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Analysis of Crude Palm Oil Price and Biodiesel Production in Indonesia: A Vector Autoregressive Model Approach

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Abstract- Palm oil is one of biodiesel feedstock that has bright prospect but utilization of palm oil as biodiesel feedstock will lead to increased demand for CPO. Thus the demand for palm oil will increase not only from the demand from the food sector but also from non-food sector. Changes in demand will result in a change in CPO prices. This study aims to evaluate the effect of biodiesel production on the price of palm oil through vector autoregressive model approach. Responses provided by the CPO prices to changes in the production of biodiesel standard deviation tend to be negative. Increased production of biodiesel does not caused rapid CPO price increase. Response of biodiesel production on crude palm oil price shocks tends to be fluctuating. However, the response of biodiesel production is seen to be positive this can be caused by several factors including government policies that require the use of biodiesel, so biodiesel production increases. Although crude palm oil prices rose but production of biodiesel is still responded positively. One reason for biodiesel production was less affected by changes in the price of CPO is because the majority of biodiesel production is for export markets so that biodiesel prices follow the international price of biodiesel. Analysis in variance decomposition shows that biodiesel production only affect slightly less than 5% while two variables mostly affect CPO price are cooking oil price (43.96%) and CPO price itself (35.69%). Research result implies that CPO price movement in Indonesia is not greatly influenced by biodiesel production. This shows that biodiesel production in Indonesia is sustainable because it does not interfere with national food supply and prices.

Keywords- biodiesel industry, palm oil, sustainability, bioenergy, Indonesia, vector autoregressive model.

1. Introduction

Energy is one of vital needs in human life. Energy demand increase in line with the growth in population, advance in technology and in human activity. To date majority of energy usage in Indonesia is based on fossil fuel (crude oil, coal and gas). Government of Indonesia has making several regulation regarding national energy policy such as President Instruction No. 1 Year 2006 about Supply and usage of biofuel as an alternative energy to fossil fuel and also President Decree No. 5 Year 2006 about National Energy Policy (NEP). Based on President Decree of NEP, the objective of NEP is to fulfill security in domestic energy supply

One of energy source that can be used as an alternative is bioenergy. Bioenergy is fuel from biological sources. Bioenergy form including solid, liquid and gas. Fuel such as woods, charcoal, dung and agricultural wastes can be used as fossil fuel replacement directly or indirectly. In its liquid form biofuel is known as bioethanol and fatty acid methyl ester (FAME biodiesel). Smith et al. [1] presented biodiesel is the main biofuel for transport used in the EU and accounted for about 70 percent of the biofuel market on the volume basis in 2012 while bioethanol had a 28 percent market share. Research in Agency for the Assessment and Application of Technology shows that Indonesia has 60 crops potential as bioenergy feedstock. Crop such as oil palm, coconut, castor and cottonwoods can be used as biodiesel feedstock while sugarcane, corn, cassava, sweet potato and thatch as bioethanol feedstock.

Thornley and Cooper [2] presented bioenergy has been chosen as an alternative energy for fossil fuel. That is because bioenergy is the easiest to convert into fuel or electricity. Hambali et al. [3], Marek and Wojciech. [4] present other advantages of bioenergy are renewable, environmentally friendly, decomposable, greenhouse gas reduction, supply continuity and even in economy.

Elinur [5] and Chung [6] studied during 1990-2008 period bioenergy production in average increase 2.15 percent annually from 193.20 million Barrel Oil Equivalent (BOE) to 277.96 million BOE. Increase in bioenergy production create chances in fossil fuel substitution by replacing gasoline and diesel with bioethanol and biodiesel respectively. High biomass production support national energy supply, in 2025 biomass energy and renewable energy expected to increase to 17% in national energy mix.

Purwantoro [7] and Chung [6] presented choosing biofuel as alternative energy is not without risk because feedstock for these energy is vegetation that needs land, time and maintenance. Arifin [8] and Jeffers et al. [9] presented even some feedstock for these biofuel is used as food source such as sugar cane, cassava, corn, oil palm and soybean. In one side, Indonesia needs to develop bioenergy but on the other side Indonesia needs to maintain food security

Domestic policy that regulate bioenergy gives positive impact to biofuel so that it has market competitiveness. However bioenergy development in Indonesia is not as simple as it seems. Bioenergy development related to fossil fuel price and food commodity in domestic and international level.

Popp et al. [10], Ciaian and d'Artis [11], Timilsina et al. [12] presented food is a basic needs essential for human life that needs to be fulfilled first before other needs. Food and energy availability is vital for each country. Both are consumed to fulfill basic needs and as an input in production process. Bioenergy development that based on food crops can stimulate competition with food fulfillment. Therefore bioenergy development raises the potential threat to food security due to land conversion and competition in energy and food fulfillment.

Bioenergy development is one of solutions to overcome energy problems. However competition between food security and bioenergy development can arise. Considering feedstock for bioenergy mostly from food crops, food vs. fuel is still become major attention worldwide.

Research from Denny et al. [13] shows that increase in palm oil productivity influence trade off optimization between biodiesel and CPO industry. In Indonesia, domestic CPO consumption mainly for cooking oil, margarine, oleo chemical and soap. If CPO supply for those industries lessen it can cause increase in domestic price. Simulation result shows the fluctuated domestic CPO price with increase trend.

Handoko et al. [14] studied that if Indonesia has to supply 10.22 million kilo liter (KL) per year to reach targeted biodiesel mix in Indonesia energy mix 2025 then it cannot be achieved with the current condition, mainly because of three factors (i) low mixing mandate (ii) limited supply on feedstock because of allocation with cooking oil, oleo chemical, food and biodiesel industry, and (iii) market is limited to public services obligation (PSO) transportation sector.

Supriyadi [15] conduct a research that aim to analyze impact of CPO based biodiesel development to palm oil product derivatives. To achieve the goal, the econometric approach is used to build models of systems of simultaneous equations. One of the scenario is that 20 percent biodiesel development resulted in the dominant variable is the price of fresh fruit bunches increases 4.72 percent, consumption increases 24.99 percent palm oil, diesel oil imports fell down 5.83 percent, cooking oil demand increases 8.43 percent and rising demand for margarine 10.36 percent.

Akbar [16] used system dynamic to model palm oil supply regarding biodiesel production in Indonesia. Simulation shows that at present rate 20% biodiesel mix in 2016 will not be achieved but 2018 instead. To achieve 20% mix in 2016 then biodiesel production needs to be increased but the consequence is that CPO supply will be reduced, however domestic needs is still fulfilled.

The aim of this research is to observe the influence of biodiesel production on CPO price in Indonesia by using vector autoregressive (VAR) approach. Variables observed are CPO price, biodiesel production, cooking oil price, CPO export and CPO production. By knowing the influence of biodiesel production on CPO price the formulation of national energy policy to achieve food and energy security in Indonesia will be more effective and efficient.

2. Methodology

2.1. Sources of data

This research uses monthly data from various secondary sources including Directorate General of New Energy, Renewable and Energy Conservation, Ministry of Energy and Mineral Resources, SMART Agribusiness and Food, Ministry of Agriculture, and Statistics of Indonesia from September 2010 to December 2013.

2.2. Empirical framework

2.2.1. Unit root and co integration tests

Generally time series data are stochastic or have non-stationer trend. To proceed with model estimation stationery test need to be performed, this test also called unit root test. Unit root test will be analyzed by using Augmented Dickey Fuller (ADF) test. This test modeled autocorrelation influence on disturbance. CPO priceand Biodiesel production equations for this test are:

CPO price model

$$CPO\_PRC_t = \sum_{i=1}^{l} A_i LN\_BDF\_PRD_{t-1} + \sum_{i=1}^{l} B_i LN\_COO\_PRC_{t-1} + \sum_{i=1}^{l} C_i LN\_CPO\_EXP_{t-1} + \sum_{i=1}^{l} E_i LN\_CPO\_PRD_{t-1} + \varepsilon_{it}$$

Biodiesel production model

$$BDF\_PRD_t = \sum_{i=1}^{l} B_i LN\_COO\_PRC_{t-1} + \sum_{i=1}^{l} C_i LN\_CPO\_EXP_{t-1} + \sum_{i=1}^{l} D_i LN\_CPO\_PRC_{t-1} + \sum_{i=1}^{l} E_i LN\_CPO\_PRD_{t-1} + \varepsilon_{it}$$

Where CPO_PRCt is analytical variables that consist of biodiesel production, cooking oil price, CPO export and CPO production. BDF_PRDt is analytical variables that consist of CPO price, cooking oil price, CPO export and CPO production. ε_{it} is vector white noise, l is order lag.

Variables that are used in this study are CPO_PRC = CPO Price, BDF_PRD = Biodiesel Production, COO_PRC = Cooking Oil Price, CPO_EXP = CPO Export, CPO_PRD = CPO Production. Granger and Newbold [17] presented the possible presence of cointegration must be taken into account when choosing a technique to test hypotheses concerning the relationship between two variables having unit roots (i.e. integrated of at least order one).

2.2.2. Vector Error Correction Model (VAR)

This method is used when the variables are not cointegrated at the first difference. In general, this method is based on the following formula:

$$yt = b_{10} - b12zt + \gamma11yt - 1 + \gamma12zt - 1 + \epsilon yt$$

$$zt = b20 - b21yt + \gamma21yt - 1 + \gamma22zt - 1 + \varepsilon zt$$

Where (a) yt and zt stationer, (b) εyt and εzt are error with standard deviation σy and σz and (c) εyt and εzt not correlated.

2.2.3. Impulse Response Function (IRF)
Impulse Response Function (IRF) is used to observe the response of an endogenous variable on a certain shock. IRF shows the dynamic response of a variable due to one period standard deviation shock of another variable.

3. Empirical finding and analysis
3.1. Unit root and co integration tests
Generally time series data are stochastic or have non-stationer trend. To proceed with model estimation stationery test need to be performed, this test also called unit root test. Unit root test will be analyzed by using Augmented Dickey Fuller (ADF) test. This test modeled autocorrelation influence on disturbance. General equation for this test is:

$$\Delta Xt = \alpha + \beta Xt - 1 + \delta t + \sum_{t-1}^{p} \theta t \Delta Xt - 1 + ut$$

Where ΔXt is first different, A is intercept, X is variable tested for stationery, P is lag, ut is error.

Null hypothesis (H0) is there are unit root while alternate hypothesis (H1) is there is no unit root. If ADF test statistic greater than McKinnon critical value then alternate hypothesis is accepted that means there are unit root in those data which means those data is stationer.

Granger and Newbold [17] analyzed the possible presence of cointegration must be taken into account when choosing a technique to test hypotheses concerning the relationship between two variables having unit roots (i.e. integrated of at least order one). According to Engle et al. [18], regression of two non-stationer variable will result in spurious regression thus differentiate needs to be done.

3.2. Model stability
Gujarati [19] have conducted the next test is model stability test. If model is stable then the estimation result will not change with a great deviation even though with longer period. Model is said to be stable if its modulus is less than one. Result of model stability can be seen on table 1.

3.3. Analysis for Crude Palm Oil Price (CPOP) model
3.3.1. Impulse Response Function (IRF) Analysis for CPOP Model
Impulse response can be used to observe a variable if other variables are shocked. IRF gives value on the inter-variable influence.The variables in this case areCPO Price, Biodiesel Production, Cooking Oil Price, CPO Export, and CPO Production. Figure 1 shows response of CPO price when other variables are shocked.

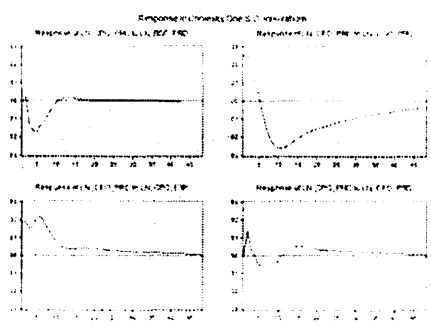

Fig 1. Impulse response function of CPO price

When there is a shock in biodiesel production, CPO price reacts positively and then negatively with the lowest in the 5th month with the value of -0.017440. Afterwards the trend becomes positive and increases until the 10th month. Stability starts in the 20th month with the value of 0.000407. On the other hand, CPO price reacts positively to the cooking oil price until the 5th month and then afterwards negatively with the lowest in the 11th month with the value of -0.026229. Afterwards the trend becomes positive and trying to reach stability in the 48th month.

Furthermore, CPO price has positive response towards shocks in the CPO export. The stability started in the 13th month with the value of 0.003405. Shocks in CPO production shows fluctuated response by CPO price. CPO price reacts positively and then negatively with the lowest in the 7th month with the value of -0.007985. Afterwards the trend becomes positive and trying to stabilize in the 20th month with the value of 0.003323.

3.3.2. Variance Decomposition (VD) analysis for CPOP model
Table 2 shows that CPO price is mainly affected by cooking oil price (43.96%) and CPO price itself (35.69%). Afterwards followed by CPO export (12.52%), biodiesel production (4.99%) and lastly CPO production (2.83%).

3.4. Analysis for Biodiesel Production (BDP) Model
3.4.1. Impulse Response Function (IRF) Analysis for BDP Model

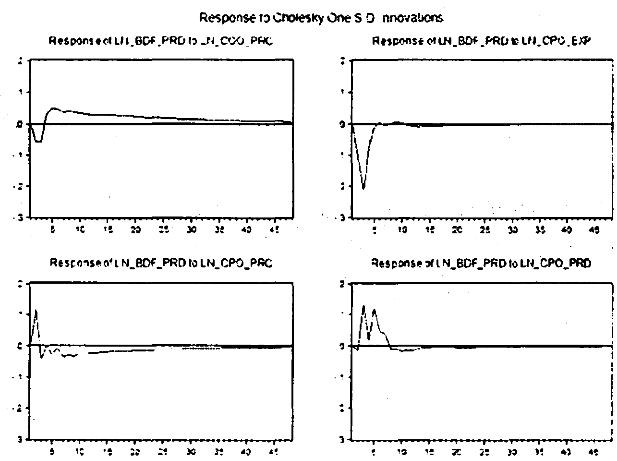

Fig 2. Impulse response function of biodiesel production

Shock in cooking oil price is negatively responded by biodiesel production with the lowest value in the 2nd month with value of -0.059490 but afterwards the trend is increase until the 5th month with the value of 0.046453 and then decline and trying to stabilize in the 0 value. Same pattern happened with the shock of CPO export. The lowest value is in the 2nd month with -0.217814 and stabilize in the 6th month.

The other two variables, CPO price and CPO production give similar pattern in shock. Both react positively and the decline to find stability around 0 value. CPO price start to stabilize in the 29th month while CPO production start to stabilize at 13th month.

3.4.2. Variance Decomposition (VD) analysis for BDP model

Table 3 shows that biodiesel production is mainly influenced by biodiesel production itself with 49.38% and CPO export with 20.82%. Afterwards followed by CPO production with 12.34%. Lastly affected by cooking oil price and CPO price with 8.99 % and 8.47% respectively.

4. Conclusion

This research has shown the influence of biodiesel production to CPO price in Indonesia. It is found that when there is a shock in biodiesel production, CPO price reacts positively and then negatively with the lowest in the 5^{th} month. Afterwards the trend becomes positive and stabilize around 0 value. This pattern shows that biodiesel production only affect CPO price in relatively small percentage. Further analysis in variance decomposition shows that biodiesel production only affect slightly less than 5% while two variables mostly affect CPO price are cooking oil price (43.96%) and CPO price itself (35.69%). On the other hand biodiesel production itself is mainly affected by biodiesel production itself with 49.38% and CPO export with 20.82%. While CPO price affect is slightly less than 9%. This result shows that biodiesel production does not have negative impact on food security in Indonesia.

5. Acknowledgment

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