International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2016, 6(1), 82-87.

Oil and Food Prices Co-integration Nexus for Indonesia: A Non-linear Autoregressive Distributed Lag Analysis

Rizgar Abdlkarim Abdlaziz[1,2]*, Khalid Abdul Rahim[3], Peter Adamu[4,5]

[1]Darbandixan Technical Institute, Sulaimani Polytechnic University, Iraq, [2]Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia, [3]Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia, [4]Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia, [5]Department of Economics, Kaduna State University, Kaduna, Nigeria.
*Email: rizgarabdlkarim@gmail.com

ABSTRACT

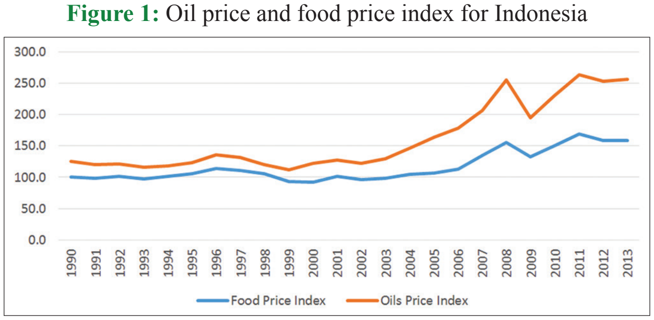
This paper examines the relationship between the prices of oil and food price for Indonesia using non-linear autoregressive distributed lag (NARDL) method. The bound test for co-integration for the NARDL model shows the evidence of co-integration between food price, growth rate of gross domestic product and oil price. The estimated NARDL for the oil price in domestic currency provides strong evidence of long- and short-run co-integration between food and oil price when the latter increases while the relations for oil price reduction is not present and insignificant. The estimators of positive change in oil price model measured in US Dollar are significant in our study.

Keywords: Oil Price, Food Price, Non-linear Autoregressive Distributed Lag, Indonesia
JEL Classifications: B4, E3

1. INTRODUCTION

In recent years, changing oil price impacted our lives in the different ways, one notable result of the oil price spike has affected food price positively. In other words, oil price fluctuation go co-movement with inflation in general and with food inflation in particular. That means oil price change impact our basic needs indirectly through the food inflation (Chen et al., 2010). As illustrated in Figure 1, mutual association in food and oil prices in Indonesia were observed. When oil price fell dramatically in 2008 correspondingly food price decreased and after the oil price went up in 2009 food price steadily began to rise. The volatile nature of oil price and how it affects the domestic and external sector has attracted profound scientific debate among researchers about the nature and direction of the relationship between food and oil price in recent times.

Figure 1: Oil price and food price index for Indonesia



Many factors lead to food price volatility. Besides agricultural production and/or consumer consumption shock, high oil prices may generate extra demand for grains as biofuel feedstock which consequently lead to an increase in its price. However, the impact of high and volatile agricultural prices are concentrated on the poorer rather than the richer countries and/or the poor rather than the rich within each society. In other words, it is probably true to argue that in the richer developed economies such as USA and the European countries, energy price volatility is more awkward than food price volatility. Food price instability, therefore, has a greater effect on the developing countries which depend on agricultural production, where maize and rice are the most important food staples (Gilbert & Morgan, 2010).

Indonesia is one of the most populous countries in the world after continental countries (China, India, Russia and United States). At the same time, Indonesia is regarded as one of the invisible giant growth Asian countries that was affected by the 1997 Asian Financial crisis more than its neighbors (Djiwandono, 2000). Table 1 illustrates the severity of the 1997 financial crisis on Indonesia among South East Asian countries (Djiwandono, 2000). Indonesia was the first economy to record serious inflation and its economy contracted by 13.6% in the same year. Figure 2 illustrates the consumer price index for food and exchange rate respectively. At the first glance on the figures, notice that both consumer price index for food and depreciation of Indonesia Rupiah dramatically increased from the second quarter of 1997 to reach the peak at the end of 1998. When we compare the food price inflation to the oil price graph by domestic currency (rupiah), we notice that both of them have the same trends. As mentioned earlier, the impact of rising food prices on poor families is much more than the rich households. Ravallion and van de Walle (1991) found that an increase of rice price by 10% in Indonesia (resulted from government's reforms) clearly increased aggregate poverty without any effect on producer income. In other words, while food prices changed, the income effect on poor families was higher than the rich households.

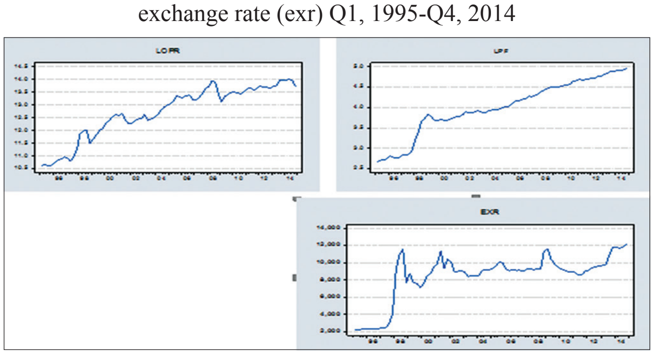
This paper examines the long- and short-run co-integration between oil price change and food prices in Indonesia during 1995-2014. Quarterly data are used in applying the non-linear autoregressive distributed lag (NARDL) approach. The rest of the paper is organized as follows: Some short reviews of empirical studies about the impact of oil price on food prices is provided in the next section. Section 3 describes the methodology and the model. Results and empirical findings are provided in Section 4 followed by the conclusion.

Table 1: South East Asian Economy indicators (%)

Country/ Indicator	Indonesia	Malaysia	Philippines	Singapore	Thailand
GDP					
1991-95	7.8	8.7	2.2	8.5	8.6
1996	8.0	8.6	5.5	6.9	5.5
1997	4.7	8.0	5.1	7.8	−0.4
1998	−13.6	−6.7	0	1.3	−6.5
Inflation					
1991-95	8.9	3.6	10.5	2.6	4.8
1996	6.5	3.5	8.4	1.4	5.8
1997	11.6	2.6	5.1	2.0	5.6
1998	65.0	5.4	9.0	0.2	8.1

Source: Hal Hill, Indonesian Economy, 2000, 2nd ed.. GDP: Gross domestic product

Figure 2: Oil price in domestic currency (lopr), food price (lpf) and exchange rate (exr) Q1, 1995-Q4, 2014



2. LITERATURE REVIEW

The rapid increase of commodity price causes tension in most countries, regardles whether they are developed or developing countries. Oil and food prices have a strong impact on macroeconomic variables. That is because of their economic nature as necessary goods have relatively inelasticity demand. After the oil boom in 1970s, studies on the oil price shock attracted attention of many researchers because it was one of the most effective cause for a universal economic slowdown, especially in oil importing countries (Alom et al., 2013). Despite numerous researches showing the impact of the oil price shock on local or/and global economy, there are not many studies which illustrated the role of the oil price shock on food prices. Results and outcome were mixed with different explanations. These explanations can be approximately divided into two categories: Demand side and supply side factors. The demand side factors considered the fundamental force of rising food prices. Based on that fact, increasing population, rapid economic growth, rising consumption, and rapid increase in production of biofuel and ethanol, etc. led to increase in aggregate demand on agriculture commodities and finally caused food prices to increase. Supply-side factors were also cited highlighting higher agricultural prices. Among others, slow growth in agricultural production, soaring crude oil prices, and droughts were more pronounced supply-side explanations.

Feedstock demand for biofuel and its relation to oil price seemed to keep their roles in determining the recent behavior of agricultural product prices and were considered some of the important factors of agricultural commodity demand and agricultural prices. Other studies indicated the relationship between food and oil prices as factors of rising production of biofuels (Gilbert, 2010). Baffes (2007), Yu et al. (2006) and Zhang and Reed (2008) tried to investigate the dynamics of oil and agricultural commodity interconnection. Yu et al. (2006) could not discover any effect of oil prices on edible oil prices (sunflower oil, olive oil palm oil) and the agricultural raw materials price index, respectively. Zhang and Reed (2008) also found that oil price fluctuations did not cause any reaction in different types of agricultural commodities' prices in China like corn, soy meal, and pork. Similar results were found by Nazlioglu and Soytas (2011) for Turkey. Moreover, Nazlioglu (2011) concluded that there is no linear causality between oil price and agricultural commodities but found a non-linear relation between oil and food prices.

Mutuc et al. (2010) found evidence of a weak effect of petroleum prices on US cotton prices. On the other hand, Baffes (2007), Baffes and Dennis (2013) found evidence of a strong impact of oil price change on food price index. However, he suggested that individual commodity prices be analyzed separately. In a more recent study, Ibrahim (2015) pointed that there exist a long-run relation between oil price increase and food price while the long-term oil price reduction and food price is non-existent. Baffes and Haniotis (2010) found that the highest pass-through from energy prices to non-energy prices exists for fertilizer specifically followed by agriculture in general.

While detecting the impact of petroleum prices on food prices, exchange rate movements have a great role and its importance cannot be ignored. Harri et al. (2009) provided a clear evidence of a long-run equilibrium relationship between oil prices, corn and exchange rate. Kwon and Koo (2009) explained the impact of the exchange rate fluctuation via energy price on the food markets inflation in US between 1998 and 2008. Baek and Koo (2010) supported previous studies in that the exchange rate and agricultural commodity play a fundamental role in determining short- and long-run movement of US food prices. Gohin and Chantret (2010) pointed out the possibility of an adverse link between world energy and food prices when real income is considered.

There are a complex set of factors which are interrelated with each other affecting an increase in agricultural prices. However, the most important factors that influence global food price are: Global change in production and consumption of agricultural commodity, the depreciation of dollar and the oil/food linkage. Nazlioglu and Soytas (2012) explained the relationship between oil price and 24 world agricultural commodity prices in panel setting. They found strong evidence of transmission from world oil price to agricultural commodity prices, on one side and a positive impact of the weak dollar on food prices on another side.

At the national level, most previous studies on food prices in Indonesia concentrated on government food policy in general and rice price policy in particular Tyers (1982) and Timmer (2004). Timmer (2004) attempted to evaluate the effect of rice price for the poor people, real wages in the rural and urban areas. He also illustrated the relationship between the rice price stabilization with economic and political circumstances. David and Huang (1996) used an econometric analysis to explain the role of factors that impact the price of rice in nine Asian countries. They found that consumers were the major beneficiary of policies that reduced the unit cost of rice production.

At the level of Asian countries, Teera Kiatmanaroch (2014) explained the impact of crude oil price on palm oil and soyabean oil prices for ASEAN members using C-vine copula model. They found a slight relationship between crude oil price and palm oil and soyabean oil prices. Teera Kiatmanaroch (2014), in another study, analyzed the relationship between dollar exchange rate and the crude oil and palm oil price. They used generalized autoregressive conditional heteroskedasticity (ARCH) (1-1) and vine copula model to explain the volatility of the exchange rate and the future price of both mentioned commodities and their dependency. They found that exchange rate, palm oil, and the crude oil price had a long-run persistence volatility.

3. DATA AND METHODOLOGY

In our study, we employed the quarterly data from 1995 to 2014. Consumer price index for food in Indonesia is used to capture the food price (PF) and growth rate of gross domestic product in constant price (Y). West Texas Intermediate crude oil price is used as oil price both in US dollar (OPU) and Indonesia Rupiah (OPR).

(OPR = OPU×R)

Where, R is the Rupiah (IDR) exchange rate *viz*. the US dollar. The source of all data is the Federal Reserve Bank of St. Louis (FRED).

To study asymmetric cointegration and long-run relation between oil price and food price as our objective we follow Ibrahim (2015) where he adopted NARDL model that was advanced recently by Shin et al. (2011) for the analysis that captured short- and long-run asymmetric relation between oil and food prices in Malaysia. We also employed NARDL model to evaluate the short- and long-run asymmetries in Indonesian economy using quarterly data from 1995 to 2014.

In the first step, we specify the long-run equation for food price, FP (Shin et al., 2011),

$$\text{lf}\,p_t\ a_0 + a_1 y_t + a_2^+ OP_t^+ + a_3^- OP_t^- + \mu_t \tag{1}$$

Where, *fp* is food price, *y* is real income, *op* is oil price, and $a = (a_0, a_1, a_2, a_3)$ are long-run coefficients that will be estimated. OP_t^+ and OP_t^- are positive and negative changes in op_t:

$$op^+ = \sum_{i=1}^{t} \Delta op^+ = \sum_{i=1}^{t} \max(\Delta Opi^+, 0) \tag{2}$$

And

$$op^- = \sum_{i=1}^{t} \Delta op^- = \sum_{i=1}^{t} \min(\Delta Opi^-, 0) \tag{3}$$

At time *t*, a_2 captures the long-run relation between food and oil price increase that is expected to be positive while a_3 indicates the long-run relation between food and oil price reduction that is also expected to be positive. As Shin et al. (2011) illustrated, we can extend the concept of partial asymmetries for long- and short-run to obtain the following asymmetric error correction model:

$$\Delta pf_t = a + \beta_0 pf_{t-1} + \beta_1 y_{t-1} + \beta_2^+ op_{t-1}^+ + \beta_3^- op_{t-1}^- + \sum_{i=1}^{p} \pi_i \Delta pf_{t-i}$$
$$+ \sum_{i=1}^{q} \O_i \Delta y_{t-i} + \sum_{i=1}^{s} (\theta_i^+ \Delta op_{t-i}^+ + \theta_i^- \Delta op_{t-i}^-) + \mu_t \tag{4}$$

Where, *P* and *s* are lag order and $a_2 = -B_2/B_0$, $a_3 = -B_3/B_0$, are long-run effects of oil price increase and oil price decrease respectively on the food price. $\sum_{i=0}^{s} \theta_i^+$ and $\sum_{i=0}^{s} \theta_i^-$ measure the short-run impact of oil price increase and decrease respectively on the regressand. To examine the property of the data before the estimation of the dynamic model in Equation (4), the following tests are necessary. We applied the conventional co-integration approach based NARDL (Pesaran et al., 1999). Firstly, the non-stationary or integration of the data is tested using the well-known augmented Dickey–Fuller (ADF) and Phillip–Perron (PP) unit root tests. Secondly, confirming the order of integration of the time series, the residual-based test by Engel-Granger (1987) (EG) and the vector autoregressive-based test by Johansen (1988) and Johansen and Juselius (1990) were used to test for co-integrating relationship between the variables. To complete this work we follow four important steps, firstly, by using the standard ordinary least squares we estimated Equation (4), as in Katrakilidis and

Trachanas (2012). We employed the general to specific approach to obtain the final specification of NARDL model by removing the insignificant lags. Then we used the bound test approach of Shin et al. (2011) to examine long-run co-integration among interesting variables and tested the null hypotheses of $B_0 = B_1 = B_2 = B_3 = 0$ jointly. In the final step, we used Wald test to examine the long-run asymmetry between oil price and food prices.

4. RESULTS AND DISCUSSION

For the time series data, unit root test or stationary test were performed to analyze the integrity of interesting variables, which can help spurious regression. We applied ADF and PP unit root test as an important preliminary test for our empirical study. The results are presented in the Table 2. The test include both the constant and the trend. The optimum lag structure for ADF and PP test was chosen based on Schwarz information criterion (SIC). Both tests confirm that all variables are stationary at first difference I(1). It means that none of the variables are I(2); so we can use the bound test procedure.

If the variables are co-integrated in the same order, we can apply the Johansen–Juselius (JJ) maximum likelihood methods of co-integration to obtain the number of co-integration vectors. The asymmetric co-integration test observed below shows the EG two-step co-integration test for food price (lpf) and the oil price in Indonesia Rupiah (lopr). Also, the JJ test for trace and max-Eigen suggested the existence of one co-integrating relationship between the variables. The symmetric test of EG two stages and JJ shows that long-run relationship exists between the variables under consideration (Table 3).

Table 2: Unit root test

Variables	Level		1st difference	
	ADF	PP	ADF	PP
LPF	−3.26*	−2.22	−5.137***	−5.283***
Y	−3.86**	−3.10	−5.71***	−5.95***
LOPR	−2.43	−1.50	−6.95***	−8.85***
LOPU	−3.40*	−2.70	−6.78***	−5.86***

L indicates the natural log of the variables and SIC is used to select the optimum lag order, and ***, ** and * denote significance at 1%, 5%, and 10% levels respectively. ADF: Augmented Dickey–Fuller, PP: Phillip–Perron

Table 3: Symmetric co-integration tests: lpf ly lopr

EGT2S	JJ test	Lag length	r=0	r≤1	r≤2
EG					
5.473***	Trace	1	66.457***	16.739*	3.0914
	Max-eigen		50.465***	13.383	3.0914
	Trace	2	40.590**	11.285	2.885
	Max-eigen		29.304**	8.400	2.885
	Trace	3	35.355**	12.668	3.204
	Max-eigen		22.686**	9.464	3.204
	Trace	4	33.054**	13.326	2.568
	Max-eigen		19.728	10.758	2.568
Critical value					
5%	Trace		29.797	15.495	3.842
	Max-eigen		21.131	14.265	3.842

The SIC is used to select the optimal lag order in EG test. The VAR lag order for JJ test is based on non-autocorrelation errors. ***, ** and * denote significance at 1% 5% and 10% respectively. SIC: Schwarz information criterion, EG: Engel–Granger, VAR: Vector autoregressive

In the first step we estimated Equation (4) and we applied the general to specific techniques to frame the final specification of the model. Vector error correction model suggests that long-run relation between food and oil prices exist in both Indonesia Rupiah and US dollar models, because the error correction estimator are negative and significant for the two models. Lag maximum selection denotes 6 for rupiah model and 3 for USD model based on SIC. Table 4 represents the bounds F - A statistical test that used standard Wald test. The result embodies that three variables, real income, food prices and oil price co-move in the long-run. The F statistic 8.691, for the oil price in rupiah and 5.446 for the oil price in US dollar exceed the critical upper bound. These results allow us to measure the dynamic relation between the food price, real income and positive and negative oil price changes.

Results of the model estimation as in Equation (4) are presented in the Table 5. From these results we can estimate the long-run asymmetric equation for both models. Oil price model with domestic currency and oil price model measured in USD. As shown in Table 6, the long-run coefficients of real income are negative and highly significant. These finding are questionable

Table 4: Bounds test for non-linear co-integration

Oil price specification	F statistic	95% lower bound	95% upper bound	Conclusion
Opr	8.691	3.940	5.043	Co-integration
Opu	5.446			Co-integration

The critical values are from the Narayan 2005

Table 5: NARDL estimation results

Independent variable	Oil specification			
	Oil price/rupiah		Oil price/USD	
	Coefficient	P value	Coefficient	P value
Constant	1.096969	0.0000	0.317375	0.005
$pf(-1)$	−0.375864	0.0000	−0.08297	0.017
$Y(-1)$	−0.009424	0.0000	−0.00571	0.007
$Op^{+}(-1)$	0.135988	0.0000	0.05327	0.028
$Op^{-}(-1)$	0.017209	0.4009	0.03602	0.222
$\Delta pf(-1)$	0.061399	0.5855	−0.0794	0.555
$\Delta y(-1)$	−0.001164	0.6385	−0.0062	0.019
Δop^{+}	0.13	0.0044	−0.0778	0.296
$\Delta op^{-}(-1)$	0.00483	0.9286	0.006	0.914
R^2	0.62		0.45	
J-B	3.3067	0.1914	30.43	0.0000
LM(1)	0.001142	0.973	0.727	0.3936
LM(2)	0.2559	0.88	0.727	0.695
ARCH(1)	6.84	0.9979	0.751	0.386
ARCH(2)	0.1403	0. 9322	2.092	0.3512

J-B is the Jarque –Bera for normality, LM(), is the LM test for error autocorrelation, up to the lag order given in parentheses, and ARCH(), is ARCH test is for autoregressive conditional heteroskedasticity up to the lag order given in parentheses. NARDL: Non-linear autoregressive distributed lag

Table 6: Long-run relation

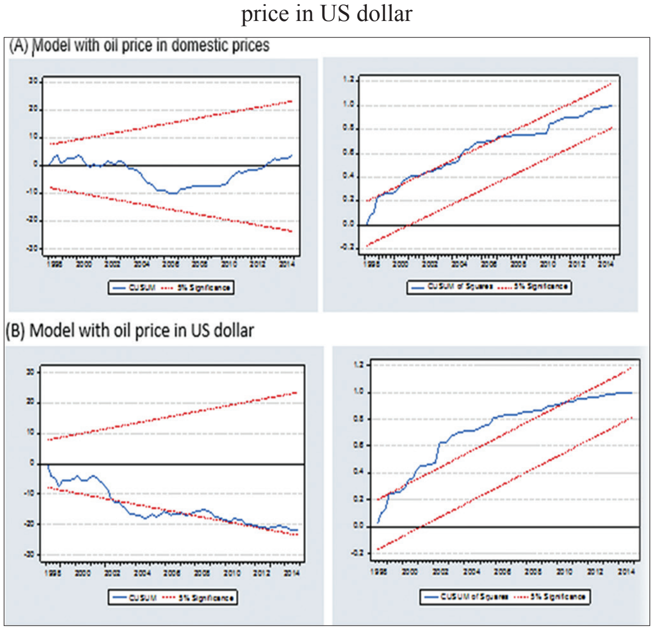
Variables	Oil price specification			
	Oil price rupiah		Oil price rupiah	
	Coefficient	P value	Coefficient	P value
Constant	2.9185	0.000	3.8251	0.000
Y	−0.0250	0.000	−0.0688	0.0062
Op^{+}	0.3604	0.000	0.6421	0.0089
Op^{-}	0.04578	0.409	0.4342	0.263

and unexpected. However, the asymmetric long-run relation between food prices and oil price increase are highly significant but the relation between the food prices during the reduction in oil price are not significant. Our estimate suggests that a 10% increase in oil price leads to 3.6-6.4% increase in food price for oil price model with domestic currency and oil price measured in USD respectively. This finding confirms the previous findings of Baffes and Dennis (2013) which estimated the long-run coefficient of oil price passing through the food price on average at 3%. As we mentioned before, Indonesia is one of the South-East Asian countries that was affected dramatically by Asian financial crises in 1997. The rate of inflation and depreciation of domestic currency in contrast to US dollars were very high compared to the rest of the Pacific countries. Therefore, our estimates are two times larger than the Malaysian cases (Ibrahim, 2015).

Results from Table 5 provide evidence of the existence of short-run asymmetry. It is observed that only the positive change in the oil price model with domestic currency is significant while the negative change in the oil price is not significant for both models. The coefficient of short-run association between food and oil price increase is positive implying that an immediate increase in oil price increases the food price by 13% in the short-run which is twice the immediate impact in Malaysian case (Ibrahim, 2015) because of the serious depreciation of rupiah against the USD during the period of study.

Finally, we checked the adequacy of our dynamic models based on various diagnostic statistic tests. In terms of normality in error term Jarque-Bera statistic was used, Lagrange multiplier (LM) for autocorrelation up to lag (2) and the ARCH statistic for ARCH up to lag (2). All these results are shown in the lower panel of the Table 5. Cumulative sum (CUSUM) and CUSUM of squares (CUSUMSQ) tests are used for checking the structure stability in the model and illustrated in Figure 3. The model of oil price in the domestic currency passes all statistic diagnostic tests except the LM test and CUSUMSQ test, which exceeded a little the two red lines but still is a reliable model. For the oil price model in US dollar the error term suffers from normality problem because the model does not pass Jarque–Bera test and at the same time it suffers from the structure stability that it fails the CUSUM and CUSUMSQ tests.

Figure 3: Cumulative sum (CUSUM) and CUSUM square test for stability, (a) Model with oil price in domestic prices, (b) model with oil price in US dollar



5. CONCLUSION

Indonesia is one of the developing Asian countries that was most affected by the financial crisis in 1997-1998. In this paper we evaluated the impact of the oil price shock on food prices. We used an advanced NARDL to analyze the co-integration of positive and negative oil price on the food price during 1995-2014. The results show evidence of a strong positive relation between oil price increase and food price in both short- and long-run in domestic currency. In the domestic currency model, an increase in the oil price by 10% cause the rise of food price by more than 3.6%. This is larger than the result of the Malaysian case (Ibrahim, 2015) and other previous studies. The high rate of inflation and depreciation of the domestic currency (IDR) against the US dollar may have caused the strong long-run co-integration between oil price and the food price. In other words, the high oil pass-through the food price comprises highly the impact of exchange rate and inflation rate, which policy makers in Indonesia should be aware of in dealing with the problem of oil price increase.

REFERENCES

Alom, F., Ward, B.D., Hu, B. (2013), Macroeconomic effects of world oil and food price shocks in Asia and Pacific economies: Application of SVAR models. OPEC Energy Review, 37(3), 327-372.

Baek, J., Koo, W.W. (2010), Analyzing factors affecting U.S. food price inflation. Canadian Journal of Agricultural Economics, 58(3), 303-320.

Baffes, J. (2007), Oil spills on other commodities. Resources Policy, 32(3), 126-134.

Baffes, J., Dennis, A. (2013), Long-Term Drivers of Food Prices, May. p35.

Baffes, J., Haniotis, T. (2010), Placing the 2006/08 Commodity Price Boom into Perspective. World Bank Discussion Papers, 5371(July). p1-40. Available from: http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2010/07/21/000158349_20100721110120/Rendered/PDF/WPS5371.pdf.

Chen, S.T., Kuo, H.I., Chen, C.C. (2010), Modeling the relationship between the oil price and global food prices. Applied Energy. Available from: http://www.scopus.com/inward/record.url?eid=2-s2.0-77953150858&partnerID=40&md5=e4a039e1b8deafeae15425d1cdffe5de.

David, C.C., Huang, J. (1996), Political economy of rice price protection in Asia. Economic Development and Cultural Change, 44(3), 463.

Djiwandono, J.S. (2000), Causes and implications of the Asian crisis: An Indonesian view. In: Hunter, W.C., Kaufman, G.G., Krueger, T.H., editors. The Asian Financial Crisis: Origins, Implications, and Solutions. 2nd ed. Cambridge: Springer. p115-126.

Engle, R.F., Granger, C.W.J. (1987). Co-Integration and Error Correction: Representation, Estimatio, and Testing. Econometrica, 55(2), 251-276.

Gilbert, C.L. (2010), How to understand high food prices. Journal of Agricultural Economics, 61(2), 398-425.

Gohin, A., Chantret, F. (2010), The long-run impact of energy prices on world agricultural markets: The role of macroeconomic linkages. Energy Policy, 38(1), 333-339.

Gilbert, C.L., & Morgan, C.W. (2010), Food price volatility. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 365(1554), 3023-3034.

Harri, A., Nalley, L., Hudson, D. (2009), The relationship between oil, exchange rates, and commodity prices. Journal of Agricultural and Applied Economics, 2, 501-510. Available from: http://www.researchgate.net/publication/46534254_The_Relationship_between_Oil_Exchange_Rates_and_Commodity_Prices/file/d912f512392af7eb13.pdf.

Ibrahim, M.H. (2015), Oil and food prices in Malaysia: A nonlinear ARDL analysis. Agricultural and Food Economics, 3(1). Available from: http://www.doi.org/10.1186/s40100-014-0020-3.

Johansen, S. (1988). Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control, 12(2-3), 231-254.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration- with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.

Katrakilidis, C., Trachanas, E. (2012), What drives housing price dynamics in Greece: New evidence from asymmetric ARDL cointegration. Economic Modelling, 29(4), 1064-1069.

Kwon, D., Koo, W.W. (2009), Price transmission channels of energy and exchange rate on food sector : A disaggregated approach based on stage of process. Selected Paper Prepared for Presentation at the Agricultural & Applied Economics Association 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, Wisconsin, July 26-29, 2009.

Mutuc, M., Pan, S., Hudson, D. (2010), Response of cotton to oil price shocks. Selected Paper Prepared for Presentation at the Southern Agricultural Economics Association Annual Meeting, Orlando, FL, February 6-9, 2010.

Nazlioglu, S. (2011), World oil and agricultural commodity prices: Evidence from nonlinear causality. Energy Policy, 39(5), 2935-2943. Available from: http://www.doi.org/10.1016/j.enpol.2011.03.001.

Nazlioglu, S., Soytas, U. (2011), World oil prices and agricultural commodity prices: Evidence from an emerging market. Energy Economics, 33(3), 488-496.

Nazlioglu, S., Soytas, U. (2012), Oil price, agricultural commodity prices, and the dollar: A panel cointegration and causality analysis. Energy Economics, 34(4), 1098-1104.

Pesaran, M.H., Shin, Y., Smith, R.J. (1999), Bounds testing approaches to the analysis of long-run relationships. Journal of Applied Econometric, 16, 289-326.

Ravallion, M., van de Walle, D. (1991), The impact on poverty of food pricing reforms: A welfare analysis for Indonesia. Journal of Policy Modeling, 13(2), 281-299.

Shin, Y., Byungchul, Y., Greenwood-Nimmo, M. (2011), Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework.

Teera Kiatmanaroch, S.S. (2014), Relationship between exchange rates, palm oil prices, and crude oil prices: A vine copula based GARCH approach. Advances in Intelligent Systems and Computing, 251, 399-413.

Timmer, C.P. (2004), Food Security in Indonesia : Current Challenges and the Lon-Run Outlook. Center for Global Development. p48.

Tyers, R.A.R. (1982), Food security, consumption diversification and foreign exchange balances in Indonesia: Results from a multi-commodity simulation. Journal of Policy Modeling, 4(3), 363-393.

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

Zhang, Q., 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. Southern Agricultural Economics Association Annual Meetings, 1-17. Available from: http://www.ageconsearch.umn.edu/bitstream/6797/2/sp08zh01.pdf.