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The Effect of External Shocks on Food Price in Indonesia: A VECM Analysis

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Abstract

Purpose – This research examines the short-run and long-run effect of external shocks (oil price and exchange rate) on domestic food price in Indonesia.

Research design, data, and methodology – Three variables are used in this research. The variables are food price index, Rupiah's exchange rate of Indonesia, and crude oil price from 1998 until 2015 using Vector Error Correction Model (VECM).

Results - The increasing of oil price and the depreciation of Rupiah's rate push the domestic food price in long-run, but do not impact significantly in short-term. The response of food price to oil prices shock and exchange rate shock are positive and persistent throughout the entire sample period. The exchange rate and oil price shocks have a small proportion explaining for the fluctuations of food price index but increasing over time.

Conclusions - The policymaker should concern on solving the problem of oil price increase and depreciation of exchange rate on Indonesia's food price as they are important factors that can affect the price stability. The government should not rely on food imports because the price is strongly influenced by the movements in the exchange rate.

Keywords: Food Price, Oil Price, External Shock, VECM Analysis.

JEL Classifications: C32, E31, Q11.

1. Introduction

The food price surge of 2007/08 came as a big and unexpected shock to the world. Prices rose very sharply in late 2007 and by the first half of 2008 food prices increased much faster than other commodity prices. International rice prices, for example, were three times higher (in US dollar terms) in late May 2008 than in May 2007 (Jayasuriya et al., 2012). The international food crisis led to food shortage in the global market which has impact on scarcity in the domestic market. As a result, food prices in the global market and domestic market experienced a surge in high rise.

Several factors that contributed to 2007/08 global food crisis are weather-related crop losses, export restrictions, and high oil prices (Food and Agriculture Organization: FAO, 2011). Agricultural commodity prices are becoming increasingly correlated with oil prices. Actually, oil prices can

affect food prices through three main channels. First, higher oil prices can increase the cost of farm inputs such as inorganic fertilizer, pesticides, and fuel for tractors or pumps. Second, oil price increases can drive up transport costs, which affect the prices of all traded commodities. Finally, higher global oil prices can directly affect food prices by demand for agricultural commodity to convert to biofuel (Dillon & Barret, 2015).

According to Statistics Indonesia (BPS) (2016), Indonesia has about 255 million people and become one of the most populous countries in the world after continental countries (China, India, Russia and United States). On the other side, Indonesia is a developing country whose income per capita still low and many consumers expend as much as half of their budget on basic foods. Based on USDA (2016) calculations, the share of consumer expenditure spent on food in Indonesia ranks the 68th among 86 countries. Consumer expenditures of households is 2,042 USD and share of consumer expenditures spent on food is 38.4 percent when another developed country such as America and Singapore only spent 10 percent of consumer expenditures. In 1857, Ernst Engel stated given that taste is unchanged, the percentage of expenditure on food declines as income increases.

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High need of food does not match with domestic production so Indonesia has to import food staple, such as rice, corn, soybeans, wheat, and beef. Dependency on food imports make food prices vulnerable to volatile given the exchange rate in Indonesia remains unstable. Rowland (2004) said that changes in the exchange rate is responded quickly by import prices. Exchange rate is international prices help coordinate the decisions of consumers and producers as they interact in world markets (Mankiw, 2007). So, a great depreciation on exchange rate will increase of domestic food prices.

According to BPS (2016), food price inflation in Indonesia over recent years has exceeded general inflation and another non-food price inflation. Inflation which tend to fluctuate will create decrease purchasing power parity so that public welfare also decrease. Rising price make people to reduce food expenditure and then reduce the quality of their diet.

Monitoring food prices is essential in a food market monitoring system. In a similar manner, analysing the changes of oil price and exchange rate on food markets is important. Better information about domestic price movements is necessary to understand how international shocks affect domestic markets in Indonesia better. Such information is important for early warning systems of vulnerability food in Indonesia. It is also crucial for policy making and designing effective risk management instruments for developing countries.

Even though have been researches on relationship between food prices and oil prices, the result is far from in agreement. In this study, we will focus on determining the effect of external shock in which oil price shock on food price considering another variable, exchange rates, both in short and long run in Indonesia. Furthermore, there will be an analysis about how does food price will respond when there is a shock in oil prices and exchange rate. We also include forecast error variance decomposition to examine which variable has the biggest contribution to food price's variance.

2. Literature Review

The literature on the relationship between crude oil and food prices have no identically result. Zhang and Reed (2008) used monthly prices 2000 to 2007 to investigate effects of the world crude oil price on feed grain prices and pork prices in China. The results show the influences of crude oil price are not significant over the study period.

Similar result in a recent study, Nazlioglu and Soytaş (2011) examined the short and long-run interdependence between world oil prices and individual agricultural commodity prices in Turkey using the monthly data from 1994 to 2010. The impulse response analysis suggests the Turkish agricultural prices do not significantly react to oil

price both in the short-run and long-run. Baumeister and Kilian (2013) also concluded that there was no evidence that oil-price-driven increases in the cost of food processing, packaging, transportation and distribution which are responsible for higher retail food prices.

On the other hand, some other studies have provided contradictory evidence. Pala (2013) investigated form of the linkage between crude oil price index and food price index using Johansen Cointegration test by VECM. Empirical results of monthly data from 1990 to 2011 indicated that there was a clear long-run relationship between these series for the full and sub sample. Similarly results, Rezitis (2014) examined the relationship between crude oil prices and agricultural prices using panel VAR methods with monthly observations of the period from June 1983 to June 2013. The empirical results indicated that crude oil prices affect international agricultural commodity.

Fernandez (2014) examined the long run relationship between world price of maize, soybeans and sugar with the real world price of crude oil and a series of macroeconomic variables using a cointegration analysis from January 1982 until December 2012. The main empirical results support a strong causal relationship between maize and soybeans with crude oil for the entire sample period and that real oil prices have a one-to-one relationship with these commodities.

Furthermore, in determining the transmission channels, another factor such as exchange rates should be included in the model to get a better result. Harri et al. (2009) said that exchange rates have long been thought to have an important impact on the export and import of goods and services. They concluded that exchange rates do play a role in the linkage of prices over time. Similar result, Zhou (2015) examined relationship between RMB real effective exchange rate and agricultural food prices using Cointegration VAR with data from the year of 1990 to 2014. The result showed that there are long-term interaction effects between China's RMB real effective exchange rate and agricultural food prices. Agricultural food prices will increase by 0.015 percentage when exchange rate at lag 1 period increased one percentage.

From the literature above, we conclude that there was no identically result about the relationship between crude oil and food prices. Therefore, in this study we try to estimate any relationship between food price and oil price using exchange rate as one of the external factor that impact food prices to get a better result. Furthermore, in the previous studies, there is no further explanation about the effect of external shocks on food price. So, in this study, we also include impulse response function to analyze both in short run and long run. For further information, we include forecast error variance decomposition to examine which variable has the biggest contribution to food price's variance.

3. Data and Methodology

This research was conducted in Indonesia by using quarterly time series data from 1998 to 2015 so there were 72 observation included in this study. The variables used in this model are food price index, Indonesian crude oil price, and exchange rate. Food price index of Indonesia is an index that describes the average price of a package of goods and services consumed by households within a certain time frame. It was taken from Statistics Indonesia (BPS). Indonesian crude oil price (USD per barrel) was taken from Ministry of Energy and Mineral Resources. Rupiah's exchange rate of Indonesia was taken from CD-ROM International Financial Statistics (IFS) published by International Monetary Fund (IMF).

4. Unit Root Test

The assumptions of the classical regression model necessitate that errors have a zero mean and a finite variance. The regression equation is necessarily meaningless if the residual series (ϵ_t) is nonstationary (Enders, 2004). The augmented Dicky-Fuller (ADF) test is used to check stationary data. The ADF test here consists of estimating the following regression :

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t+1} + \sum_{i=1}^m \alpha_i \Delta Y_{t-i} + \epsilon_t$$

where ϵ_t is a pure white noise term. The null hypothesis is that $\delta = 0$; that is, there is a unit root and time series data is nonstationary.

4.1. Cointegration Test

Regression of a nonstationary time series on an other nonstationary time series may produce a spurious regression. But, if their residual of linear combination is stationary at level, the two variable are cointegrated and the regression's result is meaningful (Gujarati, 2004). We used Johansen Cointegration test to determine if cointegration relationships exist between the variable. Consider a general VAR of order p :

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + v_t$$

where y_t is a vector of non-stationary variables that are for instance integrated of order 1 and commonly denoted as $I(1)$. In this study, y_t is a vector consists of food price index (LN_FPI_t), oil price (LN_OIL_t) and exchange rate (LN_ER_t) and ϵ_t is a vector of innovations or random shocks. The VAR may be rewritten as:

$$\Delta Y_t = A_0 + \sum_{i=1}^k \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-1} \epsilon_t$$

If rank (Π) = 0, the matrix is null and the model is VAR in first differences. Instead if rank (Π) = 1, there is a single cointegrating vector and the expression ΠY_{t-1} is the error-correction term. Coefficients in Γ_i estimate the short-run effect of shocks to the variables on and thereby allow the short ΔY_t and long-run responses to differ.

4.2. Impulse Response Function

According to Lutkepohl (2005), impulse response function is to know the response of one variable to an impulse in another variable in a system that involves a number of further variables as well. If there is a reaction of one variable to an impulse in another variable we may call the latter causal for the former. In this study, we will trace out the effect of external shocks (oil prices and exchange rates) on some food price in Indonesia.

4.3. Forecast Error Variance Decomposition

Since unrestricted VARs are overparameterized, they are not particularly useful for short-term forecasts. However, understanding the properties of forecast errors is exceedingly helpful in uncovering interrelationships among the variables in the system. According to Enders (2004) forecast error variance decomposition tells us the proportion of the movements in a sequence due to its "own" shocks versus shocks to the other variable.

5. Result

<Table 1> shows the result the Augmented Dickey Fuller (ADF) test of unit root test. The result shows that all variables (food price index (LN_FPI), exchange rate (LN_ER), and crude oil price (LN_OIL) are non-stationary in level. The regression equation is necessarily meaningless if the residual series (ϵ_t) is nonstationary. So, we tried to make in in first differences state. In first differences test, the result for all variables shows that they are significant at one percent. It means that all variables are stationary in first differences and therefore integrated of order one, $I(1)$.

<Table 1> Augmented Dickey Fuller (ADF) unit root test

Variable	Level		First differences	
	critical value	t-stat	critical value	t-stat
Ln_FPI	-3.480463	-1.787253	-3.478305	-6.906955**
Ln_ER	-3.474363	-0.946284	-3.476275	-6.915680**
Ln_Oil	-3.485218	0.510223	-3.485218	-5.102218**

** significance at 1% level

Source: Eviews 8.

Before cointegration test, estimating the lag length of autoregressive process for a time series is a crucial econometric exercise in most economic studies. The determination of autoregressive lag length used in the model is very important to avoid model over-fitting by limiting the length of lags included in the VAR by not selecting too small a lag length (Khim & Liew, 2004). In this study, we estimated with three lags selected based on three criteria: AIC, LR, and FPE.

The Johansen co-integration test was used to check for long-run relationship between food price, oil price, and exchange rate. The results are presented in <Table 2>.

<Table 2> Johansen Cointegration Test Results^a

Null Hypothesis ^b	Eigen Value	Trace Statistic	Critical Value
r=0	0.325749	35.00525	29.79707
r≤1	0.083720	8.202851	15.49471
r≤2	0.032652	2.257397	3.841466

^a Trace statistic test indicates one cointegrating equation at the 5% level.

^b r is the cointegrating rank

Source: Eviews 8.

The results from Johansen test show for null hypothesis r=0, the trace statistic value is 35.01 higher than the critical value (trace) 29.80 at 5% significant level so we can reject null hypothesis and conclude that the long-run equilibrium relationship between all three variables do exist. It implies that short-run fluctuation variables deviate from the long-run, the fluctuation will be back to equilibrium, by error correction for the relationship.

Three diagnostic test i.e., Jarque-Bera test, Breusch-Pagan-Godfrey (BPG test), and Lagrange Multiplier (LM) Test are used to identify the reliability of the model. Jarque-Bera test is used to identify the normality of the disturbance term. Based on the diagnostic test we do not reject the hypothesis that the error terms are normally distributed. Similarly results for BPG test and LM test, the probability of obtaining such a statistic is above alpha five percent. It means that the model does not suffer from autocorrelation and heteroskedasticity. So, the result from the model is reliable.

Since the model is reliable, we can estimate VECM to explain relationship between oil price, exchange rate and food price index both in short and long run. The result of the VECM estimation is presented in <Table 3>. The R² value for models indicates that the overall goodness of fit of the VAR is satisfactory. For instance, 34.87% of the variation in LN_FPI is explained by LN_OIL and LN_ER. The F-statistic shows the joint significance of all the variables in determining the individual price volatility in each case.

<Table 3> VECM Results

Lag	Short Run		
	ΔLN_FPI	ΔLN_ER	ΔLN_OIL
1	-0.2061*	-0.1508*	-0.0158
2	-0.1562	-0.1095	0.0007
3	-0.0558	0.0756	0.0210
ECT	-0.0657**		

Note : * significant at 5%, ** significant at 1%

Source : Eviews 8.

The parameter of the error correction term/ECT (speed of adjustment) of the model is negative and significant at 1% level. It represents overshooting parameters, indicating how quickly the system adjusts to its long-run equilibrium. The error correction coefficient is -0.0657, it means that 6.57 percent short run disequilibrium in previous period will be corrected to the long run equilibrium in the next period. ECT coefficient is significant and negative, which means that the proposed model has valid specification

The result of the VECM test also shows that the change in dependent variable is affected by independent variables in the short run. Only exchange rate does affect the food price but the oil price does not. It is because economy policy need time (lag) to affect the food price. Another one is because of the fuel subsidies in Indonesia. The government policy intend to alleviate the burden on society because oil prices tend to be high so that people are not directly affected by oil prices.

Long run Equilibrium equation:

$$\widehat{LN_FPI}_{t-1} = 2.5232*LN_ER_{t-1} + 0.6365*LN_OIL_{t-1} - 21.4813$$

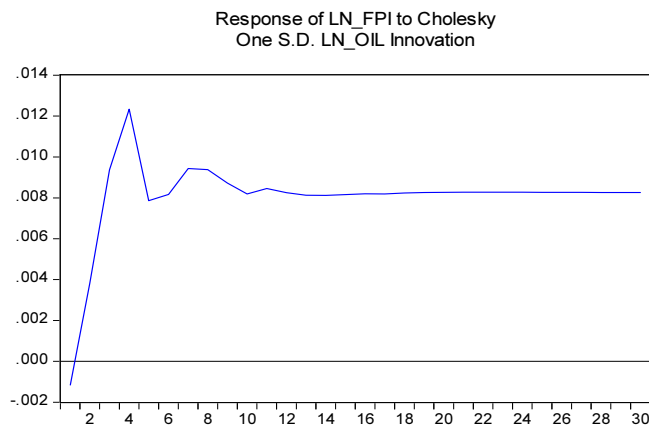
(0.42984) (0.06808)

Note:*significance at alpha 5%, (standard error in parentheses)

In the long run, the exchange rate has significant and positive effect on food price index. It means that in the long-term, the weakening of the Indonesia's exchange rate to US dollar (depreciation) would cause domestic food prices cause the increase in domestic food. It influences on the increase in commodity prices, especially of imported goods (imported inflation), or consumer goods imports such as rice, beef, milk, wheat, flour, soybean, etc. As a country has a high dependency on food imports, the depreciation of rupiah exchange rate (IDR) will increase food prices. The growth of oil price is also a positive and significant impact on growing of food price index. It means that in the long run, the higher oil price will enable prices of domestic foodstuffs increase generally. The increase in domestic prices is the result of higher production costs such as irrigation pumping costs, transportation costs at home and abroad, and other production costs.

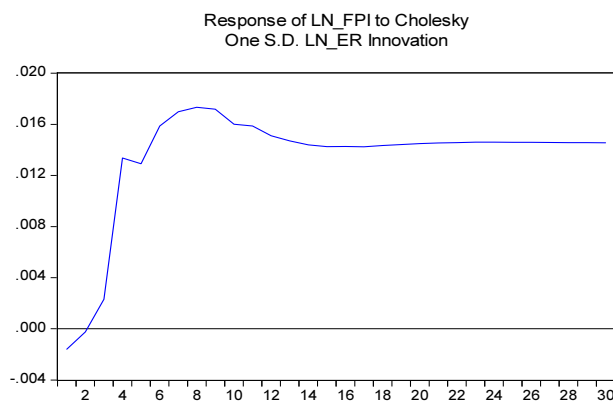
5.1. Responses to External Shocks

Further evidence of the relationship between the variables can be inferred from the impulse responses. The impulse responses of the food price index to a shock in oil price and exchange rate are presented in <Figure 1> and <Figure 2>. From <Figure 1>, the response of FPI to a one standard deviation innovation in the oil prices is positive and persistent throughout the entire period. FPI increases faster till up to 4 period (one year) then started to flatter or decline very slowly. Response of FPI after oil price shock fade after 12 period (3 years) to a new equilibrium with a higher prices. It means that in the long run, there is a positive relationship between food price and oil price.



<Figure 1> Responses of the food price index to a one standard innovation on oil price

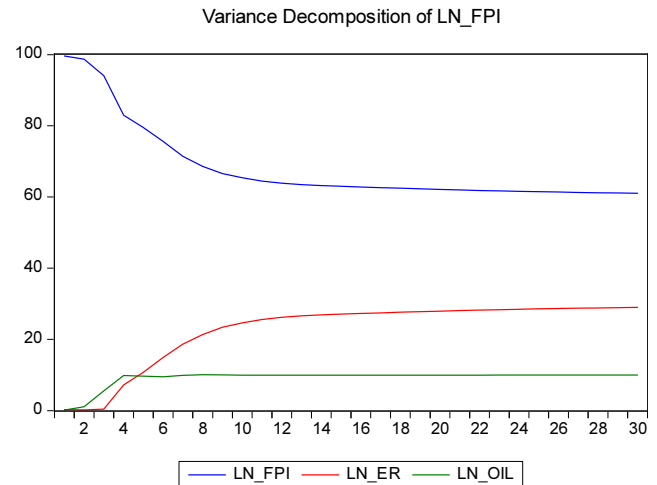
From <Figure 2>, the response of FPI to a one standard deviation innovation in the exchange rate is also positive. An exchange rate shock mostly felt within 8 period (2 year) then started to decline. This longer period because of the effect of oil price on food price (FPI) is indirect. The effect through an input cost, such as fertilizer, transportation, etc. Response of FPI after exchange rate shock fade after 13 period to a new equilibrium with a higher prices.



<Figure 2> Response of the food price index to a one S.D. innovation on exchange rate

5.2. Variance Decomposition of Food Price

Variance decomposition helps us in assessing the importance of exchange rate shocks and oil price shocks in explaining the behaviour of food price over the sample period. In the context of variance decomposition, a variable is said to explain the fluctuations in another variable if it accounts for a large proportion of that variable's forecast error variance. Therefore, we decompose variations in food price index into the shocks to endogeneous variables in the VAR model.



<Figure 3> Variance decomposition on food price index

The result of the variance decomposition seems to suggest that exchange rate and oil price shocks in early period have a small proportion of the fluctuations in food price index. As shown in <Figure 2>, the variation in food price is mainly explained by its own innovations. For the first quarter, food price variation is explained by its own innovations of about 99.58 percent, exchange rate shocks about 0.14 percent, and oil price shocks about 0.27 percent. The relative contribution of its own innovations decreases over time, reaching 80 percent after one year and 61 percent after two year along with the increasing contribution of the exchange rate and the oil price shock in explaining the variation of the food price.

The relative importance of exchange rate innovations tends to increase over time from 0.14 percent to 10 percent after one year and 20 percent after two years. In fact, firms do not timely change their prices following fluctuations of exchange rates, but prefer to adjust their mark-ups, following a pricing-to-market strategy. Contribution of oil price shock to food price variation is less than exchange rate shock. The oil price only explains for 9 percent of the forecast error variance of the simulated shock to the food price index. The results due probably to the energy price regulation and government subsidization.

6. Conclusion

This research explains the relationship among three variables. The food price in Indonesia, and the two external shocks; oil prices and Rupiah's exchange rates. The results show that in the long-run, there is a strong positive relation between oil price increase and food price, but they are not significant in the short run. In the long run, the depreciation of Rupiah and the increase of oil price force the food price to increase.

The response of food price index to a one standard deviation innovation in the oil prices and exchange rate shock are positive and persistent throughout the entire sample period. The result of the variance decomposition suggests that exchange rate and oil price shocks in early period have a small proportion of the fluctuations in food price index but increasing over time. Contribution of oil price shock to food price variation is less than exchange rate shock. The results due probably to the energy price regulation and government subsidization.

We recommend the policymaker should concern on dealing with the problem of oil price increase and depreciation of exchange rate on Indonesia's food price as they are important factors that can affect the stability of prices. The government should reduce the dependency on food imports because the price of imported goods is strongly influenced by movements in the exchange rate.

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