), Bessler, D. A., and Fuller, S. (2006), " Cointegration and causality analysis of world vegetable oil prices". Paper Presented at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006.

Zhang, Q. and Reed, M. (2008), "Examining the impact of the world crude oil price on China's agricultural commodity prices: the case of corn, soybean, and pork". The Southern Agricultural Economics Association Annual Meeting, Dallas, TX, February 2nd – 5th, 2008, available at http://ageconsearch.umn.edu/bitstream/6797/2/sp08zh01.pdf.

APPENDIX

Sample: 2000Q1 2016Q2
Included observations: 61
Q-statistic probabilities adjusted for 15 dynamic regressors

Lag	AC	PAC	Q-Stat	Prob*
1	-0.155	-0.155	1.5474	0.214
2	0.057	0.034	1.7602	0.415
3	-0.202	-0.194	4.4761	0.214
4	0.050	-0.010	4.6429	0.326
5	-0.062	-0.047	4.9066	0.427
6	-0.143	-0.211	6.3300	0.387
7	-0.038	-0.091	6.4338	0.490
8	0.089	0.057	7.0139	0.535
9	0.041	-0.010	7.1357	0.623
10	-0.198	-0.248	10.095	0.432
11	-0.080	-0.167	10.582	0.479
12	0.086	0.023	11.157	0.515
13	-0.024	-0.136	11.202	0.594
14	0.115	0.055	12.282	0.584
15	-0.047	-0.012	12.465	0.644
16	0.082	-0.080	13.039	0.670
17	-0.029	-0.068	13.112	0.729
18	-0.000	0.005	13.112	0.785
19	-0.053	-0.036	13.366	0.819
20	0.082	0.019	14.000	0.831
21	0.002	-0.009	14.000	0.870
22	-0.129	-0.190	15.631	0.834
23	-0.004	-0.081	15.633	0.871
24	-0.022	-0.009	15.686	0.899

*Probabilities may not be valid for this equation specification.

Figure A1Correlogram Q-Statistic for 24 Lags