

Sugar Price Analysis in Indonesia

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Abstract—This study examines the dynamic relationship between sugar price, exchange rate, oil price, rice price, and consumer price index (CPI); and to detect is there any difference between exchange rate, oil price, rice price, and CPI in effecting sugar price. We employ Vector Auto-regressions methods for a time series of monthly data from January 1998 to December 2011. Generally, the Impulse Response Function results provide the positive response of Indonesian sugar price from shock of the change of world sugar price, oil price, rice price and CPI; but there is negative response of Indonesian sugar price from shock of the change of exchange rate. The empirical results in variance decomposition test provide evidence that variability of the change of Indonesian sugar price are vary between each variable. Overall variance decomposition results are below than ten percent. These results indicate there is low transmission of international prices into Indonesian sugar prices.

Index Terms—Indonesia, impulse response function, sugar price, variance decomposition, vector auto-regressions.

I. INTRODUCTION

According to FAO [1], the global food and financial crises of 2008 have pushed an additional 115 million into hunger. The price of food is continuously high and volatile until now. The price volatility can be transmitted through other commodities.

In the year 2008, rice price is at the highest level, about U.S.\$1.040/ton, an increase of two times compared to 1998. Also oil price in the same year reach U.S.\$144.07/barrel, an increase of 11 times compare to 1998. But sugar only increase 0.72 times compare to 1998. This condition change in 2011 where oil prices increase just 4.6 times compare to 2001. Also sugar prices increase 1.85 times compare to 2001. Then rice prices increase 2.33 times compare to 2001. What happened to these prices? What is the relationship between these commodities? What is the impact to other commodity like sugar?

To answer these questions, we try to give several arguments and calculation about the concept of sugar, the important of sugar product compare to other commodities, and also the relation between International commodities prices and Indonesian sugar price. According to Hannah and Spence [2], sugar is a special product, with strong social, political, geographical and emotional attributes. There are 130 countries produce sugar. Many people working in the sugar industry, for example: in Brazil 1.28 million people, in Indonesia 900.000 people. Also millions of other workers associated with food companies that use sugar.

Manuscript received March 3, 2013; revised May 3, 2013.

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In the world market, sugar also very important commodity future trading. The price of the sugar it is depending on several factors. Oil price gives influence to all commodity prices including rice and sugar price. Maybe rice is not really important in developed countries, but in developing countries, especially in Asia, it is still become very interesting topic.

For example, in developing countries like Indonesia, the problem of price is still become concerns. Because it is relates to price policy to control inflation. Inflation means increases in price and when prices increase, purchasing power decrease. If the basic commodities prices increase the first people who suffer are 1.29 billion poor people in the world. 400 million poor people live in India; 173 million people live in China. Also 108 million poor people live in Indonesia.

What this poor people eat every day? They basic food is rice. Indonesian people eat rice 139 kg/capita/year (the biggest in the world). So rice is one of the important commodities beside sugar. But what is the relation between these commodities? This is one opportunity to learn more about it. According to Association of Indonesian Sugarcane People's Farmer, the ratio of sugar price is one and half of rice price [3].

Also Indonesian government built roadmap to make sugar and rice self-sufficiency in the year 2014. But the problem is, there are five commodities that must be self-sufficient in 2014. There are sugar, soybean, corn, rice, and beef. The production minimum to become self sufficiency is: sugar 3.1 million tons; soybean 2.7 million tons; corn 29 million tons; beef 510 thousand tons; and rice 81 million tons milled rice.

Another reason this research analyze sugar because the coefficient of variation (CV) Indonesian sugar price is bigger compare to another commodities. Coefficient of variation of price is diversity value or price deviation seen from the average value. It is usually used as an indicator of price stability. To calculate CV, we use the equation below.

$$CV = \frac{\left(\sum (X^t - X^a)^{1/2}\right)}{\left(\sum X^t\right)^{N-1}} \times 100\% \quad (1)$$

where: CV = coefficient of variation (%); X^t = price of year t (Rp/ kg); X^a = the average price during the observation period (Rp/ kg); N = Number of years of observation (years).

As seen in the table, in 2009 the coefficient of variation sugar is 12.1. It is bigger than 6 other commodities. It is even bigger to the average coefficient of variation in 2009. Furthermore, from January until March 2012, the condition repeated again when sugar coefficient of variation is bigger than other commodities. Moreover, coefficient of variation rice is 0.6 in the period January until March 2012. This CV of rice is the second biggest compare to other commodities.

The price of Indonesian sugar price is related to other

indicator like exchange rate. Because according to USDA [4], in 2012 about 60 percent of sugar domestic consumption in Indonesia is imported from another country such as Australia, Thailand, Brazil and India. So this is one of the indications why exchange rate is so important in this research.

TABLE I: CV INDONESIAN SUGAR PRICE COMPARE TO OTHER COMMODITY YEAR 2009 AND 2012

No	Commodity	Coefficient of Variation	
		2009	January- March 2012
1.	Rice	1.0	0.6
2.	Sugar	12.1	0.8
3.	Corn	2.3	0.2
4.	Soybean	1.3	0.1
5.	Wheat Flour	0.4	0.0
6.	Milk	0.5	0.4
7.	Beef	1.6	0.3
	Average	2.7	0.3

The connection between these macroeconomic indicator and basic food commodities especially sugar become very important issue. Several researchers already wrote some fact and findings about the relationship between sugar price and other commodities prices.

Rahayuningrum *et al.*, [5] said that in the long run the increase of imported sugar price (world sugar price) one percent, *ceteris paribus*, can significantly increase Indonesian sugar price about 5.66 percent. In other word, there is positive relation between world sugar price and Indonesian sugar price.

Esmaili and Shokoohi [6] used principal component analysis (PCA) to further understand the influence of the macroeconomic index on food prices. They also use correlation and causality test with Augmented Dicky Fuller and Granger Causality Test. The result said that crude oil prices have an indirect effect on food prices.

Serra [7] used different approach to see the volatility links between food and energy prices. They used semi parametric estimator of the conditional covariance matrix developed by Long *et al.*, [8]. They show that the prices for food commodities are cointegrated with crude oil prices, indicating the presence of the direct bio-fuel channel. There is a long-run Granger causality from oil to agricultural commodity prices, but not vice versa.

Another paper from Alghalith [9], about the interaction between food prices and oil prices, used national Nominal Rate of Assistance to agricultural producers (NRA) and Nominal Assistance Coefficient (NAC). The empirical results indicate that higher oil price increases food price. Also, higher the oil price volatility yield makes higher the food price. Moreover, an increase in the oil supply reduces the food price.

Moreover Lastrapes [10] using Vector Autoregression (VAR) in his research and he found that there is indication of positive correlation between inflation and sugar price. The research was done in USA and the period of time is from 1959 until 2003 using monthly data. Then Nazlioglu and Soytaş [11] found that there is positive impact of a weak dollar on agricultural prices including sugar. Different thing happened in McConnell *et al.*, [12] research that there is

negative relation between Brazilian sugar price and exchange rate Brazilian Real against US\$.

Based on the literature review above, this paper attempts to contribute to the literature by investigating the shock of exchange rate, oil price, rice price, Consumer Price Index (CPI) on sugar price (world raw sugar price, world refined sugar price and Indonesian sugar price). In that respect, this study brings new insights into the literature on the energy, exchange rate, CPI, and food nexus.

II. THE VAR

VAR models, first formulated by Sims [13], used to estimate the simultaneous equations using time series data where all variables are endogenous variables, the right hand side equation is the lag (lag value) of the dependent variable, and it is called vector because contain more than two variables.

General equation of the VAR is as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_k Y_{t-k} + B X_t + \epsilon_t \quad (2)$$

Furthermore, VAR models are developed by Enders [14], that give A_0 that is matrices $n \times 1$ from intercept but used exogenous variable, the equations as is follow:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_k Y_{t-k} + B X_t + \epsilon_t \quad (3)$$

Vector Autoregressions (VAR) procedure to do this research are: research data identification, specification VAR model, stationary test, lag length criteria, VAR estimation, stability test, and innovation accounting (includes impulse response function and variance decomposition).

III. DATA

The VAR is estimated based on 168 monthly series of Indonesia and the world from January 1998 until December 2011. The data covering Indonesian sugar price, world refined sugar price, world raw sugar price, nominal exchange rate between Brazilian Real (BRL) and US\$, world oil price, world rice price, and CPI in Indonesia.

IV. VAR MODEL SPECIFICATION

Model Specification: relation between DGKP, DREFINED, DRAW, DER, DOIL, DRICE, and DCPI.

$$DGKP_t = \alpha_{A0} + \sum_{i=1}^n \alpha_{A1} DGKP_{t-i} + \sum_{i=1}^n \alpha_{A2} DREFINED_{t-i} + \sum_{i=1}^n \alpha_{A3} DRAW_{t-i} + \sum_{i=1}^n \alpha_{A4} DER_{t-i} + \sum_{i=1}^n \alpha_{A5} DOIL_{t-i} + \sum_{i=1}^n \alpha_{A6} DRICE_{t-i} + \sum_{i=1}^n \alpha_{A7} DCPI_{t-i} + \epsilon_{At} \quad (4)$$

$$DREFINED_t = \alpha_{B0} + \sum_{i=1}^n \alpha_{B1} DGKP_{t-i} + \sum_{i=1}^n \alpha_{B2} DREFINED_{t-i} + \sum_{i=1}^n \alpha_{B3} DRAW_{t-i} + \sum_{i=1}^n \alpha_{B4} DER_{t-i} + \sum_{i=1}^n \alpha_{B5} DOIL_{t-i} + \sum_{i=1}^n \alpha_{B6} DRICE_{t-i} + \sum_{i=1}^n \alpha_{B7} DCPI_{t-i} + \epsilon_{Bt} \quad (5)$$

$$DRAW_t = \alpha_{C0} + \sum_{i=1}^n \alpha_{C1} DGKP_{t-1} + \sum_{i=1}^n \alpha_{C2} DREFINED_{t-1} + \sum_{i=1}^n \alpha_{C3} DRAW_{t-1} + \sum_{i=1}^n \alpha_{C4} DER_{t-1} + \sum_{i=1}^n \alpha_{C5} DOIL_{t-1} + \sum_{i=1}^n \alpha_{C6} DRICE_{t-1} + \sum_{i=1}^n \alpha_{C7} DCPI_{t-1} + \epsilon_{Ct} \quad (6)$$

$$DER_t = \alpha_{D0} + \sum_{i=1}^n \alpha_{D1} DGKP_{t-1} + \sum_{i=1}^n \alpha_{D2} DREFINED_{t-1} + \sum_{i=1}^n \alpha_{D3} DRAW_{t-1} + \sum_{i=1}^n \alpha_{D4} DER_{t-1} + \sum_{i=1}^n \alpha_{D5} DOIL_{t-1} + \sum_{i=1}^n \alpha_{D6} DRICE_{t-1} + \sum_{i=1}^n \alpha_{D7} DCPI_{t-1} + \epsilon_{Dt} \quad (7)$$

$$DOIL_t = \alpha_{E0} + \sum_{i=1}^n \alpha_{E1} DGKP_{t-1} + \sum_{i=1}^n \alpha_{E2} DREFINED_{t-1} + \sum_{i=1}^n \alpha_{E3} DRAW_{t-1} + \sum_{i=1}^n \alpha_{E4} DER_{t-1} + \sum_{i=1}^n \alpha_{E5} DOIL_{t-1} + \sum_{i=1}^n \alpha_{E6} DRICE_{t-1} + \sum_{i=1}^n \alpha_{E7} DCPI_{t-1} + \epsilon_{Et} \quad (8)$$

$$DCPI_t = \alpha_{G0} + \sum_{i=1}^n \alpha_{G1} DGKP_{t-1} + \sum_{i=1}^n \alpha_{G2} DREFINED_{t-1} + \sum_{i=1}^n \alpha_{G3} DRAW_{t-1} + \sum_{i=1}^n \alpha_{G4} DER_{t-1} + \sum_{i=1}^n \alpha_{G5} DOIL_{t-1} + \sum_{i=1}^n \alpha_{G6} DRICE_{t-1} + \sum_{i=1}^n \alpha_{G7} DCPI_{t-1} + \epsilon_{Gt} \quad (9)$$

$$DRICE_t = \alpha_{F0} + \sum_{i=1}^n \alpha_{F1} DGKP_{t-1} + \sum_{i=1}^n \alpha_{F2} DREFINED_{t-1} + \sum_{i=1}^n \alpha_{F3} DRAW_{t-1} + \sum_{i=1}^n \alpha_{F4} DER_{t-1} + \sum_{i=1}^n \alpha_{F5} DOIL_{t-1} + \sum_{i=1}^n \alpha_{F6} DRICE_{t-1} + \sum_{i=1}^n \alpha_{F7} DCPI_{t-1} + \epsilon_{Ft} \quad (10)$$

Response to Cholesky One S.D. Innovations ± 2 S.E.

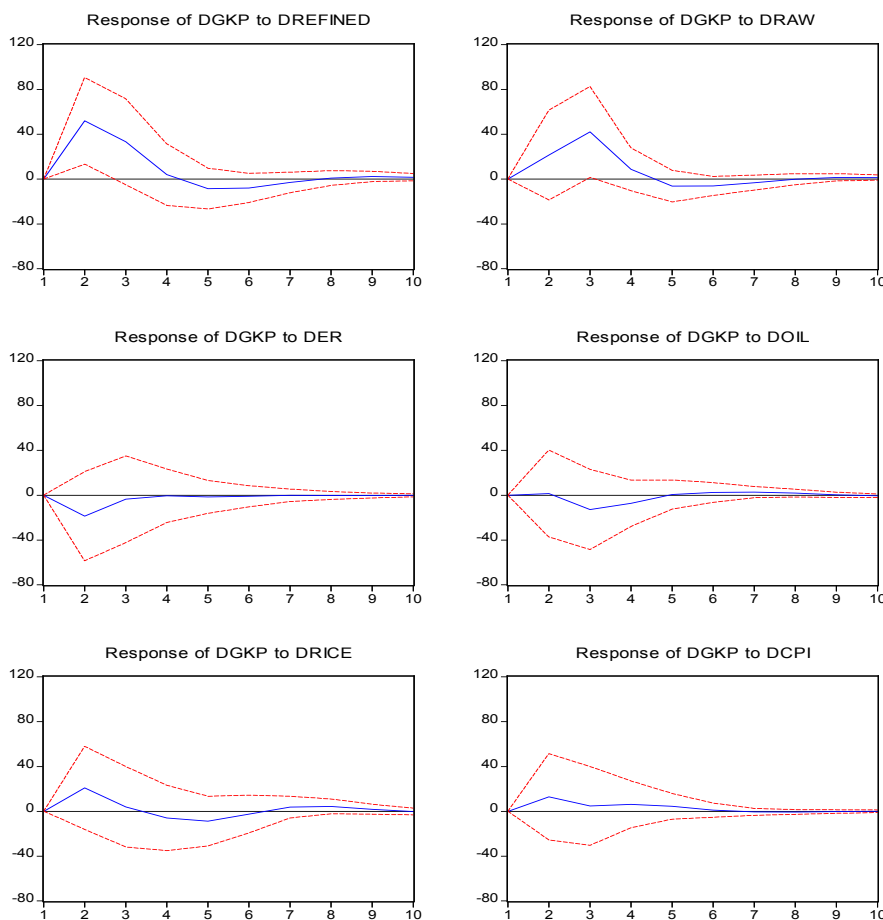


Fig. 1. Impulse response function Indonesian sugar price (DGKP)

V. EMPIRICAL RESULT

A. V.1. Stationarity Test Results of the Data

Stationarity test must be done before running the VAR estimation. Time series data can be called stationer if the value of mean, variance and autocovariance for each lag is constant with time [15]. To detect the stationarity of seven variables, which are GKP, REFINED, RAW, ER, OIL, RICE, and CPI is using Augmented Dickey-Fuller (ADF) test. ADF test conducted with the degree level and at the first difference

level for series of data from 1998M01 until 2011M12. The result is all variables stationaire in first difference.

B. V.2. Leg length Criteria

Estimated VAR lag is very sensitive to the amount of data that is used. It must be determined the optimal amount of lag. Determination of the length of this lag used to determine the duration of the effect of a variable period of variables in the past and to the other endogenous variables. Lag length can be determined using several approaches, FPE (Final Prediction Error) and AIC (Akaike Information Criterion) give the same

suggestion to choose second lag.

C. V.3. VAR Estimation Result

Based on the VAR estimation result are not all significant lag in every equations, for more details will be described one by one. Significant variable affecting the change in the price of sugar in Indonesia is change in the price of sugar two month before. Then significant variables affecting the change in the price of refined sugar in the world is the change in price of world raw sugar one month before. After that the significant variables affecting the change in the price of raw sugar in the world is the change in the world raw sugar one month before.

VI. INNOVATION ACCOUNTING

In the innovation accounting will be detailed how far and how much is the influence of shock or disturbance of variables formed in the equation. Innovation accounting consists of two parts, namely the impulse response function (IRF) and variance decomposition (VDCs).

A. VI.1. Analysis of Impulse Response Function (IRF)

IRF track the effect of one shock to another shock at this point and time that will come from an endogenous variable. In the event of a shock to the i^{th} variable directly it will effect on the variable itself and spread to other variables Endogenous others through VAR dynamic structure. IRF can also provide direction of the relationship between the magnitudes of the influence of the endogenous variables. Thus the shock that occurs in a variable if given new information could affect the variable itself and the other variables in the VAR system of equations. In this research, IRF is used to see the effect of the shock World Refined Sugar, World Raw Sugar, Exchange Rate, Oil Price, Rice Price and CPI to variable Indonesian Sugar Price.

The existence of shock from the change of World Refined Sugar Price (DREFINED) responded positively by the change of Indonesian Sugar Price from the first month to 4th month. This positive effect is the same result with research from Rahayuningrum, et al. [5] said that there is positive relation between world sugar price and Indonesian sugar price. This result also indication that the World Refined Sugar Price gives positive effect to Indonesian Sugar Price through importation. For example in 2012, Indonesia import 94,711 ton world refined sugar for food and beverage industry and 54,998 ton world refined sugar for fulfill Aceh and West Kalimantan boarder needs.

Then the shock of the change of World Refined Sugar Price responded negatively by the change of Indonesian Sugar Price from the 5th month to 8th month. If the world refined sugar price increase can also stimulate Indonesian sugar cane farmer and industry to increase their productivity. So there is indication that in the 5th until 8th after the World Refined Sugar Price shock, Indonesian Sugar Price will be decreased because of domestic sugar cane supply increased.

Then the existence of shock from the change of World Raw Sugar Price (DRAW) responded positively by the change of Indonesian Sugar Price from the first month to 5th month. Like World Refined Sugar Price shock, World Raw Sugar Price shock also gives positive effect to Indonesian Sugar Price through importation. For example in 2012,

Indonesia import: 2,385,457 ton of world raw sugar for refined sugar industry; 182,000 ton of world raw sugar to be turned into plantation white sugar; 223,438 ton of world raw sugar for fulfill idle capacity sugar industry; and 171,100 ton of world raw sugar for MSG (Monosodium Glutamate) industry.

Then the shock of the change of World Raw Sugar Price responded negatively by the change of Indonesian Sugar Price from the 5th month to 8th month. The reason is the same with the change of World Refined Sugar Price shocks to the change of Indonesian Sugar Price. But the different is the response of Indonesian Sugar Price slower because World Raw Sugar is not ready to consumed food. So it is take some time to change from raw sugar into refined sugar and take more time again to sell in the market and effecting Indonesian Sugar Price

After that the existence of shock from the change of Exchange Rate responded negatively by the change of Indonesian Sugar Price from the first month to 4th month. There is indication that the change of Exchange Rate Brazilian Real/US\$ effecting the change of Indonesian Sugar Price through Brazilian sugar price. According to McConnell, et al. [12] there is negative relation between Brazilian sugar price and exchange rate Brazilian Real againts US\$. Then because Brazil is the biggest sugar producer and exporter in the world, Brazilian sugar price effecting world sugar price. Finally world sugar price effecting Indonesian Sugar Price.

Then the existence of shock from the change of Oil Price responded positively by the change of Indonesian Sugar Price from the first month to 2nd month. This result is similar with Alghalith [9] and Hanson, et al. [16] said that there is positive relation between oil price and agricultural commodity price. Oil is input factor in sugar cane production like transportation and fertilizers of sugar industry.

After that the shock of the change of Oil Price responded negatively by the change of Indonesian Sugar Price from the 3rd month to 5th month. If the price of good increase, then the supply of goods tend to increase also because the seller want to get more profit. According to Alghalith [9], an increase in the supply of world oil will reduces the food price, including sugar.

Moreover the shock from the change of Oil Price responded positively again by the change of Indonesian Sugar Price from the 6th month to 9th month. According to Srinivasan [17], the raised of oil price will increase ethanol price also as a substitute product of oil. So, if oil price increase then the last response is sugar price increase again.

Then the existence of shock from the change of World Rice Price responded positively by the change of Indonesian Sugar Price from the first month to 3rd month. Actually, it is difficult to explain this condition because there is no direct channel between sugar and rice price. Although this condition indicates that high economic growths in the emerging countries can contribute for keeping the sugar and rice price increase [18].

Moreover the existence of shock from the change of Consumer Price Index responded positively by the change of Indonesian Sugar Price from the first month to 6th month. This result is the same with research by Nazlioglu and Soytaş [11].

B. VI.2. Variance Decomposition (VDCs)

VDCs is used in order to construct forecast error variance a variable, how large the differences between variants before and after the shock occurs, either from shock and the other variables derived from the variable itself, the way is to measure the percentage of shock of each variable. For example if there is shock in the change of Indonesian sugar

price (DGKP) then the changes can be explained from the percentage of change of Indonesian sugar price, the change of World Raw Sugar Price, the change of World Refined Sugar Price, the change of Exchange Rate, the change of Oil Price, the change of Rice Price and the change of Consumer Price Index.

TABLE II: VARIANCE DECOMPOSITION OF THE CHANGE OF INDOONESIAN SUGAR PRICE (DGKP)

Period	S.E.	DGKP	DREFINED	DRAW	DER	DOIL	DRICE	DCPI
10	264.72	88.83	5.67	3.41	0.52	0.33	0.86	0.35

Cholesky Ordering: DGKP DREFINED DRAW DER DOIL DRICE DCPI

TABLE III: VARIANCE DECOMPOSITION OF WORLD RAW SUGAR PRICE (DRAW)

Period	S.E.	DGKP	DREFINED	DRAW	DER	DOIL	DRICE	DCPI
10	264.72	3.27	61.86	31.79	0.70	1.49	0.64	0.22

Cholesky Ordering: DGKP DREFINED DRAW DER DOIL DRICE DCPI

TABLE IV: VARIANCE DECOMPOSITION OF WORLD REFINED SUGAR PRICE (DREFINED)

Period	S.E.	DGKP	DREFINED	DRAW	DER	DOIL	DRICE	DCPI
10	264.72	4.35	87.94	4.00	1.98	0.60	0.32	0.78

Cholesky Ordering: DGKP DREFINED DRAW DER DOIL DRICE DCPI

Based on this table, can be concluded that variable of the change of Indonesian Sugar Price has the biggest percentage to explained variability of the change of Indonesian sugar price about 88 percent. In 10th period, the change of world refined sugar price to explain variability of the change of Indonesian sugar price is 5.6 percent, then average change of world raw sugar price to explain variability of Indonesian sugar price is 3.4 percent, and average change of exchange rate to explain variability of Indonesian sugar price is 0.5 percent.

The variability of Indonesian sugar price can be explained by world refined sugar and raw sugar are bigger than other variables because in Indonesia world refined sugar was imported to fulfilled food and beverage industries. Also world refined sugar was imported and distributed for direct consumption in household. According to Decree of The Ministry of Industry and Trade No. 527/MPP/Kep/9/2004 about the Importation of Sugar, they both are imported to fulfill the needs of Indonesian sugar consumption total 5.2 million ton for 240 million people lived in Indonesia.

The small number of variance decomposition that can explain the change of Indonesian sugar price is indicates that there is low transmission of international prices (world refined sugar price, world raw sugar price, oil price and rice price) into domestic prices. This result is similar with the research from Janvry and Sadoulet [19] in Guatemala.

Based on table above, can be concluded that world refined sugar price variable has the biggest percentage to explained variability of world raw sugar price with average 61.8 percent in the 10th period. The second biggest is world refined sugar price itself about 31.7 percent. This condition happened because refined sugar price is the indicator price to sell raw sugar. The condition that Indonesian sugar price variable has 3.2 percent to explain the variability of world raw sugar price is difficult to explain. But this condition at least explain that even importer sugar countries like Indonesia can give contribution to world raw sugar price from demand side because every year Indonesia import about 2.3 million ton world raw sugar.

The surprising thing in this calculation is that variability of oil price can only explain about 1.4 percent to variability of world raw sugar. Although this number is bigger than the variability of exchange rate, rice and CPI, but this is one of indication that there is no direct channel between variability of oil price to explain the variability of world raw sugar price. The similar result also mention in Zhang et al. [20] that there is no direct price relation between fuel and agricultural commodity prices.

Based on this table, can be concluded that world refined sugar price variable has the biggest percentage to explained variability of world refined sugar price. In 10th period, the variability of world raw sugar price to explain variability of world refined sugar price is 87.9 percent. Then variability of world raw sugar price to explain variability of world refined sugar price is 4 percent. So world refined sugar price is also become reference sugar price for policy maker all over the world.

The other interesting part of this calculation is that variability of exchange rate can only explain the variability of world refined sugar about 2 percent. This number is bigger compare to the variability of oil price, rice price and CPI. The small number indicates that there is no direct channel between exchange rate and world refined sugar price. In the future research, the calculation can be added another variable that can influence directly to world refined sugar price related to sugar price trade policies from sugar big player countries.

VII. CONCLUSION

This study is probably the first to examine the dynamic relationship between Indonesian sugar price, world refined sugar price, raw sugar price, exchange rate, oil price, rice price and CPI in a Vector Autoregression analysis setting. We employ innovation accounting with impulse response function and variance decomposition calculation on monthly variable data ranging from January 1998 to December 2011 to know how the sugar price response if there is a shock from other variables and to know the composition of other variable

that can explain the variability of sugar price. The empirical results provide strong evidence of the shock on World Raw Sugar Price, World Refined Sugar Price, CPI responded positively by Indonesian Sugar Price. Besides that, world refined sugar price can explain only 5.6 percent variability of Indonesian sugar price. Also world refined sugar price can explain only 3.4 percent variability of Indonesian sugar price.

There is indication that Indonesian sugar price is derived by others factor besides world refined sugar price, world raw sugar price, exchange rate, oil price, rice price and inflation. The next research can input other things like Indonesian sugar policy that related to the price.

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