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FOOD INFLATION: A STUDY ON KEY DETERMINANTS AND PRICE TRANSMISSION PROCESSES FOR MALAYSIA

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ABSTRACT

In Malaysia, food price inflation reached its highest level at 8.8% in mid-2008 compared to overall inflation of 5.5% for the same period, mainly blamed on the spike in world commodity prices. However, recent moves by the government to rationalize food and energy subsidies have also led to higher than normal headline inflation figures and cause public concern. This study investigates the supply-side determinants of food price through a price transmission perspective. Horizontal price transmission channel relates to how trade, transportation cost, exchange rates and distances between geographical areas affect producer prices. On the other hand, vertical price transmission relates to how price changes throughout the domestic supply chain to reflect food processing and distribution costs. A vector error correction model (VECM) using monthly data from 1991 to 2013 confirms that world food commodity prices and real effective exchange rate are the primary determinants of food prices in Malaysia; whereas changes in the vertical transmission channel may have been muted by government price controls and subsidy programs or the industry's organization. Given that world commodity price is likely to be more uncertain in the near future, understanding the dynamics of these shocks and price transmission processes will be important for future policy enhancements.

***Keywords*:** Commodity Prices, Food Price Inflation, Price Transmission Channels.

1. INTRODUCTION

High increase in food prices often elicit policy responses that can either cushion or exacerbate the impact on vulnerable households in many countries. Policy options may range from export restrictions, control on domestic prices, income support programs to massive public agricultural investment initiatives. While the rich households are likely to be able to adjust their expenditure patterns to deal with higher food prices, the poorer households tend to be exposed to greater risk of malnutrition as food already takes a large proportion of their income. On the other hand, food price inflation continues to dominate the academic sphere not least because its behavior tends to be disconnected with general inflation trends as a whole, corresponding to food's nature as a perishable commodity and its production subjected to the vagaries of climate, politics and trade structure at both the world and domestic levels. For the case of Malaysia, the overall trend suggests

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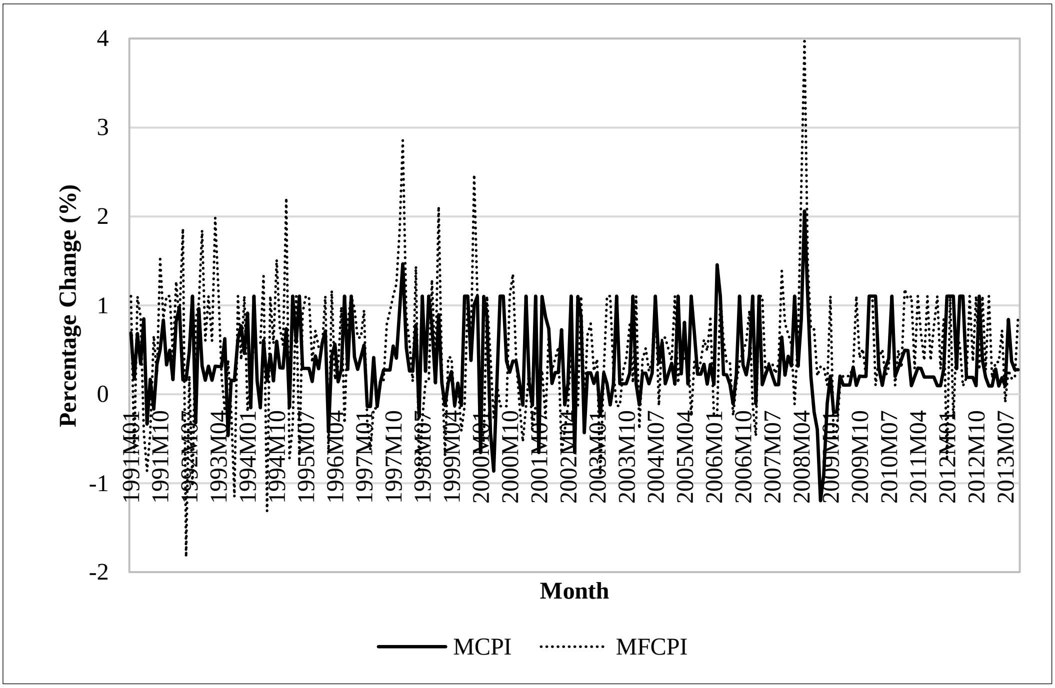
that food price inflation exhibit higher rate of volatility compared to general consumer prices (Figure 1).

Literature on food prices often emphasized the effect of world agricultural commodity markets on domestic prices of food products. However, Vavra and Goodwin (2005) argued that the world food price is more volatile than price of food production in domestic market and could have very little influence on domestic retail prices. This is mostly true in the case of Malaysia (Figure 2). They explained that changes in the global market are not always perfectly transmitted to the consumers due to a number of factors such as trade and domestic agricultural price support policies. In addition, different levels of activity from production to consumption and vice versa would affect the speed and size of the impact of a shock in prices at one level to another, either upstream or downstream.

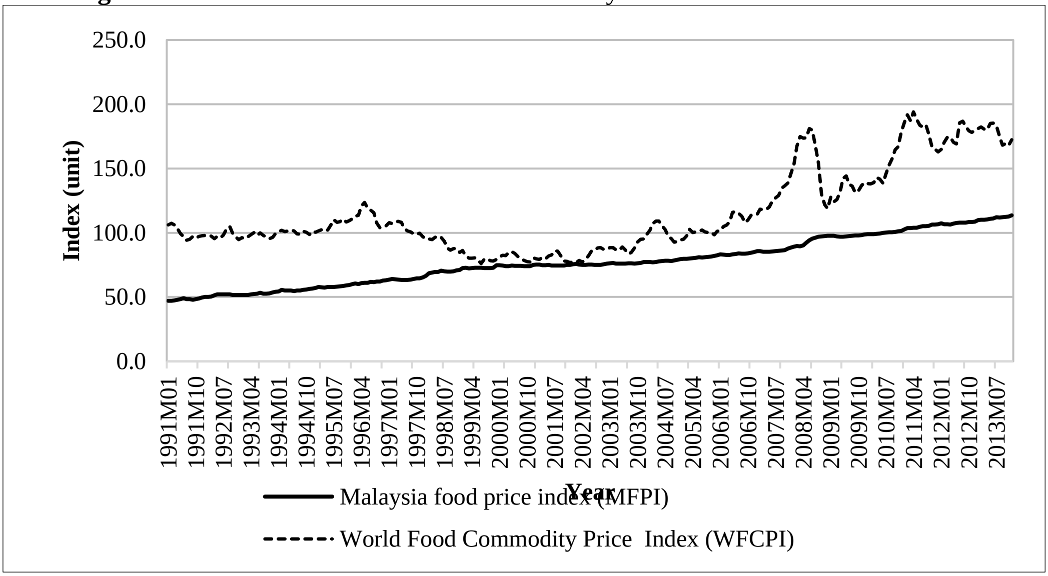
Figure 1: Percentage Change of Monthly Malaysian Consumer Price Index and Malaysian Food CPI



Source: Department of Statistics Malaysia

Theoretically, higher exchange rates contribute to higher costs of importing. What does this mean for Malaysia as food items constitute a major part of the country's import profile? The trend of weak ringgit could inhibit imported inflation for Malaysia despite the exchange rate pass through effects in the form of higher domestic prices especially for food items. To understand the relationship between exchange rates and food prices in Malaysia, we plotted both data in Figure 3. Granted, the development in the exchange rate of Malaysia trading partner and changes in inflation rates, have caused the real effective exchange rate of Malaysia to be unstable. Notably, in the year 1998 the Ringgit depreciated as the Malaysian economy became affected by the Asian Financial

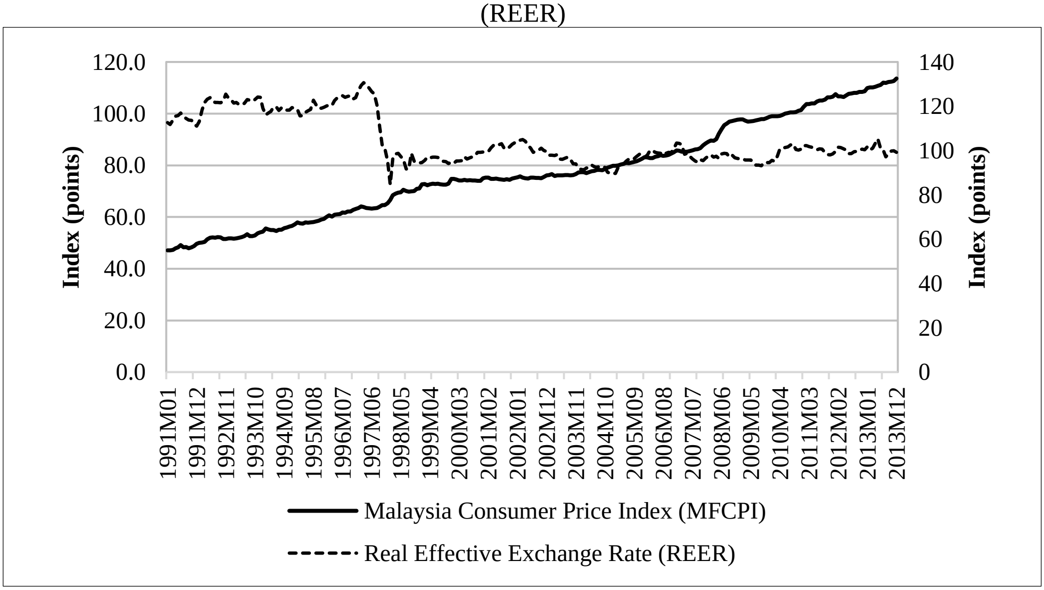
Figure 2: Indices of World Food Prices and Malaysian Food Price Production Index



Source: Department of Statistics Malaysia

crisis, going as low as 84.71 points. After the crisis, it began to strengthen albeit slowly, increasing by more than 10 points after a year. In contrast, Malaysian food price index increased gradually and reached the peak in the year 2013. This sets up the question whether changes in exchange rates do play a role in determining domestic food prices in Malaysia.

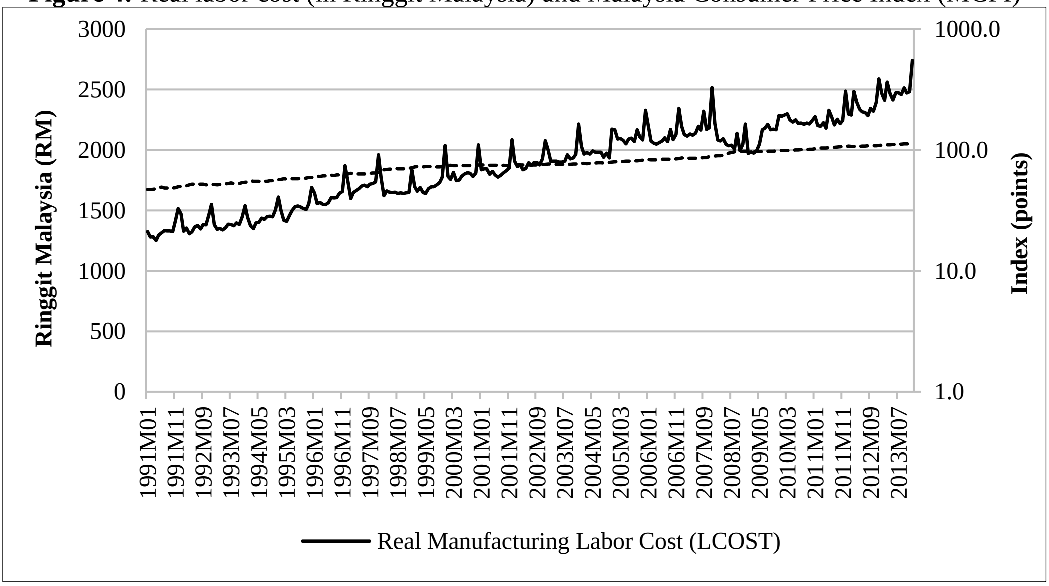
Figure 3: World Commodity Food Price Index (WCPI) and Reel Effective Exchange Rate (REER)



Source: Department of Statistics Malaysia

On the domestic front, additional determinants of food price are those that affect cost of food processing and retailing. Raw food imported from abroad such as milk, corn sugar and wheat are processed to produce final food products in many of Malaysian large and small-scale industries in Malaysia. High labor factor intensity in these industries inevitably affects food prices through changes in labor costs. Real labor cost of manufacturing sector increased consistently in the sample period (Figure 4) except in 2008 where firms struggle to adjust production levels and labor costs especially in the manufacturing sector (Nambiar, 2012). Again, the trend in no way shows any resemblance to the domestic food price movements. Increase of labor cost tends to lead to the increasing of food price while its reduction does not seem to have any effect.

Figure 4: Real labor cost (in Ringgit Malaysia) and Malaysia Consumer Price Index (MCPI)

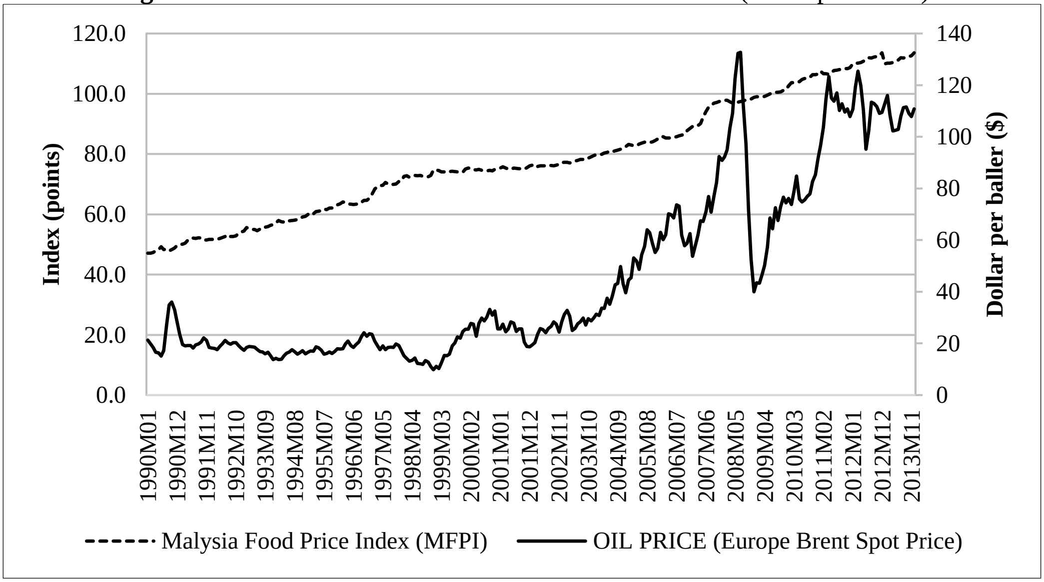


Source: Department of Statistics Malaysia

An equally important factor to be considered is world oil price. Agriculture as an energy-intensive sector makes it highly vulnerable to oil price shocks. On the other hand, for food processing firms, oil prices affects the costs of energy used for machines whilst for food retailing firms, it affects their costs of delivering the products to warehouses and retail outlet. In a nutshell, shocks in the oil market will give pressure to food prices at so many levels as the cost of importing, producing, processing and distributing food increase. Figure 5 below shows the relationship between world oil price (Brent oil price) in dollar per barrel and the Malaysian Food Price Index. From the graph, it can be seen that in the long run, an oil price increase tends to increase the food price while the oil price reduction does not seem to affect food price, contributing to the 'downward stickiness' theory of price.

This study investigates the supply-side determinants of food price through a price transmission perspective: horizontal and vertical. At the outset, horizontal price transmission process, i.e. from the world market to the domestic market appears to play a dominant role to influence the domestic of food price in Malaysia. It is because, for much of its food supply, Malaysia still needs to import from the other countries. Malaysia's food import bill reached RM 15.4 billion mainly for sugar,

Figure 5: Domestic Food Price Index and Brent Oil Price (dollar per barrel)



Source: Department of Statistics Malaysia

vegetables and fruits, and cocoa, dairy products and cereals for further processing for human consumption and animal feed production (MIDA, 2016). The vertical price transmission relates to how price changes throughout the domestic supply chain. The vertical price transmission process is important to understand given the changing structural characteristics, given Malaysia's shift from a manufacturing-based economy to one that is service-based. This has implications on costs of food preparation, processing and should be studied in depth.

Furthermore, this research aims to expand the pool of research available on this topic as far as a middle-income country is concerned. In particular, the study aims to fill in the void in studies on determinants of food price inflation in Malaysia, where the main papers are Ibrahim (2015) and Applanaidu and Baharudin (2014). There is no study that we know of which investigates horizontal and vertical price transmission processes of food items. It is critical to have a strong understanding of the dynamic price shocks on the domestic retail price for policy formulation in agriculture, trade and government transfers. Given recent events of food price surge in the market with high level of food price inflation in Malaysia, this study will determine which is the more critical price transmission channel and subsequently direct focus to the most effective solutions to food inflation issues.

Food price inflation is a result of unique combination of micro and macro factors in the economy. It continues to be an important thread in development economics literature and has been studied extensively. Our contribution to the relevant literature are threefold: the use of an expanded C-VAR model to explain food prices per se, the horizontal and vertical price transmission analysis and finally a short and long run dynamic relationship analysis. The remaining text of the paper is organized as follows. Section 2 describes the literature available, followed by a section outlining the empirical technique and data. Section 4 discusses findings while Section 5 concludes.

2. LITERATURE REVIEW

The main focus of this chapter is to explore the literature on key determinants of domestic consumer food price inflation. For traction, the literature review will be divided into two parts. The first part will discuss the theoretical concept of horizontal and vertical price transmissions for food. The second part will highlight findings from previous studies to help guide the modeling of food price determinants specifically for Malaysia.

2.1. Price Transmission Processes

In a general context, price transmission can be understood as a change of one good's price that causes another good's price to change. Cachia (2014) defines price transmission in the food sector as "*a percentage change in food consumer prices resulting from given changes in the international market price of a basket of agricultural commodities"*. Listorti and Esposti (2012) defines horizontal price transmission as price linkages from the raw commodity to producer levels. It can also be perceived as linkages occurring among different markets at the same position along the supply chain. The horizontal price transmission process is influenced by other factors such as the number of stages in marketing and the corresponding contractual arrangements between economic agents, storage and inventory holding, delays caused in transportation or processing, or "price-levelling" practices (Davidson et al., 2011) as well as government's subsidy and price control policies. All these point to the role of the food industry's degree of competition or government intervention in determining domestic food price behavior in response to global market shocks.

Davidson et al. (2011) found that world commodity prices only indirectly affects UK food price inflation in which the horizontal transmission process occurred through oil price effects. Bakucs et al. (2015) investigates the efficiency of European Union (EU) internal dairy market between 2000 and 2014 through a systemic approach analysis. They found that, the horizontal price transmission in milk sector in EU was less prominent than other sectors such as pork and cereals, mainly because of milk's low trade costs and high trading volumes. Although physical trading is not a pre-requisite for market integration in EU, its membership system significantly influences the integration of price across member countries. This underscores the importance of trade regime and trade activities in influencing horizontal price transmission within EU countries. The former concerns factors such as trade cost, volumes, trade liberalization, exchange rates and distances between geographical areas that may influence what happens between world's agricultural commodity prices to producer price at the domestic level, also known as farm gate prices (Davidson et. al., 2011, Listorti and Esposti, 2012; Bakucs et al., 2015; Areté Reasearch & Consulting in Economics, 2011; Asche et al., 2007).

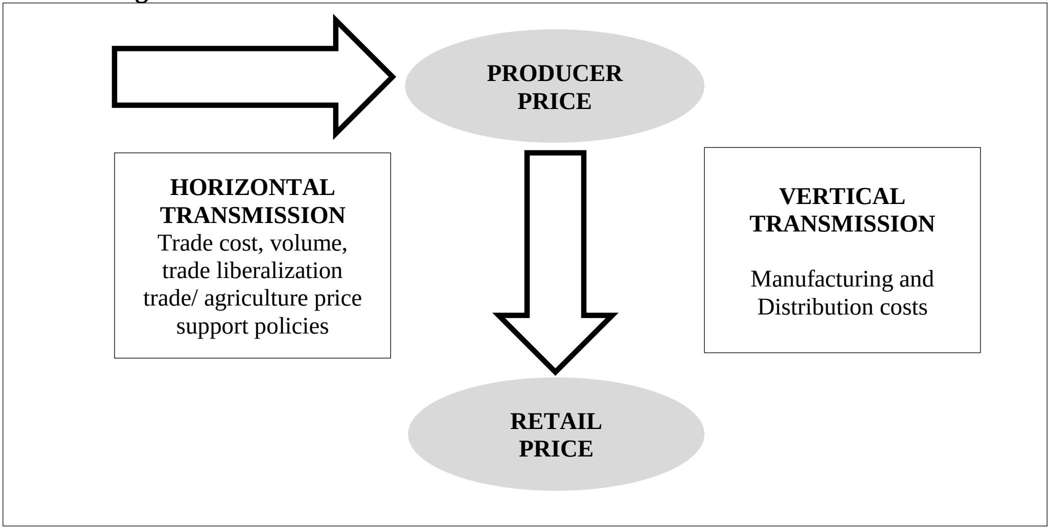
Vertical price transmission concerns price changes mainly from producer to wholesale and to retail level, reflecting food processing and distribution costs. Research on vertical price transmission caught on relatively late compared horizontal price transmission. Basically, the studies try to understand how uncertainties in the country's local resource markets are eventually reflected in domestic food price formation. The scope of literature in vertical transmission studies often deals with the following dimensions: (i) the magnitude of the response at each level given shock to other level; (ii) the speed of the lag of adjustment of price to the equilibrium price in the market; and (iii) the nature of adjustment either following the positive or negative shock associated with asymmetric price transmission and lastly the direction of adjustment of price transmission either upwards or downwards in the supply chain (Vavra, & Goodwin, 2005).

Davidson et al. (2011) found that retail food price movement is accounted only in a small degree by world raw commodity prices, the remaining is explained by changes in manufacturing costs of food. This finding is similar to Vavra and Goodwin's (2005) in that raw agriculture commodity prices account for only around 20-30% of the final good price in the developed countries.

Often the discussion about vertical price transmission also focuses on the issue of market power along the food supply chain. For instance, Lloyd et al. (2006) investigate the UK Bovine Spongiform Encephalopathy (BSE) crisis using a Vector Error Correction Model (VECM), and found that the high degree of market concentration in the UK beef market do influences relative changes in retail and farm prices. The result also highlighted that the BSE crisis affect production prices more than retail prices. More importantly, the presence of shocks to the retail demands and supply will affect the retail farm margin. In contrast, the absence of shock will cause the risk on margin losses to become minimum because the cost of production of food is solely determined by the marketing cost throughout the supply chain.

However, the nature and rate of adjustment may be affected by market distortions especially by government intervention in the form of policies such as price support mechanism, agriculture policy instrument and so forth. Rajendran's (2015) study for India found a large gap between the wholesale and retail prices especially in certain districts in India. Both positive and negative asymmetries exist partly because of high risks of price loss due to weak-harvest infrastructure, imperfect price information and high transportations cost between the markets. Furthermore, the study detected the presence of market distortion due to high price mark-up and margins which later create price differences in India domestic retail market of onions. This goes to show the importance of trading structure and scale in influencing local food distribution costs and subsequently food prices. In our study, the variables that reflect the vertical price transmission process are labor costs and oil prices. While oil price has a role in both transmission channels, its effect in the horizontal price transmission channel is believed to be subsumed in the movement of global commodity prices, hence our study investigates oil prices in the horizontal channel (Figure 6).

Figure 6: Horizontal and Vertical Price Transmission Process for Food items



Source: Author's own

2.2. Empirical Evidences

This subsection highlights findings from previous studies to help guide the variable selection and empirical approach for our study on food prices for Malaysia.

(a) World food commodity prices

Most of the empirical literature found domestic retail food price to be positively related to world food commodity prices. Davidson et al. (2011), for instance, find that the world food commodity is one of the determinants of food price inflation in the case of UK. This finding is similar to the study done by Ferrucci et al. (2010) using a Vector Auto-Regression (VAR) estimation model of different food commodities and monthly data from January 1997 to June 2009. Local prices were the result of dynamic reactions in the EU market to external and internal factors affecting world commodity prices such as bad weather condition, low inventories at the onset of the boom, imposition of trade in major food exporting countries as well as changes of consumption demand of the EU countries members. The impact of world commodity markets also applies to less developed countries. For instance, Rangasamy (2011) proves the increase of world commodity price gives immediate positive impact to food price formation in South Africa.

(b) Labor cost

In general, retail prices are made of the price of raw commodities known as farm gate prices and its processing and marketing bills. The food processing bill involves to a large extent labor costs since the food industry remains mainly labor-intensive. As people consumed more processed and prepared food, the demand for inputs, especially labor, will increase and push up cost of production (Henderson and Executive, 2008; Irz et al., 2013). Often the study on the impact of labor cost towards inflation has been influenced by other dynamic macroeconomics factors. Landerretche et al. (2007) examined the price transmission effect of energy prices and inflation. In the presence of oil price shocks, labor become more expensive in the economy as workers adjusts their inflation expectations in the wake of shocks. The expectation margin falls and aggregate supply of goods and services contracts. Consequently, labor cost is reverted to customer through price transmission mechanism in terms of higher prices on finished food products. However, Davidson et al. (2011) found that labor cost is less significant to food price inflation rate in the UK, probably because in advanced countries, food manufacturing is relatively less labor-intensive. In sum, labor cost as a potentially important supply shifter in the food price framework as long as food processing and retailing sectors remain labor-intensive and wage rates variable.

(c) Real effective exchange rate

Exchange rate play dominant role in the price transmission of the world commodity prices to domestic market (Abbot et al., 2009; Landerretche et al., 2007; Nakamura and Zerom, 2010). Notably, world commodity prices and world oil price are the most important factors in the food supply. Any changes of these two factors are transmitted to domestic prices by what is called the exchange rate pass-through effect. As most of the commodities in the international market are priced in US dollar, small changes in exchange rate may give significant impact to the other countries (Abbot et al., 2009). Trostle (2008) explained that the depreciation of dollar has produced a positive impact on the international trade of food commodities as other countries are able to import from the United States with lower prices. The depreciation of dollar also gives advantages to the countries that have large foreign exchange reserves. Thus the appreciation of other currency against the dollar will result to relative advantages of other countries to increase their food export from the international market.

Davidson et al. (2011) found that movement in the dollar exchange rate may offset or exacerbate the effects of dollar denominated price of agricultural commodities in world market. Their study found that given 10% of shocks to dollar exchange rate, there is an immediate and largest quantitative impact to the market. This indicates that the food price inflation in UK is elastic to the changes in the exchange rate. Similar findings are also found by Baek and Koo (2010). By applying (VECM) model, they found that exchange rate has a significant causal relationship at least in the long run. In the case of Euro area, Ferrucci et al. (2010) concluded that a surge on aggregate demand causes commodity prices to jump above the new long-run value in order to restore the simultaneous equilibrium in the money and goods markets. As a result, although shock originates in the retail sector, the commodity prices are the first to react because they are more flexible. Thus, the cost of exchange rate will be transferred to the commodity market first before be transmitted to the producer and consumer level. Previously, Abbott et al. (2009) show in the case of United States, depreciation of the exchange rate lead to higher prices in the United States, but a lower price to the rest of world and vice versa. Essentially, movement in the dollar exchange rate may offset or exacerbate the effects of dollar denominated price of agricultural commodities in world market (Davidson et al., 2011).

For the case of Malaysia Applanaidu and Baharudin (2014) apply the VAR approach to study dynamic relationship of macroeconomics variables such as biodiesel production, exchange rates, government expenditure, Malaysia GDP and Malaysia's policy towards food security in Malaysia. Exchange rate and government expenditure give highest shock to food security in year five while GDP in year six indicating a high degree of domestic and global market integration via the exchange-rate effect.

(d) World oil price

Shock from oil prices may affect domestic food prices through various points in its supply chain: production, processing and distribution at both the global and local levels. Majority of the studies support the existence of an oil-price pass through effect in vertical and horizontal transmission channels (Nazlioglu and Soytas, 2012; Davidson et al., 2011; Blanchard and Gali, 2007). Oil price affects directly agriculture food prices in the short run and this later results in increase of energy cost throughout the domestic food chain.

In the case of Malaysia, a study by Ibrahim (2015) shows that in the long run, an oil price increase tend to increase food prices while the oil price reduction does not seem to affect food prices. The study, which used a NRDL model and co-integrating vectors, noted that the degree of price transmission from oil price increase to the food price tends to be low with the changes only significantly related in the short run. As Malaysia is one of the net oil-producing country in the world, the adjustment of oil pass-through effect is very important to help policy-makers determine food producer prices. The important highlights from the study is the presence of market power is the most probable reason for fast upward adjustment of oil price into retail food price formation.

The cross-country analysis by Jongwanich and Park (2011) found that Malaysia displays positive level of oil price through into domestic food price as a result of high intensity of oil use in total energy consumption. Oil price shocks may not affect consumer prices depending on the firms' ability to pass higher cost into consumer prices in the presence of government intervention in the form of subsidies and price controls.

3. METHOD AND DATA

The study attempts to build a structural model of food price inflation for Malaysia. Firstly, the stationarity properties for each of the variable included in the model is examined. The stationary series in I (1) are said to be co-integrated if there exists a linear combination of two time-series which produces a stationary trend. If a set of series are co-integrated, there always exists a generating mechanism called 'error-correction mode' which forces the variable to move closely together over time, while allowing for a wide range of short run dynamics (Engle and Granger, 1987). The stationary times series also means that, the shock will be temporary and over time, their effects will be eliminated to ensure the time series data revert to their long run values (Hendry & Juselius, 2001; Asteriou and Hall 2011).

The maximum number of lags that need to be included in the model is determined through a lag selection model criteria test. The number of lags under consideration must be applied and the hypothesis for both tests specified. For this we employ Augmented Dickey Fuller (ADF) test and Philip-Perron (PP) test as alternative to test the stationarity of the times series of the data (Dickey & Fuller, 1979; 1981).

The procedure to test for non-stationarity of the data is necessary as the error term is unlikely to be white nose. The null hypothesis $H_{o:}$ $\Phi = 1$ (unity and hence 'unit root') and the alternative hypothesis $H1_{:}$ $\Phi < 1$. The DF test statistics given by ADF test is the t-statistics for the lagged dependent variable. Hence, if the DF statistical value is smaller than the critical value then we can reject the null hypothesis and conclude that the variable does not has unit root or has stationary process (Asteriou and Hall, 2011).

The second test for unit root test is PP test. Phillip and Perron (1988) developed generalized of ADF test procedure. The PP test makes a correction to the t-statistics of the coefficient γ from the AR (1) regression to account serial correlation in *e*t. The same hypothesis goes to PP test with ADF test. Hence, if the ADF-statistical value is smaller than the critical value then we can reject the null hypothesis and conclude that the variable does not has unit root or has stationary process.

To check the presence of structural breaks from changes in government policy on food price subsidies and controls for Malaysia, a multivariate Chow test is implemented (Chow, 1960; Fisher, 1970). This test is preferable to the general Chow test because the study does not pre-determine the specific points of structural breaks in the model due to lack of information on exact date of government policy changes. To ensure robustness of the test, the study also employs CUSUM test to verify the presence of structural breaks in the time series. The results give the number of structural breaks present and identify the remedies to this problem. A common solution is to divide the time series into subsamples according to the structural breaks. Another alternative is to include dummy variables in the model. CUSUM test also are preferable because is said to have trivial power (power of equal size) for local changes that specify at onetime change in the coefficient model (Perron, 2006). Next, co-integration test been applied in the model by apply two test statistics that known as Trace and Maximal Eigenvalue statistics. As both of test are used to help identify the number co integration of the model, as determined by Trace and the Maximal Eigenvalue statistics ;

$$\lambda_{trace\ (r)} = -T \sum_{i=r+1}^{k} \ln(1-\widehat{\lambda_i})$$

$$\lambda_{max\ (r,r+1)} = -T \sum_{i=r+1}^{k} \ln(1-\widehat{\lambda_{r+1}})$$

From the functions λ's are estimated eigenvalues and where T is the number of effective observations. The trace and maximum eigenvalues statistics by factor (T-np)/T, where T is the effective number of observations and n is the number variables and p is the lag order. Both of above hypothesis denominated as:

Adjusted trace statistics as:

H0: the number of distinct co-integrating relationship is less than or equal to 1.
H1: the number of co-integrating relationship is more than r co-integrating relationship.

Adjusted maximum Eigenvalue test statistics:

H0: the number of distinct co-integrating relationship is less than or equal to 1.
H1: the number of co-integrating relationship is more than r+1 co-integrating relationship.

The result of co-integration will be represented by a linear combination of Y_t and X_t which are stationary variables by taking the residuals of $\widehat{ut} = Y_t - \widehat{\beta 1} - \widehat{\beta 2 X_t}$. The decision of the test indicates that if $\hat{u}t \sim 1(0)$ then the variables of Y_t and X_t (Jalil, Ghani & Duasa, 2009; Asteriou & Hall, 2011).

Based on the literature and discussion above, the empirical model derived to study Malaysia's retail food price determinants is shown as:

$$MFPI_t = WFPI_t + LCOST_t + REERt + OILPRICE + \in_t \quad (1)$$

where $MFPI_t$ is Malaysian Food Price Index, $WFPI_t$ is World Food Price Index, $LCOST_t$ is real labor cost in manufacturing sector, $REER_t$ is Real Effective Exchange Rate and OILPRICE is Oil Prices. $MFPI_t$ is derived from monthly data of Malaysia Price Index of food and non-alcoholic drinks (2005=100). It is an index based on classification of Individual Consumption According to Purpose (COICOP) prepared by Department of Statistics (DOS), Malaysia. $WFPI_t$ is a proxy for world food agriculture prices measured by unit indices, (2005=100). This variable is used to indicate changes in real cost prices of raw food commodity in the international market (International Monetary Fund, 2016). It is expected to have a positive sign since Malaysia heavily dependent on food imports to fulfill commercial and consumer demands for food products. $LCOST_t$ is a proxy for food manufacturing cost in Malaysia, taken from monthly manufacturing cost per worker divided by monthly consumer price index for Malaysia (Department of Statistics Malaysia, 2016). $LCOST_t$ is expected to have positive sign as the labor cost increase will lead to increase the food price in the domestic market. $REER_t$ refers to weighted average of the ringgit against the currencies of Malaysia's trading partner, adjusted for differences in inflation rates. This variable is added into the model to determine whether there is a strong exchange rate pass through effect that may be channeled to the consumers in the form of higher prices of food at the farm gate and retail levels. If the real depreciation of exchange rate causes food imports to increase hence $REER_t$ should display a negative sign. The last explanatory variable is $OILPRICE_t$ which refers to the monthly Europe Brent Spot Price (FOB) which is a proxy for world oil prices, measured in US dollars per barrel. A higher price of oil price in the international market is expected to increase the food production cost through its effect on distribution and manufacturing costs of food items. Hence, the study would expect the $OILPRICE_t$ to have positive sign. Monthly data is obtained for the period between January 1991 and December 2013. Data source for the various variables are:

Table 1: Data Sources

Variables	Source
$MFPI_t$	Department of Statistics Malaysia
$WFPI_t$	IMF primary Commodity Prices
$LCOST_t$	Department of Statistics Malaysia
$REER_t$	Bluenomics economic database
$OILPRICES_t$	US energy Information Administration

Studies in the area of food price inflation make use of varied empirical methods; the most popular being the vector error correction model (VECM), which was used by Davidson et al. (2011) in the case of UK, by Baek and Koo (2010) in the case of US Irz et al. (2013) in the case of Finland, Rangasamy (2011) in the case for Africa as well as Huppé et. al (2013) in the case of Morocco. The main advantage of the VECM is that it allows adjustment to the parameters in the model. The estimators also allow the stationary series in I (1) to be co-integrated and measure the speed adjustment of price transmission form one price into another. The dynamic properties of co-integrated series mean that the existence of causality reaction that can be tested by past observation of one price to the other. Since ECM is incapable in performing causality test at the point adopted, a procedure to capture the causality known as the vector error correction model (VECM) can be employed. This procedure will provide both short run and long run dynamic relationships between the variable through the use of significant error correction term (Johansen, 1992) model which describe a p-dimensional, k^{th} order VAR-model, written in error correction form:

$$\Delta X^t = \sum_{t-1}^{k-1} \tau i \ \Delta X_{t-1} + X_{t-1} + \in_t \tag{2}$$

Later, the model is expressed in its vector error correction (VEC) form where, the co-integrated relationships are explicitly parameterized by the matrix β, coefficient which provides estimates of the long run causality. A defined matrix of error correction, thereby quantify the equilibrium that measures the speed of adjusted equilibrium coefficient. In this study, non-stationary behavior that characterizes the food and producer price index give the possibility of co-integrated long-run relationship among commodity prices and other variables. The error correction modeling format is as follows:

$$\Delta MFPI_t = \alpha + \sum_{k=1}^{n1} \Delta WFPI_{t-1} + \sum_{k=1}^{n1} \Delta LCOST_{t-1} + \sum_{k=1}^{n1} \Delta REER_{t-1} + \sum_{k=1}^{n1} \Delta OILPRICE_{t-1} + \beta_1 WFPI_{t-1} + \beta_2 LCOST_{t-1} + \beta_3 REER_{t-1} + \beta_4 OILPRICE_{t-1} + \beta_4 REER_{t-1} + \in_t \tag{3}$$

4. RESULTS AND DISCUSSION

4.1. Results

The Augmented Dickey Fuller (ADF) and Philip Pherron (PP) tests suggest all the variables are integrated in order 1 or can be denominated as I(1). The results also show that the model has long-term equilibrium running among the variables (Table 2).

Table 2: Results of Unit Root Tests.

Variable	Level		First Difference	
	ADF	**PP**	**ADF**	**PP**
MFPI	-1.09	-1.04	-12.63***	-12.66***
WFPI	-2.42	-2.13	-10.40***	-10.35***
LCOST	-3.29	-5.88	16.49***	-26.63***
OILPRICE	-3.42	-2.85	-11.22***	-11.03**
REER	-2.41	-1.90	-13.38***	-13.33***

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

The values of the Akaike information criteria (AIC) and Schwarz Bayesian Criterion (SBC) criteria and other preliminary diagnostic test indicates that the model suffer from serial correlation. Hence, the study decided to increase the number of lags and used lag 10 in the model. A stability test was carried out to find structural breaks in the model by using multiple break point test and a total of four structural breaks were discovered; July 1994, February 1998, September 2004 and May 2008. It is important to consider as much as possible the full range of unique macroeconomics and microeconomics factors that including subsidy rationalization and price control. It is reported that in 2013, for instance, that moves by the government to rationalize food and energy subsidies have led to higher headline inflation figures. This is not surprising given that subsidies costs make up an estimated 21% of the government's operating expenditure in 2013 (Department of Statistics, 2013). Consequently, four dummy variables mainly DUM1, DUM2, DUM3 and DUM4 were regressed through the Ordinary Least Square (OLS) method and proved to be significant, which means that they are effective to control for structural breaks in the model (Table 3). CUSUM and CUSUMQ statistics stayed within the two critical lines thus confirming that the model is stable and there are no more structural break changes in the model. (Figure 7 and Figure 8).

Table 3: Result of (OLS) Estimation of Dummy Variables.

Break date	Represent Dummy	OLS estimation
July 1994	DUM1	7.147***
February 1998	DUM2	15.121***
September 2004	DUM3	1.302*
May 2008	DUM4	26.771***

Note: [ ] denotes t-statistcs value and *** denotes significance at 5% level, ** denotes 1% significance level and * denotes 10% significance level.

Figure 7: CUSUM test results

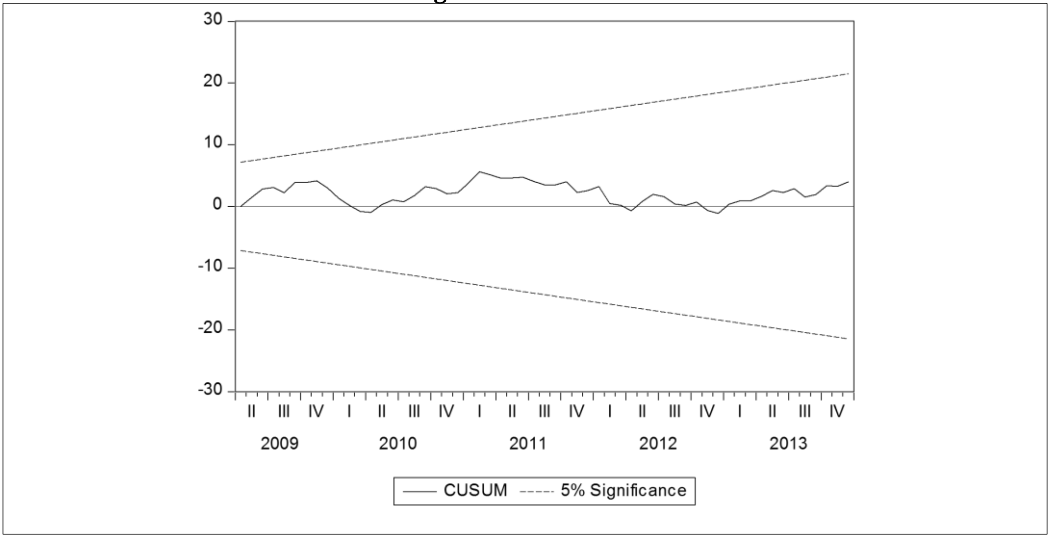
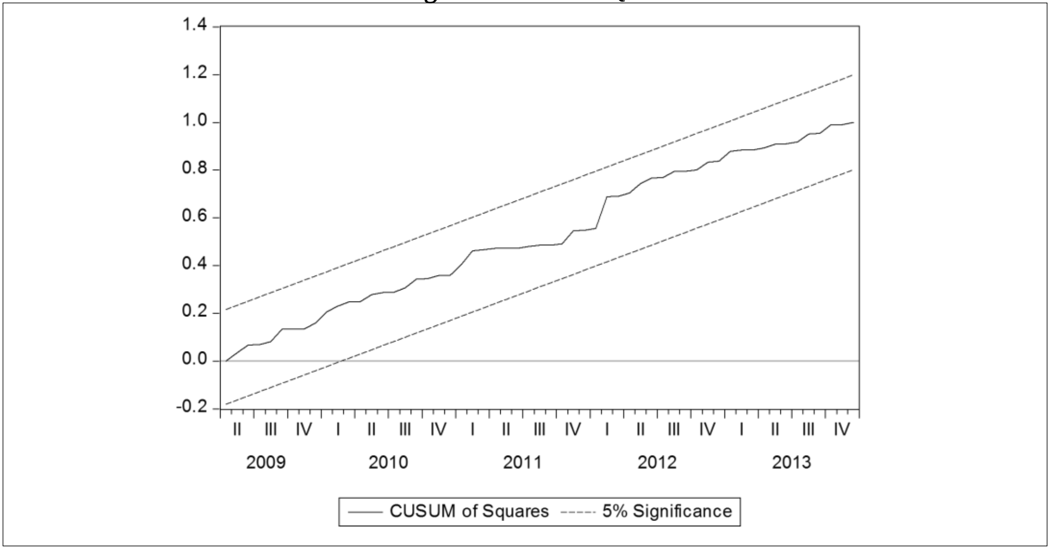


Figure 8: CUSUMQ test results



Following the results above, our Malaysian food price inflation model is specified as follows:

$$\Delta MFPI_t = \alpha + \sum_{k=1}^{n1} \Delta WFPI_{t-1} + \sum_{k=1}^{n1} \Delta LCOST_{t-1} + \sum_{k=1}^{n1} \Delta REER_{t-1} + \sum_{k=1}^{n1} \Delta OILPRICE_{t-1} + \beta_1 WFPI_{t-1} + \beta_2 LCOST_{t-1} + \beta_3 REER_{t-1} + \beta_4 OILPRICE_{t-1} + \beta_4 REER_{t-1} + DUM_1 + DUM_2 + DUM_3 + DUM_4 + \epsilon_t \quad (4)$$

Results from co-integration test indicates that the model have two co-integration vector (r=2) at 5% significance level (Table 4). Adjusted trace statistics indicates that the model contains one co-integration relationship. It is also implied that the variables have long run causal relationship. Any deviation in the long run equilibrium path will be corrected by the model. Furthermore, the test proves that, there must be at least one unidirectional causality from one variable to another. As expected from the outset, changes within the set of explanatory variables would give significant impact to domestic food prices in the Malaysian market.

Table 4: Results of Johansen co-integration rank test

Null hypothesis	Eigenvalue	Trace statistics
$H0$: $r = 0$	85.037***	283.551***
$H0$: $r \leq 1$	58.224***	198.514***
$H0$: $r \leq 2$	46.490	140.289
$H0$: $r \leq 3$	30.336	93.799
$H0$: $r \leq 4$	20.465	63.463
$H0$: $r \leq 5$	18.649	42.348
$H0$: $r \leq 6$	9.397	24.948

Notes: *** denotes significance at 5% level

Results on long run causal relationship supports a positive long run relationship between WFPI and LCOST towards domestic food price in Malaysia, while OILPRICE and REER found to have negative relationship with food price in Malaysia. However, from the estimation, only WFPI, REER and OILPRICE coefficients appear to be statistically significant at 5% of significance level (Table 5). World food price has been found to be significant in previous studies such as Davidson et al. (2011), Ferrucci et al. (2010) and Rangasamy (2011). Exchange rate has been found to be important as well in studies such as by Trostle (2008), Nakamura et al. (2010), Baek and Koo (2010) and Applanaidu et al. (2014). Our findings regarding the role of oil prices are also consistent with previous studies such as Nazlioglu et al. (20112), Davidson et al. (2011), Blanchard and Gali (2007), Jongwanich and Park (2011) amongst others.

The findings indicate that if other factors held constant, 1 unit increase in the world food commodity price index is associated with 0.6175 unit increase domestic food price in the long run, ceteris paribus. This result is the same as the priori expectation in this study and confirms the horizontal price transmission theory. The second significant variable is REER whereby a 1 unit decrease/depreciation of Malaysia's real effective exchange rate is expected to increase food price index by 0.5124 unit, ceteris paribus. This basically means that any depreciation of Malaysia Ringgit will increase the food price in the domestic market.

OILPRICE is found to have a negative relationship to domestic producer price index i.e. a one dollar increase in world oil price per barrel is associated with 0.097 unit decrease in domestic food price index, ceteris paribus. Ibrahim (2015) explains the unexpected result. After Malaysia's decision to de-peg the Ringgit in July 2005, the Ringgit went on an appreciating trend corresponding with the time's sharp upwards swing of oil prices. The government later implemented a managed float system at the end 2014 (The Star, Nov 2014) which is not covered by our dataset. Increase in oil prices will increase cost of production by the producer which is then passed on to consumers, except that for Malaysia the impact is more or less cushioned by price control and energy subsidy programs implemented by the government.

Table 5: Result of Long Run Relationship

Variables	Coefficient
World food commodity Price Index	0.617
	[-7.575]***
Real labor cost	0.0119
	[-1.982]
Real effective exchange rate	-0.512
	[3.508]***
Oil price	-0.286
	[3.629]**
DUM1	3.104
	[-1.765]
DUM2	11.747
	[2.685]
DUM3	4.169
	[-2.187]
DUM4	1.669
	[0.701]

Note: Standard errors are in parentheses. *** and ** denotes significant at 5% and 1% level.

Hence from the cointegration result we can derive long run model of food price inflation in Malaysia as follows:

$$\Delta MFPI_t = \alpha + 0.617499WFPI_{t-1} + 0.512403REER_{t-1} - 0.2868OILPRICE_{t-1} + 3.104020\,DUM_1 + 11.74722DUM_2 + 4.16991DUM_3 + 1.6991DUM_4 + \in_t \quad (4)$$

In order to understand the dynamic relationship among the variables, the study conducted long run weak exogeneity test to identify the driving variables in the model. Driving variables can be understood as variables that pushes the other variables from adjusting to long-run equilibrium, but is not be influenced by the other variables in the model. The null hypothesis of weak erogeneity cannot be rejected for the WFPI, REER and OILPRICE; indicating that these variables are weakly exogenous to the long run relationship in the model (Asteriou and Hall, 2011). The dynamic relationship of all the variables is driven primarily by WFPI (Table 6) whereas REER, LCOST and OILPRICE should be treated as endogenous to the system.

Table 6: Results of Weak Exogeneity Tests

Variables	Weak exogeneity $H_0 : \alpha i = 0$
ΔWFPI	22.545[0.0126]***
ΔLCOST	13.087[0.2188]
ΔREER	12.826[0.2336]
ΔOILPRICE	13.466[0.1987]
DUM1	8.2039[0.6089]
DUM2	14.322[0.1588]
DUM3	6.3485[0.7852]
DUM4	14.153[0.1661]

Notes: Likelihood ratio test is based on the χ^2 distribution and the brackets are p-values ** and * denotes the rejection of null hypothesis at the 5% and 10% significance level respectively.

Domestic food price or MFPI is Granger caused by other variables specifically WFPI, REER, OILPRICE and DUM2 but not by LCOST and other dummies (Table 7). This implies both tests are consistent for WFPI as a primary determinant of domestic food prices in Malaysia.

Table 7: Granger Causality Test

Lag length	K=10	
Hypothesis	**F-stat.**	**Prob.**
WFPI does not Granger cause MFPI	2.347	0.0116**
LCOST does not Granger cause MFPI	1.145	0.3290
REER does not Granger cause MFPI	2.391	0.0101**
OILPRICE does not Granger cause MFPI	1.918	0.0434**
DUM1 does not Granger cause MFPI	0.705	0.7189
DUM2 does not Granger cause MFPI	2.463	0.0080**
DUM3 does not Granger cause MFPI	0.680	0.7422
DUM4 does not Granger cause MFPI	1.363	0.1981

The speed of adjustment coefficient associated with the error correction (EC) terms have the expected negative sign that is required for the model to return to the long-run equilibrium following a shock (Table 8). Notably the negative sign represents the correct sign of error correction, meaning there is evidence of causality in at least one direction.

Table 8: Results of the Vector Error Correction Model

Ind.Variables/Equations	ΔDFPI
$\Delta LCOST_{t-1}$	0.002**
$\Delta LCOST_{t-2}$	0.002**
$\Delta LCOST_{t-3}$	0.002**
$\Delta REER_{t-1}$	0.0.395**
$\Delta REER_{t-2}$	0.0578**
Ect_{t-1}	0.050
Included Observations	265
Adjusted R^2	0.5250
Diagnostic test (f-statistics)	
Far	0.1911
Fbreush	0.9209
Farch	0.2833

Notes: (1) Far is the F-ststistics of Breush-Godfrey Serial Correlation LM test, Fbreush is the F-statitistics for Breush Godfrey Heteroscedasticity test, Farch is the F-statistics of ARCH Test. (2) ** and * denotes the rejection of null hypothesis at the 5% and 10% significance level respectively.

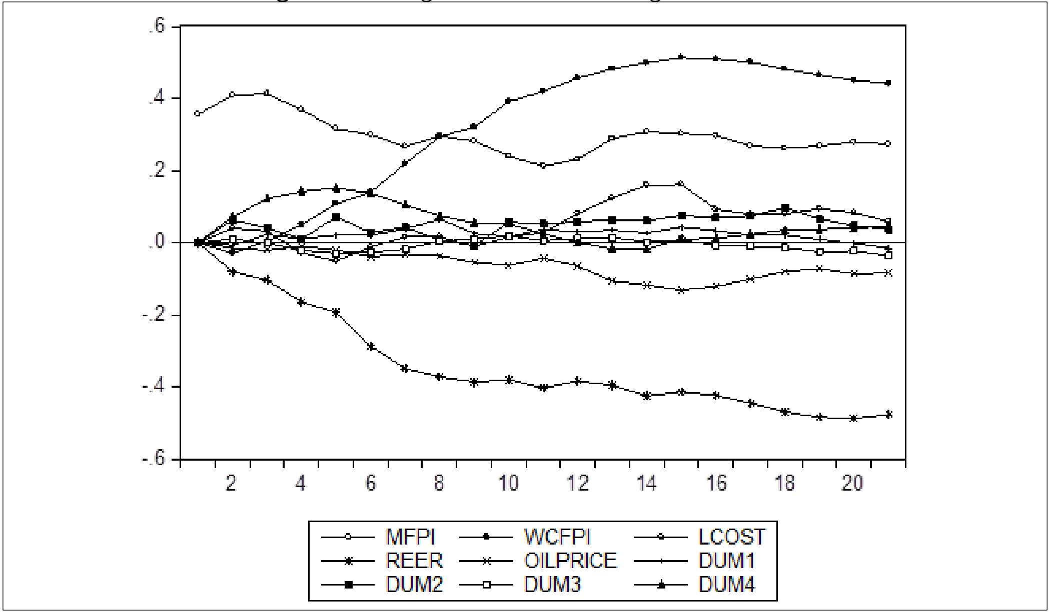
The estimation result also shows that, there are short-run dynamic (causal linkages) between the dependent variables and MFPI but this is influenced by the lagged changes of the variables. The short-term impacts come largely from REER and LCOST. Specifically, the results indicate that increase in REER negatively affects food price inflation in Malaysia and is the most significant variable in the short run. The results concur with the study done by Butkowski et al. (2013). That labor cost is positively related to food price inflation is consistent with studies such as by Abbott et al. (2009) and Davidson et al. (2011).

The results of vector error correction model (VECM) show that when deviating from equilibrium condition, WFPI, REER and OILPRICE adjust to correct the long-run disequilibria. Estimation of the PVEC model shows that the error correction term for MFPI is negative and significant at 5% of significance level. Adjustment of the model is not instantaneous; rather it takes approximately 1/0.050043 or 20 months to revert to equilibrium.

As for diagnostics tests, the F-statistics estimates for Breush-Godfrey Serial Correlation LM test, Breush Godfrey Heteroscedasticity test and the ARCH Test have all confirmed that the model does not suffer from serial correlation and heteroscedasticity problems.

To obtain a more complete picture of the effect of various dynamic shocks on Malaysia's food price trends, we undertake the impulse response analysis. Each impulse response function measures a 10% of shocks in each determinant on MPFI in the 21 month period following the shocks. Figure 8 shows the dynamic impacts of permanents 10% shock to each of the driver in the study. Shocks to world food commodity prices and real effective exchange rate have the largest quantitative impacts on Malaysia domestic producer prices. The magnitude of shock increases over time and continued to increase over 21 months. 10% of shocks to oil price world have quantitatively smallest impacts to food price formation. Relatively smaller impacts are recorded by the labor cost albeit positive and the impacts diminish after 9 months.

Figure 8: Changes in MFPI following 10% shocks



Shocks coming from WFPI and REER appears to have the largest quantitative impacts on Malaysian domestic food prices (Table 9). A single period 10% shock in WFPI is estimated to increase domestic food prices index by 11.44% in the 6 months following the shock. It affects the domestic food prices with the maximum magnitude 49% in the 15th month before diminishing slowly thereafter. REER recorded 10% of changes within 3 months after the shock. The depreciation of REER reached the maximum level on the 21st month with an increase of food prices approximately by 48.6%. The other variables such as LCOST, OILPRICE and the structural dummies recorded smaller impacts on domestic food price movements.

Table 9: The percentages of domestic food prices following 10% of shocks

Variables	**Duration of shocks**							
Period	**1**	**3**	**6**	**9**	**12**	**15**	**18**	**21**
WFPI	0.00	-0.008	0.114	0.311	0.4621	0.499	0.464	0.429
LCOST	0.000	-0.111	-0.111	-0.099	-0.002	2.049	0.046	0.042
REER	0.000	-0.102	-0.272	-0.381	-0.373	-0.422	-0.472	-0.486
OILPRICE	0.000	0.007	-0.008	0.053	0.003	0.009	-0.038	-0.053
Dum1	0.000	0.009	0.034	0.520	0.026	0.0521	0.028	0.007
Dum2	0.000	0.003	0.046	0.989	0.032	0.122	0.148	0.097
Dum3	0.000	-0.026	0.544	0.423	0.291	0.018	0.024	0.000
Dum4	0.000	0.109	0.130	0.087	0.022	0.056	0.098	0.134

5. CONCLUSION

All in all, the empirical exercise revealed that Malaysia food price inflation can be explained primarily by world food commodity prices and real effective exchange rate. Oil prices contribute to surge of food price inflation in the long run and may have indirect effect on domestic food prices through its impact on world food commodity prices. Labor costs as proxy of food processing and retailing cost in Malaysia seem to have very little influence on food price inflation, both in the short and long run.

It is also possible to conclude that the horizontal price transmission process is more critical to consumer food prices than vertical transmission. Both world food commodity prices and real effective exchange rate are proven to be major determinants of food prices in Malaysia. Given the current scenario, both are likely to be more uncertain in the near future, hence understanding the dynamics of these shocks on domestic food retail price is important for future macroeconomics policy design.

The empirical analyses in this study suffers from a few limitations. Firstly**,** estimation model in this study use a fixed weighted index of average selected commodity price in the international market as a proxy of world food commodity price and therefore does not always correspond to the country's own food import profile. Secondly, due to lack of relevant monthly time series data, the model does not include any demand shifters to represent changes in consumer motivation or ability to purchase food items. Gilbert (2010) argued that demand factor plays a major role in determining the aggregate level of food prices, even if supply side factor predominate for specific commodities separately. For example, Davidson et al. (2011) used unemployment rate as the proxy of demand shifters in his study.

This study proposes more regular supervision of the food supply chain in the market to observe market competition effects at wholesalers, retailers and importers level. In the long term, the government should intensify her efforts to develop domestic private agriculture and food processing sectors. Moreover, it is crucial for Malaysia to promote self-sufficiency in her food reserve. This could be supplemented by the establishment of national food reserves and shared global buffer stock as proposed by Wright (2009) and Gilbert (2010).

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