

Effect of Changes in World Ethanol Prices on Indonesian Sugar Industry

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Abstract: The use of alternative fuels in the form of biofuels from sugar cane is used as an opportunity for sugar cane producing countries. Brazil is the largest country producing sugar cane, which allocates sugar cane for raw materials for sugar and ethanol, changes in ethanol prices can affect the availability of sugar in world market. This study aims to analyze the changes in world ethanol prices on Indonesian sugar industry. The results showed that when world ethanol prices declined Brazil will allocate sugar cane to produce sugar, it would reduce the performance of the Indonesian sugar industry from upstream to downstream. Whereas when prices increased the availability of sugar in world markets will decline so that the price of sugar will increase, it would improve the performance of the Indonesian sugar industry.

Keywords - Ethanol Prices, Sugar Cane, Sugar, World Market.

I. INTRODUCTION

Technological developments in the agricultural industry that can convert sugar cane to fuel raises a strong relationship between sugar cane and ethanol based sugar prices. Ethanol is produced through fermentation from starchy plants containing sugar, such as corn, wheat, potatoes, cassava and sugar cane [15]. Ethanol is part of the solutions of developed countries to reduce fossil fuel use, reduce rising crude oil prices, create jobs, increase farmer incomes, and be environmentally friendly [18]. Sugarcane drops are the remainder of the crystallization process of sugar, which contains sugar and organic acids which can then be used to make ethanol. The order of ethanol producing countries is the largest in the last decade, namely the United States, Brazil, Europe, China and Canada. Plants that produce ethanol are very important for the rural economy of countries in America, in 2016 ethanol production created 74 420 jobs in all sectors of the economy with an industry income of US \$ 42 million and raising the level of household income by US\$ 23 million [6].

Sugar cane produces a joint product in the form of sugar and ethanol. The production cannot be done in one factory, that the possibility of producing sugar and ethanol together with financial risk and low yields to meet market demand [5]. Brazil as the world's largest ethanol producer with sugar cane raw materials can affect the world sugar market in terms of price [4]. The sugar cane is a joint product for ethanol and sugar so there is a strong relationship between the price of ethanol, crude oil and sugar. In the long run, changes in ethanol prices can affect sugar prices and vice versa, although not directly affected by crude oil prices.

In the period of 2015 to 2016 the price of petroleum on the world market was still at the lowest level, the price of Brent crude oil was recorded at US \$ 47.10 per barrel or a decrease of 2.5 percent from the previous year. The price of United States Intermediate (WTI) United States crude oil also decreased by 3 percent or at a price of US\$ 44.90 per barrel. This has caused Brazil as the largest sugar producer to increase sugar production and reduce ethanol production [3],

with part of its use mixed with crude oil so that world sugar prices will remain at a low level. World sugar prices increased in 2016 by 33 percent or increased to 21.36 cents per pound changes in world crude oil prices [1]. The shift on oil price will have an impact on production and the level of world sugar prices [16]. There was a transition in the price of ethanol and sugar when there was an increase in demand or a decrease in world oil prices [9]. The impact on the low price of sugar in the world market will cause changes in the price of sugar in the Indonesian domestic market to become unstable.

The increase in ethanol production by the Brazilian state will cause a sugar vacuum on the world market. The distribution of Brazilian sugar cane use in addition to the sugar and ethanol industries is also distributed to bioelectric, diesel, ditergen, food and beverage raw materials [10]. World sugar production has a deficit of 6.7 percent of total consumption in 2015 and the price of sugar in the world market is still relatively low at US \$ 384 per ton [8]. This condition was followed by a decline in the world's end sugar stocks, in 2014 amounting to 44.3 million tons to 40.5 million tons in 2015, down by 8.5 percent. The high level of consumption and low world sugar production causes a reduction in the volume of sugar traded in the world sugar market [20].

The Indonesian sugar industry is one of the strategic sectors to face challenges in the scope of trade in the world market. This is because there are factors in the capacity of agricultural resources, especially plantations that are very abundant such as; tropical climate that allows some plants to produce over time, extensive agricultural areas, and a considerable amount of labor in the agricultural sector. The area of sugarcane plantation is divided into three according to the concession status, namely; People's Plantation (PR), State Large Plantation (PBN) and Large Private Plantation (PBS) [11]. In 2013 Indonesia's sugar cane plantation area was recorded at 470.94 thousand hectares, then increased by 0.37 percent to 472.67 thousand hectares in 2014. In 2015 the sugarcane planting area increased slightly by 474 thousand hectares [2]. Overall the trend of the development of sugarcane planting areas in Indonesia in the period 2007 to 2016 has decreased with an average area of 481 thousand hectares per year or 0.06 percent per year. The decrease in planting area is due to the lack of certainty to improve or increase capacity at the sugar cane milling plant so that farmers prefer to plant rice or corn [21].

Indonesian sugar imports continue to increase every year, the lack of domestic sugar supply is a major factor for Indonesia to continue to import sugar [12]. In 2014

Indonesia's sugar imports reached 2.93 million tons with an import value of US\$ 1.31 billion. The volume of Indonesian sugar imports in 2015 increased by 14.87 percent with import values reaching US\$ 1.25 million. The largest supply of Indonesian sugar imports came from Thailand, Brazil, Australia, South Africa, Korea and Guatemala. Brazil's contribution to imports amounted to 458.17 thousand tons or 13.60 percent of Indonesia's total sugar imports with an import value of US\$ 189.95.

Indonesia has 48 sugar factories in Java and 15 sugar factories outside Java which are owned by 18 companies. The majority of these factories have operated between 40 and 100 years, only 6 factories that operate for less than 25 years so their productivity is very low. The entire sugar factory in Indonesia has a total capacity of 245 900 tons of sugar cane per day or an average of 3,900 tons of sugar cane per day with a yield rate of 7.1 percent. This figure is low when compared to one ASEAN region, namely Thailand, which has 50 sugar mills with a capacity of 94 000 tons of sugar cane per day with a yield rate of 11.82 percent. The results obtained by Indonesia are a quarter of the proceeds obtained by Thailand with a capacity of 10.6 million tons of sugar cane per year and 8 million tons to be traded [21]. The government, through its revitalization program, continues to strive to increase the number of factories and land expansion which are expected to produce maximum production.

The relationship between world ethanol prices and sugar prices can affect the availability of sugar in the world market [13]. The condition when ethanol prices increase or vice versa will affect the amount of sugar exported by Brazil. Indonesia as the largest importer in the world will receive an impact rather than changing the price of ethanol. The extent to which global ethanol price factors can affect the performance of the Indonesian sugar industry.

This study aims to analyze changes in world ethanol prices in the Indonesian sugar industry.

II. METHODOLOGY

1. Source and type of data

The data used are time series data with a span of 21 years, namely from 1995 to 2016. Time series data can be developed on models to forecast, interpret, and hypothesize economic data [7]. All related data in the study were obtained from institutions and formal organizations such as the Central Bureau of Statistics (BPS), Ministry of Industry of the Republic of Indonesia, Ministry of Agriculture of the Republic of Indonesia, Ministry of Trade of the Republic of

Indonesia, Director General of Plantation of the Republic of Indonesia, Center for Socio-Economic and Agricultural Policy (PSEKP), International Sugar Organization (ISO), United States Development of Agricultural (USDA), World Bank, FAO, United Nations Department of Economic and Social Affairs, Renewable Fuel Association (RFA), Energy Statistics (IES), World Trade Organization (WTO)

2. Model estimation, validation and simulation

Identification of structural equation Indonesian sugar industry model is arranged based on order condition [14] with the formula; $(K-M) \geq (G - 1)$, where G is the number of equations (current endogenous variable), K is the total variable in the model (endogenous current and predetermined) and M is the number of variables in an endogenous and exogenous variable. If $(KM) > (G - 1)$ then the equation is identified more (over identified), $(KM) = (G - 1)$ then the equation is identified exactly (exactly identified), and if $(KM) < (G - 1)$ then equations are said to be unidentified. The model is estimated using the 2SLS method (Two Stage Least Squares). The 2SLS method is said to be not too sensitive to model specification errors and provides consistent parameter estimation results.

The criteria used in the stages of validation of the industrial models of sugar and molasses are RMSPE (Root Mean Squares Percent Error) and U or Theil's Inequality Coefficient [17]. RMSPE is used to measure the percentage deviation of predictive value from the actual value of endogenous variables during the observation period. The smaller the RMSPE value the better the prediction of endogenous variables in the study. The statistical value of U is between 0 and 1, if the value of $U = 0$, the prediction of endogenous variables is perfect or close to the actual value and if $U = 1$, the prediction of endogenous variables is not close to reality. The smaller the RMSPE and U values, the better predictions of endogenous variables [19]. The stages after validation are simulation models that are used to evaluate historical policies and predict the impact of economic policies and changes in external factors towards the Indonesian sugar industry.

3. Formulation of Indonesian sugar industry model

The Indonesian sugar industry model consists of 28 equations consisting of 16 structural equations and 12 identity equations. The equation is sorted from the Indonesian sugar industry block, exports of Brazilian sugar and the world sugar market.

Indonesian sugarcane plantation area :

1. $ASCGE_t = a_0 + a_1 PRSWS_t + a_2 PRFRZ_t + a_3 TSFAC_t + a_4 (IRRIBI_t - IRRIBI_{t-1}) + a_5 ASCGE_{t-1} + u_1$
2. $ASCPE_t = b_0 + b_1 (PRSWS_t - PRSWS_{t-1}) + b_2 PRWF_t + b_3 PRFRZ_t + b_4 TSFAC_t + b_5 IRRIBI_{t-1} + b_6 ASCPE_{t-1} + u_2$
3. $ASCSH_t = c_0 + c_1 (PRSF_t - PRSF_{t-1}) + c_2 PRWF_t + c_3 PRFRZ_t + c_4 TSFAC_t + c_5 IRRIBI_t + c_6 ASCSH_{t-1} + u_3$
4. $ASCIN_t = ASCGE_t + ASCPE_t + ASCSH_t$

Hypothesis : $a_1, a_3 > 0$, $a_2, a_4 < 0$, $0 < a_5 < 1$, $b_1, b_4 > 0$, $b_2, b_3, b_5 < 0$, $0 < b_6 < 1$, $c_1, c_4 > 0$, $c_2, c_3, c_5 < 0$, $0 < c_6 < 1$

Indonesian crystal sugar productivity :

5. $YSCGE_t = d_0 + d_1 ASCGE_{t-1} + d_2 (WRFS_t - WRFS_{t-1}) + d_3 RENDS_t + d_4 YSCGE_{t-1} + u_4$
6. $YSCPE_t = e_0 + e_1 ASCPE_{t-1} + e_2 WRFS_t + e_3 RENDS_t + e_4 RF_t + u_5$
7. $YSCSH_t = f_0 + f_1 ASCSH_{t-1} + f_2 WRFS_t + f_3 RENDS_t + f_4 T_t + f_5 RF_t + f_6 YSCSH_{t-1} + u_6$

Hypothesis : $d_1, d_3 > 0$, $d_2 < 0$, $0 < d_4 < 1$, $e_1, e_3, e_4 > 0$, $e_2 < 0$, $f_1, f_3, f_4, f_5 > 0$, $f_2 < 0$, $0 < f_6 < 1$

Indonesian sugar and molasses production:

8. $QSCGE_t = ASCGE_t * YSCGE_t$
9. $QSCPE_t = ASCPE_t * YSCPE_t$
10. $QSCSH_t = ASCSH_t * YSCSH_t$
11. $QSCIN_t = QSCGE_t + QSCPE_t + QSCSH_t$
12. $QSIN_t = QSCIN_t + QSRIN_t$

Sugar demand by Indonesian household :

13. $DSHH_t = g_0 + g_1 (PRSR_t - PRSR_{t-1}) + g_2 (PRPSIN_t - PRPSIN_{t-1}) + g_3 PRCOFF_{t-1} + g_4 (RGDPIN_t - RGDPIN_{t-1}) / RGDPIN_{t-1} + g_5 DSHH_{t-1} + u_7$

Hypothesis : $g_2, g_4 > 0$; $g_1, g_3 < 0$; $0 < g_5 < 1$

Sugar demand by Indonesian food and baverage industry :

14. $DSIIN_t = h_0 + h_1 PRSWS_{t-1} + h_2 PRFD_{t-1} + h_3 (RGDPIN_t - RGDPIN_{t-1}) / RGDPIN_{t-1} + h_4 IRRIBI_t + h_5 DSIIN_{t-1} + u_8$

Hypothesis : $h_1, h_4 < 0$; $h_2, h_3 > 0$; $0 < h_5 < 1$

Total demand for Indonesian sugar :

15. $DSIN_t = DSHH_t + DSIIN_t$

Total Indonesian sugar supply :

$$16. SSIN_t = QSIN_t + MSIN_t + STKSIN_{t-1}$$

Indonesian sugar price equation :

$$17. PRSF_t = i_0 + i_1 PRSWS_t + i_2 QSIN_t + i_3 PRSF_{t-1} + u_9$$

$$18. PRSWS_t = j_0 + j_1 PRSR_t + j_2 STKSIN_{t-1} + j_3 PRSWS_{t-1} + u_{10}$$

$$19. PRSR_t = k_0 + k_1 (PRMSIN_t - PRMSIN_{t-1}) + k_2 SSIN_t + k_3 DSIN_{t-1} + k_4 PRSR_{t-1} + u_{11}$$

$$\text{Hypothesis : } i_1 > 0, i_2 < 0, 0 < i_3 < 1, j_1 > 0, j_2 < 0, 0 < j_3 < 1, k_1, k_3 > 0, k_2 < 0, 0 < k_4 < 1$$

Indonesian sugar imports from Brazil :

$$20. MSINBZ_t = l_0 + l_1 (PRMSIN_t - PRMSIN_{t-1}) + l_2 DSIN_t + l_3 MSINBZ_{t-1} + \mu_{12}$$

$$\text{Hypothesis : } l_2 > 0, l_1 < 0, 0 < l_3 < 1$$

Indonesian sugar import price equation :

$$21. PRMSIN_t = m_0 + m_1 (PRSW_t - PRSW_{t-1}) + m_2 TMSIN_t + m_3 RERIN_t + m_4 (MSIN_t - MSIN_{t-1}) + m_5 PRMSIN_{t-1} + \mu_{13}$$

$$\text{Hypothesis : } m_1, m_2, m_3, m_4 > 0, 0 < m_5 < 1$$

Indonesia's total sugar imports :

$$22. MSIN_t = MSINTH_t + MSINBZ_t + MSINAU_t + MSINROW_t$$

Brazilian sugar exports to Indonesia :

$$23. XSBZIN_t = n_0 + n_1 PRXSBZ_t + n_2 PRETHW_{t-1} + n_3 RERBZ_t + n_4 QSBZ_t + n_5 XSBZIN_{t-1} + u_{14}$$

$$\text{Hypothesis : } n_1, n_3, n_4 > 0, n_2 < 0, 0 < n_5 < 1$$

Brazilian sugar export price equation :

$$24. PRXSBZ_t = o_0 + o_1 PRSW_t + o_2 XSBZ_t + o_3 PRXSBZ_{t-1} + u_{15}$$

$$\text{Hypothesis : } o_1 > 0, o_2 < 0, 0 < o_3 < 1$$

Total exports of Brazilian sugar :

$$25. XSBZ_t = XSBZCH_t + XSBZID_t + XSBZIN_t + XSBZROW_t$$

Total world sugar exports :

$$26. XSW_t = XSBZ_t + XSTH_t + XSAU_t + XSROW_t$$

Total world sugar imports :

$$27. MSW_t = MSIN_t + MSCH_t + MSUS_t + MSEU_t + MSID_t + MSJP_t + MSROW_t$$

World sugar price equation :

$$28. PRSW_t = p_0 + p_1 XSW_t + p_2 MSW_t + p_3 PRSW_{t-1} + u_{16}$$

$$\text{Hypothesis : } p_2 > 0, p_1 < 0, 0 < p_3 < 1$$

Variable lable (exogenous) :

PRWF_t = real price of grain- t (rp/kg)

TSFAC_t = number of Indonesian sugar factories (unit)

T_t = time trend to - t

IRRBI_t = Indonesian investment interest rate (%)

PRFRZ_t = real price of fertilizer - t (rp/kg)

RENDSt = cane rendements - t (%)

WRFS_t = wages for plantation workers - t (rp/day)

QSRIN_t = crystal sugar production - t (ton)

PRPSIN_t = real price of brown sugar - t (rp/kg)

PRCOFF_t = real price of coffee - t (rp/kg)

POPIN_t = population of Indonesia - t (person)

RGDPIN_t = Indonesian real GDP - t (miliar US\$)

PRFD_t = real price of sugar confectionary (US\$/kg)

STKSIN_t = Indonesian sugar stock - t (ton)

TMSIN_t = Indonesian sugar import tariff - t (%)

RERIN_t = exchange rate rupiah to US\$ (rp/US\$)

MSINROW_t = Indonesian sugar import from rest of the world - t (ton)

XMOINROW_t = Indonesian molasses export to rest of the world - t (ton)

PRETHW_t = real world ethanol prices (US\$/ton)

RERBZ_t = exchange rate cruzero to US\$ (cruz/US\$)

QSBZ_t = Brazil sugar production - t (ton)

XSBZROW_t = Brazilian sugar export to rest of the world - t (ton)

XSROW_t = total sugar exports of other countries - t (ton)

MSROW_t = other country sugar imports - t (ton)

RF_t = Indonesian rainfall - t (mm)

XSBZCH_t = Brazilian sugar exports to China (ton)

XSBZID_t = Brazilian sugar exports to India (ton)

III. RESULT AND DISCUSSION

1. Exports and export prices of Brazilian sugar

Brazilian sugar exports to Indonesia are significantly affected by world ethanol prices t-1, the cruzero exchange rate against the US dollar and exports of Brazilian sugar to Indonesia t-1. The real prices of Brazilian sugar exports and

Brazilian sugar production do not have a significant effect on Brazilian sugar exports, this explains that the increase in the real prices of Brazilian sugar exports did not reduce the activity of exporting Brazilian sugar to Indonesia and Brazilian sugar production was not a benchmark for sugar exports to Indonesia. In the short term the real prices of Brazilian sugar exports provide an elastic response of 1.30 percent and in the long run also provide an elastic response where any 1 percent increase in the real price of Brazilian sugar exports will increase the amount of Brazilian sugar exports to Indonesia. The price of world ethanol t-1 has a negative influence on Brazilian sugar exports to Indonesia, this confirms that there is an influence on the transmission of the world's real ethanol prices in the Brazilian sugar industry

made from sugar cane. Sugar cane farmers in Brazil will be affected to determine the decision to configure sugar cane to produce sugar cane or directly process the sugar cane for ethanol. Although the process of sugar cane milled at the factory can produce molasses which is used as raw material for ethanol, sugar mills and ethanol can both operate their functions to directly process sugar products or directly into ethanol. The world ethanol real price has an inelastic response in both the short and long term with values of 0.46 and 0.64 percent. Factors that affect the export of Brazilian sugar to importing countries and the estimated results can be seen in Table 1.

Table 1. Results of estimated exports and real prices of Brazilian sugar exports

Variable	Parameter Estimate	Pr > t	Elasticity		Description
			Short-term	Long-term	
20. Brazilian sugar exports to Indonesia(XSBZIN _t)					
Intercept	-1181857	0.2625			
PRXSBZ _t	1847.542	0.0840	1.3024	1.7860	Export prices of Brazilian sugar
PRETHW _{t-1}	-3177.50	0.4070	-0.4699	-0.6444	World ethanol prices
RERBZ _t	44746.86	0.7072	0.2299	0.3153	Brazil's exchange rate
QSBZ _t	0.034271	0.0716	1.7119	2.3475	Brazilian sugar production
XSBZIN _{t-1}	0.270756	0.2642			
23. Export prices of Brazilian sugar (PRXSBZ _t)					
Intercept	68.77400	0.0040			
PRSW _t	0.868019	<.0001	1.1620	1.6362	World sugar prices
XSBZ _t	-9.95E-6	<.0001	-0.5484	-0.7722	Total Brazil sugar exports
PRXSBZ _{t-1}	0.289822	<.0001			

2. Impact of decreasing world ethanol prices

The simulation results of the S1 decline in world ethanol prices 10 percent in general will have a negative impact on the Indonesian sugar and molasses industry. Ethanol prices are transmitted to the equation of exports of Brazilian sugar as the largest sugar and ethanol producing country made from sugar cane. Brazil's total sugar exports decreased by 6.26%, the increase in total exports was the sum of the largest proportion of sugar exports to the country. Brazil's sugar exports to Indonesia increased by 19.52%. The declining of Brazilian sugar exports because Indonesia chose to supply sugar from neighboring countries considering the lower transportation costs of Thailand and Australia. Increased exports of Brazilian sugar reduced the real price of world sugar by 8.71% due to the increase in the availability of sugar in the world market by 3.01%. The

impact of the decline in real world ethanol prices will reduce the export value of Indonesian molasses by 0.27% or US \$ 206 thousand and the value of Indonesian sugar imports increases by 1.09% or US \$ 251 million. Government revenues from the sugar import tariff policy will decrease by 1.14% or US \$ 1.2 billion. Simulation of the policy of increasing Indonesia's sugar cane planting area by 28 percent is one of the government's programs to realize sugar self-sufficiency. Extensification of planting area can be done with the Ministry of Forestry through the off farm side. The compatibility of the simulation S1 results can be seen in Table 2

3. Impact of increasing world ethanol prices

The impact of an increase in the price of world ethanol by 10 percent (S2) is done to see the changes that will occur

in the domestic and world markets for sugar. The external change in the form of an increase in the real world ethanol price which affects the amount of Brazil sugar exports will have an impact on the decline in the total exports of Brazilian sugar by 0.69 percent. The decline in the total exports of Brazilian sugar will reduce the world's total sugar exports by 0.34 percent. The decline was more influenced by the dominance of Brazilian sugar exports compared to the total exports of Thailand and Australian sugar. On the demand side in the world sugar market, total world sugar imports will decrease by 0.02 percent. Thailand and Australian sugar exports that have not developed the ethanol industry largely continue to produce sugar and the total sugar exports of both countries are increasing, increasing the real price of world sugar. Increasing the real price of world sugar will increase the real price of Indonesian sugar imports by 0.35 percent and the real price of imported sugar will be transmitted through the real price of retail sugar which increases by 0.49 percent.

An increase in the real price of retail sugar will increase the real price of large-scale sugar traders by 0.54 percent

and the real price of farmer's sugar by 0.64 percent. The increase in domestic sugar prices will reduce the total demand for Indonesian sugar by 0.09 percent. The increase in domestic sugar prices will increase the total area of Indonesian sugar cane plantation by 0.01 percent and the total Indonesian sugar production to increase even with relatively small values. The increase in area will increase crystal sugar productivity in each land ownership status so that an increase in productivity will increase Indonesian molasses production by 0.01 percent. Increasing Indonesian molasses production will increase Indonesian molasses exports to Japan by 0.05 percent. The value of Indonesian molasses exports at an increase in the real world ethanol price increased by 0.05 percent or US \$ 52 thousand and the value of Indonesian sugar imports would increase by 0.17 percent or US \$ 3.1 million so that Indonesia's trade balance had a surplus of 0.16 percent or US \$ 3.2 million. Government revenues through the determination of sugar import tariffs will increase by 0.35 percent or US \$ 42 billion. The compatibility of the simulation S2 results can be seen in Table 2.

Table 2 Simulation results of the impact of world ethanol prices reduction on the Indonesian sugar industry

No	Variable	Unit	Base Value	$\Delta\%$	
				S1	S2
1	Government sugarcane plantation area	Ha	87196.99	-0.066	0.007
2	Private sugarcane plantation area	Ha	118142.8	-0.364	0.040
3	Smallholders sugarcane plantation area	Ha	244738.5	-0.038	0.004
4	Total Indonesian sugarcane plantations area	Ha	450078.3	-0.129	0.014
5	Sugar productivity of government plantations	Ton/ha	4.325425	-0.016	0.002
6	Sugar productivity of private plantations	Ton/ha	6.309824	-0.015	0.002
7	Sugar productivity of smallholders plantations	Ton/ha	6.038376	-0.004	0.000
8	Government plantation crystal sugar production	Ton	377066.6	-0.081	0.009
9	Private plantation crystal sugar production	Ton	746089.9	-0.387	0.043
10	Smallholders plantation crystal sugar production	Ton	1477752	-0.039	0.004
11	Total production of Indonesian crystal sugar	Ton	2600908	-0.145	0.016
12	Indonesia's total sugar production	Ton	4883802	-0.077	0.009
13	Sugar demand by Indonesian household	Ton	2805087	0.174	-0.019
14	Sugar demand by Indonesian food and beverage industry	Ton	2764689	1.680	-0.187
15	Total Indonesian sugar demand	Ton	5569776	0.922	-0.102
16	Total Indonesian sugar supply	Ton	8632031	0.458	-0.051
17	Indonesian farmer sugar prices	Rp/kg	3322.749	-10.397	1.155
18	Indonesian wholesale sugar prices	Rp/kg	4690.67	-7.970	0.886
19	Indonesian retail sugar prices	Rp/kg	5862.091	-6.663	0.740
20	Import Indonesia sugar from Brazil	Ton	691400.9	1.828	-0.203
21	Indonesian sugar import prices	US\$/Ton	371.8243	0.174	-0.019
22	Indonesia's total sugar imports	Ton	2854818	1.680	-0.187
23	Brazil sugar exports to Indonesia	Ton	633285.5	-19.527	2.170
24	Brazil sugar exports prices	US\$/Ton	330.4883	-15.422	1.714
25	Total Brazil sugar exports	Ton	25195617	6.261	-0.696

26	Total world sugar exports	Ton	52132799	3.013	-0.335
27	Total world sugar imports	Ton	48790462	0.167	-0.019
28	World sugar prices	US\$/Ton	466.3309	-8.714	0.968

Description : S1 = world ethanol price reduction 10%, S2 = increase in world ethanol prices 10%

I. CONCLUSION

The decline in world ethanol prices will have a negative impact on the Indonesian sugar and molasses industry. The decline in world ethanol prices will increase Brazil's sugar production so that the availability of sugar in the world market experiences a sugar production surplus. Conversely, an increase in world ethanol prices will have a positive impact on the Indonesian sugar and molasses industry. The increase in world ethanol prices will reduce the export of Brazilian sugar which will have an impact on the decline in total Indonesian sugar imports.

REFERENCE

- [1] Amadeo K. 2016. Oil Price Forecast 2017-2040 Oil Price Doubled in 2016. The Balance, US Economy, available on : <https://www.thebalance.com>.
- [2] [BPS] Badan Pusat Statistik. 2015. Statistik Tebu Indonesia, Jakarta
- [3] [BSIA dan ApexBarsil] Brazillian Sugarcane Industry Association and ApexBrasil.2018, Virtual Tour of Sugarcane Mill (Transcript), available on : sugarcane.org.
- [4] Chen B, Saghaian S. (2015), The Relationship among Ethanol, Sugar and Oil Prices in Brazil : Cointegration Analysis with Structural Breaks, Southern Agricultural Economics Association's, Atlanta, Georgia
- [5] Dias MOS, Filho RM, Mantelatto PE, Cavalett O, Rossell CEV, Bonomi A, Leal MRLV. 2015, Sugarcane processing for ethanol and Sugar in Brazil, Environmental Development 15 (2015) 35-51, DOI : 10.1016/j.envdev.2015.03.004
- [6] [EIA] US. Energy Information Administration. 2017. International Energy Outlook 2017, available on : www.eia.gov
- [7] Enders W. 2004. Applied Econometric Time Series. Ed ke-2. Wiley. Alabama (US)
- [8] [FAO] Food and Agriculture Organization. 1997. Impact of Trade Liberalization on the World Sugar Market. Economic and Social Development Departement. Pasific sugar conference, Fiji
- [9] Gorter DH, Drabik D, Kliauga EM dan Timilsina GR. 2013, An Economic Model of Brazil's Ethanol-Sugar Markets and Impacts of Fuel Policies, Policy research working paper 6524, The World Bank Development Research Group Environment and Energy Team
- [10] [ISJ] International Sugar Journal. 2015. ISJ's World Sugar Outlook 2015. De Smet. Informa. (UK)
- [11] Kementrian Pertanian.2016. Outlook Tebu Komoditas Pertanian Subsektor Perkebunan, Pusat Data dan Sistem Informasi Pertanian Sekretariat Jendral, ISSN 1907-1507, 2016, Jakarta.
- [12] Knight R. 2018, Indonesia's Colonial Sugar Industry, Oxford Research Encyclopedia of Asian History, Maret 2018, DOI : 10.1093/acrefore/9780190277727.013.44
- [13] Koizumi T. 2003. The Brazilian Ethanol Programme : Impact on World Ethanol and Sugar Markets, FAO Commodity and Trade Policy Research Working Paper No.1, Commodity Policy and Projections Service Commodities and Trade Division.
- [14] Kuotsoyianis, A. 1977. Theory of Econometrics: An Introductory Exposition of Econometric Methods. Second Edition. The Macmillan Press Ltd, London.
- [15] Mohammed Abdalbasit A, Gasmalla, Yang R, Nikoo M, dan Man S. 2012, Production of Ethanol from Sudanese Sugar Cane Molasses and Evaluation of its Quality, Food Processing and Technology, available on : <http://dx.doi.org/10.4172/2157-7110.1000163>
- [16] [OPEC] Organization of Petrolieum Exporting Countries. 2016. Annual OPEC oil price from 1960 to 2016, The Statistics Portal, available on : <https://www.statista.com/statistics/262858/change-in-opec-crude-oil-prices-since-1960/>.
- [17] Pindyck R S dan Rubinfeld DL.1998. Econometric Model and Economic Forecast. Ed ke - 4, McGraw hill, New York
- [18] [RFA] Renewable Fuels Association. 2016. Fueling A High Octane Future, 2016 Ethanol Industry Outlook, tersedia pada : www.EthanolIRFA.org.
- [19] Sitepu K R, Sinaga B M. 2006. Aplikasi Model Ekonometrika : Estimasi, Simulasi, Peramalan menggunakan program SAS, Program Studi Ilmu Ekonomi Pertanian, Bogor (ID) : Institut Pertanian Bogor
- [20] [USDA-GAIN] United States Department of Agriculture-Global Agricultural Information Network 2017, Sugar : World Markets and Trade, USDA, Foreign Agricultural Services.

- [21] Wright T, Meylinah. 2016. Indonesian Sugar Annual Report 2016, GAIN report No. ID1614, 21 Maret 2016, USDA.