

# Sugar Commodity Price Analysis: Examining Sugar Producer Countries

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**Abstract**—This study examined the dynamic relationship between Brazilian Sugar Price, Indian Sugar Price, French Sugar Price, Indonesian Sugar Price, exchange rate Brazilian real/US\$, exchange rate US\$/Euro, Oil Price, Gold Price, and LIBOR; and to detect if there is any difference between exchange rate Brazilian real/US\$, exchange rate US\$/Euro, Oil Price, Gold Price, and LIBOR effecting sugar producer countries' price. We employ Vector Error Correction Models methods for a time series of weekly data from February 2007 to November 2012. The Impulse Response Function results varied between each variable, but in general can it be concluded that there are: negative response of Brazilian/Indian/French sugar price from shock of exchange rate and gold price; and positive response of Indian/Indonesian sugar price from shock of interest rate. The empirical results in variance decomposition test provided evidence that variability of sugar price of producer countries is varied between each variable. In general, it can be concluded that each of the sugar prices in producer countries (Brazil, India and Indonesia) had the biggest percentage to explain the variability of their own sugar price (above 96 percent). This indicates that Brazilian, Indian and Indonesian government protect their sugar industry from macroeconomic shock through sugar price policy/program.

**Index Terms**—Sugar producer countries, impulse response function, sugar price, variance decomposition, vector error correction models.

## I. INTRODUCTION

Sugar is pure carbohydrate, an important nutrient which supplies energy to the body [1]. More than 130 countries produce sugar [2]. Also, in the international market, sugar takes important role in the world commodity trading market. In sugar producer countries like Brazil, India, France and Indonesia, the problem of sugar price is a common concern. Because it relates to price policy to control inflation, sugar price, an important income for the sugar producer countries, and multiplier effect to other industries.

Why sugar is really important commodity to discuss? The answer can be varied. It is because there are 31,800 buses in France that run on fuel derived from sugar beet [3]. Sugar cane industry in Brazil employs 1.5 millions of people [4]. There are 45 millions sugarcane farmers [5] and 660 sugar mills in India [6]. Moreover there are 900 thousand sugar cane farmers and 1.3 millions of people work in the sugar industry in Indonesia [7].

This research aims to analyze the sugar producer countries. The sugar producer countries definition in this occasion is the market leader in producing sugar beet or sugar cane in the world.

The first step was to collect data from the biggest sugar producer country in the world which is Brazil, then data from India as the second biggest sugar producer country, and then collecting representation of third biggest sugar producer in European Union which is France. Last but not least, this study collected one of the biggest producer but also one of the biggest sugar importer in the world, which is Indonesia.

There is an indication that the price of the sugar in leading sugar producer countries is depending on several factors. Researchers already wrote some fact and findings about the relationship between sugar price (as a part of food price) and other commodities prices. Hanson, *et al.* [8] said that sugar is one of the agricultural commodities that linked to oil price because oil is one of the intermediate inputs in production. The rise of the oil price, limited supplies of fossil fuel and increased concerns about global warming have created a growing demand for renewable energy sources [9]. Ethanol as one of the renewable energy is the substitute product of oil that can be produced from sugar cane or sugar beet. So, if oil price increase then the impact is sugar price can increase too.

Moreover, according to Harri *et al.* [10], oil prices has an indirect effect on agricultural price through exchange rates (in this case sugar price). Oil price usually sell in US\$; so changes in international oil price will have direct effect on domestic currency like Brazilian real and Euro. The fluctuation (appreciation/depreciation) of domestic currency gives effect to agricultural trading market (like sugar commodity market) and its prices.

Specific case about the relation between exchange rate and sugar price was analyzed by McConnell *et al.* [11]. He said that world sugar price are related to Brazilian production costs. The production costs of sugar cane in Brazil is the cheapest in the world and Brazil is the biggest sugar producer and exporter in the world and, that is why if there is depreciation in Brazilian Real againsts US\$, the Brazilian sugar export will increase, then the world sugar price will decrease, and vice versa.

Other literature used in this study is about price co-movement. According to Pindyck and Rotemberg [12] price co-movement is the prices of raw commodities that have a persistent tendency to move together. The co-movement can be explained by the regular shock of inflation, shift in aggregate demand, interest rates and exchange rates. Natanelov *et al.* [13] said that co-movement is a dynamic concept and the connection between commodities can be changed by policy and economic development. In this research we assume that there is co-movement between Brazilian sugar price, Indian sugar price, French sugar price and Indonesian sugar price.

Based on the literature review above, this paper attempts to

contribute to the literature by investigating the shock of Brazilian Sugar Price (BSP), Indian Sugar Price (ISP), French sugar price (FSP), Indonesian Sugar Price (INSP), nominal exchange rate between Brazilian Real and US\$ (EBUS), nominal exchange rate between US\$ and Euro (EUSE), International Oil Price (OP), International Gold price (GP), and London Interbank Offered Rate /LIBOR (IR) on sugar producer countries price (Brazil, India, France, and Indonesia). In that respect, this study bring new insights into the literature on the energy, exchange rate, interest rate, gold and food nexus.

## II. THE VECM

The Vector Error Correction Model (VECM) is restricted Vector Autoregression (VAR) designed to be used with non-stationary series that are known to be cointegrated. Vector Error Correction (VEC) has cointegration relation built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The term of cointegration is known as Error Correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. Based on Enders [14] and Hardiyanto [15], we modified the VECM steps: stationary test, chose the VECM model specification, chose the Vector Autoregression based on lag length criteria, do the VAR stabilization test, and innovation accounting.

## III. DATA

The VECM is estimated based on 300 weekly series from February 2007 until November 2012. The data covering Brazilian Sugar Price (BSP), Indian Sugar Price (ISP), French sugar price (FSP), Indonesian Sugar Price (INSP), nominal exchange rate between Brazilian real and US\$ (EBUS), nominal exchange rate between US\$ and Euro (EUSE), International Oil Price (OP), International Gold price (GP), and London Interbank Offered Rate /LIBOR (IR).

VECM Model Specification: relation between Model Specification: relation between (BSP), (ISP), (FSP), (INSP), (EBUS), (EUSE), (OP), (GP), and (IR) in first difference.

$$\begin{aligned} DBSP_t &= \alpha_{A0} + \sum_{i=1}^n \alpha_{A1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{A2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{A3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{A4} DINSP_{t-1} \quad (1) \\ &+ \sum_{i=1}^n \alpha_{A5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{A6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{A7} DOP_{t-1} + \sum_{i=1}^n \alpha_{A8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{A9} DIR_{t-1} + \varepsilon_{At} \end{aligned}$$

$$\begin{aligned} DISP_t &= \alpha_{B0} + \sum_{i=1}^n \alpha_{B1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{B2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{B3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{B4} DINSP_{t-1} \quad (2) \\ &+ \sum_{i=1}^n \alpha_{B5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{B6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{B7} DOP_{t-1} + \sum_{i=1}^n \alpha_{B8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{B9} DIR_{t-1} + \varepsilon_{Bt} \end{aligned}$$

$$\begin{aligned} DFSP_t &= \alpha_{C0} + \sum_{i=1}^n \alpha_{C1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{C2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{C3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{C4} DINSP_{t-1} \quad (3) \\ &+ \sum_{i=1}^n \alpha_{C5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{C6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{C7} DOP_{t-1} + \sum_{i=1}^n \alpha_{C8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{C9} DIR_{t-1} + \varepsilon_{Ct} \end{aligned}$$

$$\begin{aligned} DINSP_t &= \alpha_{D0} + \sum_{i=1}^n \alpha_{D1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{D2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{D3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{D4} DINSP_{t-1} \quad (4) \\ &+ \sum_{i=1}^n \alpha_{D5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{D6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{D7} DOP_{t-1} + \sum_{i=1}^n \alpha_{D8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{D9} DIR_{t-1} + \varepsilon_{Dt} \end{aligned}$$

$$\begin{aligned} DEBUS_t &= \alpha_{E0} + \sum_{i=1}^n \alpha_{E1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{E2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{E3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{E4} DINSP_{t-1} \quad (5) \\ &+ \sum_{i=1}^n \alpha_{E5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{E6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{E7} DOP_{t-1} + \sum_{i=1}^n \alpha_{E8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{E9} DIR_{t-1} + \varepsilon_{Et} \end{aligned}$$

$$\begin{aligned} DEUSE_t &= \alpha_{F0} + \sum_{i=1}^n \alpha_{F1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{F2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{F3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{F4} DINSP_{t-1} \quad (6) \\ &+ \sum_{i=1}^n \alpha_{F5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{F6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{F7} DOP_{t-1} + \sum_{i=1}^n \alpha_{F8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{F9} DIR_{t-1} + \varepsilon_{Ft} \end{aligned}$$

$$\begin{aligned} DOP_t &= \alpha_{G0} + \sum_{i=1}^n \alpha_{G1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{G2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{G3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{G4} DINSP_{t-1} \quad (7) \\ &+ \sum_{i=1}^n \alpha_{G5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{G6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{G7} DOP_{t-1} + \sum_{i=1}^n \alpha_{G8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{G9} DIR_{t-1} + \varepsilon_{Gt} \end{aligned}$$

$$\begin{aligned} DGP_t &= \alpha_{H0} + \sum_{i=1}^n \alpha_{H1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{H2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{H3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{H4} DINSP_{t-1} \quad (8) \\ &+ \sum_{i=1}^n \alpha_{H5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{H6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{H7} DOP_{t-1} + \sum_{i=1}^n \alpha_{H8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{H9} DIR_{t-1} + \varepsilon_{Ht} \end{aligned}$$

$$\begin{aligned} DIR_t &= \alpha_{I0} + \sum_{i=1}^n \alpha_{I1} DBSP_{t-1} + \sum_{i=1}^n \alpha_{I2} \\ DISP_{t-1} &+ \sum_{i=1}^n \alpha_{I3} DFSP_{t-1} + \sum_{i=1}^n \alpha_{I4} DINSP_{t-1} \quad (9) \\ &+ \sum_{i=1}^n \alpha_{I5} DEBUS_{t-1} + \sum_{i=1}^n \alpha_{I6} DEUSE_{t-1} \\ &+ \sum_{i=1}^n \alpha_{I7} DOP_{t-1} + \sum_{i=1}^n \alpha_{I8} DGP_{t-1} \\ &+ \sum_{i=1}^n \alpha_{I9} DIR_{t-1} + \varepsilon_{It} \end{aligned}$$

## IV. EMPIRICAL RESULT

### A. Stationarity Test Results of the Data

Stationarity test must be done before running the VECM estimation. Time series data can be called stationer if the value of mean, variance and autocovariance for each lag is constant with time [16]. To detect the stationarity of nine variables, which are (BSP), (ISP), (FSP), (INSP), (EBUS), (EUSE), (OP), (GP), and (IR) is using Augmented

Dickey-Fuller (ADF) test. ADF test conducted with the degree level and at the first difference level for series of data. The result is all variables stationaire in first difference.

### B. Leg length Criteria

Estimated VAR lag is very sensitive to the amount of data that it 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. VECM Estimation Result

Based on the VECM 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.

## V. INNOVATION ACCOUNTING

In the innovation accounting, it will be explained in detail 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. Analysis of Impulse Response Function (IRF)

#### 1) Analysis of IRF for Brazilian Sugar Price (see Fig. 1)

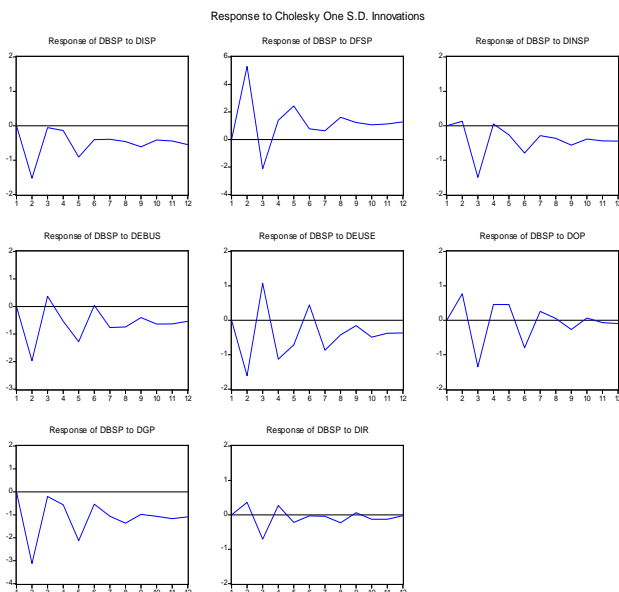


Fig. 1. Impulse response function brazilian sugar price (DBSP).

The existence of shock from the change of Indian Sugar Price (DISP) responded negatively by the change of Brazilian Sugar Price (DBSP) in all period of time. Brazil and India as

two of the biggest sugar exporter in the world has to see other opponent price policy. If the sugar price in India increase then the supply of Indian sugar will increase, this situation would make Indian sugar export increase. The increase of Indian sugar price will influence the increase of world sugar price. If world sugar price increase, then Brazil as a market leader in sugar exporting countries will increase supply of sugar. The increase of Brazilian sugar output will have two effects: first the price of Brazilian sugar will decrease then second, the output of world sugar will increase.

The shock of the change of French Sugar Price (DFSP) responded positively to the change of Brazilian Sugar Price (DBSP) in general. Although in the 3<sup>rd</sup> week, negative response by the change of Brazilian Sugar Price started to emerge. In general, there is an indication that the French sugar price and Brazilian sugar price move together (there is co-movement in price). This condition has the same result with Pindyck and Rotemberg [12], in which they said the prices of raw commodities (sugar price) has the tendency to move at the same direction.

Other reasons that could explain this situation is that France produces sugar beet, but Brazil produces sugar cane. Sugar beet has its own unique production technology and market buyer. Sugar beet can only grow in sub-tropical climate, while sugar cane can only grow in tropical climate. So the different of raw material sugar commodity explained why the price can move together.

The shock from the change of Indonesian Sugar Price (DINSP) responded negatively to the change of Brazilian Sugar Price (DBSP) in general. Like the change of Indian Sugar Price shock, the change of Indonesian Sugar Price shock also gives negative effect to the change of Brazilian Sugar Price. If Indonesian sugar price increase then the supply of Indonesian sugar would increase. But the problem is, productivity of Indonesian sugar industry not as big as other country such as Brazil, India and France. So the government policy to fix this condition is to import sugar from other countries. If the demand of sugar in world increased (because the increase of demand of sugar in Indonesia), then the sugar production in Brazil would increase. If production of sugar in Brazil increased, then sugar price in Brazil would decrease.

The shock from the change of exchange rate Brazilian Real/US\$ responded negatively to the change of Brazilian Sugar Price in general. This indicates that Brazilian exchange rate depreciation (the nominal value increase) makes sugar export (supply of Brazil sugar) increase. If the demand of sugar increased, then the price of Brazilian sugar would decrease [11].

The shock from the change of exchange rate of Euro/US\$ responded negatively to the change of Brazilian Sugar Price in general. This indicates that Euro becomes one of the most important exchange rates besides US\$, especially because world refined/white sugar was traded in LIFFE (London International Financial Futures and Options Exchange). So if the exchange rate of Euro/US\$ depreciated then the sugar producer countries that use Euro like France, the sugar competitiveness would increase. If this happened, then French sugar export could increase because the price of French sugar is more competitive than other countries. After that, the world sugar supply would increased. Then the world

sugar price could decreased. In the end, there is also indirect effect on decreasing of Brazilian sugar price.

The shock from the change of oil price responded positively to the change of Brazilian sugar price in some periods (1<sup>st</sup> and 2<sup>nd</sup> periods; 4<sup>th</sup> and 5<sup>th</sup> periods; 7<sup>th</sup> and 8<sup>th</sup> periods). This indicates that oil price has positive effect to Brazilian sugar price through production cost channel. If the price of oil increased, then the price of Brazilian sugar price would increase in certain periods of time. In the other hand, the shock from the change of oil price responded negatively to the change of Brazilian sugar price in some periods (3<sup>rd</sup>, 6<sup>th</sup> and 9<sup>th</sup> periods). This indicates that oil price has indirect effect to Brazilian sugar price through ethanol as renewable energy form by sugar cane. When the oil price increased, then the ethanol price would also increase. This situation makes sugar price as a raw material of ethanol will increase in early period of time, but after that when the supply of sugar increase, then the sugar price (Brazilian sugar price) will decrease again.

The shock from the change of gold price responded negatively to the change of Brazilian sugar price in general. This indicates that there is an indirect effect between gold price and Brazilian sugar price through commodity market channel. Both of these commodities were sold in commodity market. So there is tendency to trade-off between gold and sugar commodity prices. The same result was found by Avalos [17] in commodity corn and gold.

Last but not least, the shock from the change of interest rate responded negatively to the change of Brazilian sugar price in general. This result is difficult to explain, because usually if the interest rate increased, then the price of commodity market (for example sugar) would increase too (this condition occur in 2<sup>nd</sup> and 4<sup>th</sup> period). The situation can be explained through demand channel, if the interest rate increased, then the price would increase too. After the price increase, then the demand can adjust (decrease) because consumer behavior tend to take form in reduce spending when the price increase. This condition makes the shock of interest rate inconclusive, because it can be positive at times, but also negative in different situations.

## 2) Analysis of IRF for Indian Sugar Price (see Fig. 2)

The existence of shock from the change of Brazilian Sugar Price (DBSP) responded positively to the change of Indian Sugar Price (DISP) in general. Brazil as one of the biggest sugar exporter and producer in the world can give indirect price effect to Indian sugar price. If the sugar price in Brazil increased, then the world sugar price would increase, this situation would make Indian sugar price increase. There is indication of co-movement in price between Brazilian and Indian sugar price. This condition has the same result with Pindyck and Rotemberg [12].

The shock of the change of French Sugar Price (DFSP) responded positively to the change of Indian Sugar Price (DISP) in 2<sup>nd</sup>, 5<sup>th</sup>, 6<sup>th</sup>, and 9<sup>th</sup> period. In the other hand, the change of French sugar price shock responded negatively to the change of Indian Sugar Price in 3<sup>rd</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> period. There is an indication that the French sugar price in certain period gives positive shock because of indirect price channel, but because of the different type of sugar that produced by the France (sugar beet) compare to the Indian

sugar type (sugar cane) so in other period, the shock of the change in French sugar price responded negatively by Indian sugar price.

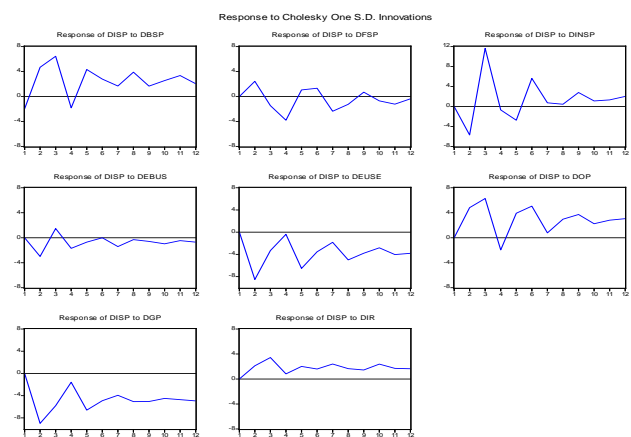


Fig. 2. Impulse response function indian sugar price (DISP).

Then the existence of shock from the change of Indonesian Sugar Price (DINSP) responded positively to the change of Indian Sugar Price (DISP) in general. Like the change of Brazilian Sugar Price shock, the change of Indonesian Sugar Price shock also gives positive effect to the change of Indian Sugar Price. If Indonesian sugar price increased, then the supply of Indonesian sugar would increase. But the problem is productivity of Indonesian sugar industry not as big as other country such as India. So the government policy to fulfill this condition is import sugar from other countries. If the demand of sugar in the world increased (because the increase of demand of sugar in Indonesia), then sugar price in India would increase because India is one of the sugar exporter country to Indonesia.

After that, the shock from the change of exchange rate of Brazilian Real/US\$ responded negatively to the change of Indian Sugar Price in general. This is an indication that Brazilian exchange rate depreciation (the nominal value increase) makes sugar export (supply of Brazil sugar) increase. If the demand of sugar increases, then the price of Brazilian sugar would decrease [11]. After that, because of the co-movement between sugar price in Brazil and sugar price in India, so in the end, if price of sugar in Brazil increased, then the price of sugar in India would also increase.

Moreover, the shock from the change of exchange rate of Euro/US\$ responded negatively to the change of Indian Sugar Price. This is an indication that Euro becomes one of the most important exchange rates besides US\$, especially because world refined/white sugar was traded in LIFFE (London International Financial Futures and Options Exchange). So if the exchange rate of Euro/US\$ depreciated, then the sugar producer countries that usually use Euro exchange rate like France, the sugar competitiveness would increase. If this condition happened, then French sugar export could increase because the price of French sugar is more competitive than other countries. After that, the world sugar supply will be increase. Then the world sugar price can be decrease. In the end, there is also an indirect effect on decreasing of Indian sugar price.

The shock from the change of oil price responded positively to the change of Indian sugar price in general. This is an indication that oil price has positive effect to Indian

sugar price through production cost channel. If the price of oil increased, than the price of Indian sugar price would increase.

Then the shock from the change of gold price responded negatively by the change of Indian sugar price. This indicates that there is indirect effect between gold price and Brazilian sugar price through commodity market channel. Both of these commodities were sold in commodity market. So there is a tendency to trade-off between gold and sugar commodity prices. The same result where found by Avalos [17] in corn and gold.

The shock from the change of interest rate responded positively to the change of Indian sugar price in general. The explanation of this condition is there is an indication that interest rate has indirect effect to Indian sugar price through production cost channel. If interest rate is increased, then the cost of sugar production in India would increase. Finally, the Indian sugar price will increase also. This result is different when we compare to shock from the change of interest rate responded that negatively by the change of Brazilian sugar price.

### 3) Analysis of IRF for French Sugar Price (see Fig. 3)

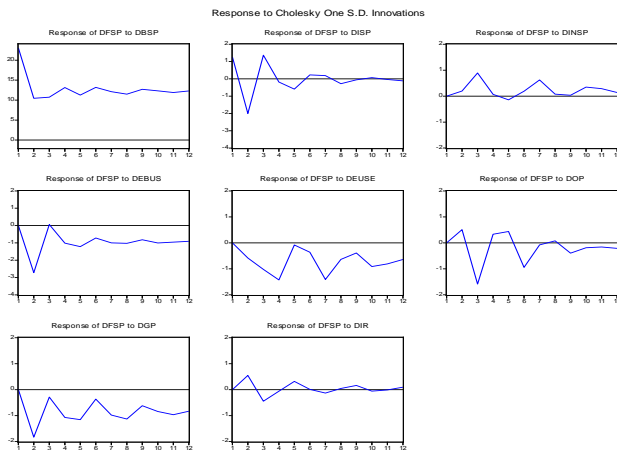


Fig. 3. Impulse response function french sugar price (DFSP).

The existence of shock from the change of Brazilian Sugar Price (DBSP) responded positively to the change of French Sugar Price (DFSP) in general. Brazil as one of the biggest sugar exporter and sugar producer in the world can give indirect price effects to the French sugar price. The same thing happened where Brazilian Sugar Price is also has indirect effect to Indian sugar price also. If the sugar price in Brazil increased, then the world sugar price would increase, this situation would make French sugar price increase. There is an indication of co-movement in price between Brazilian and French sugar price.

Then the shock of the change of Indian Sugar Price (DISP) responded positively to the change of French Sugar Price (DFSP) in 2<sup>nd</sup>, 5<sup>th</sup>, 6<sup>th</sup>, and 9<sup>th</sup> period. In the other hand, the change of French sugar price shock responded negatively to the change of Indian Sugar Price in 1<sup>st</sup>, 3<sup>rd</sup>, 6<sup>th</sup>, and 7<sup>th</sup> period. There is an indication that the change of Indian sugar price in certain period gives positive shock to the change of French sugar price because of indirect price channel. On the other hand, the change of Indian sugar price responded negatively to the change of French sugar price indicates that the different type of sugar that produced by the France (sugar beet) compare to Indian sugar type (sugar cane) so in other period

the shock of the change in French sugar price responded negatively by Indian sugar price.

Then the shock of the change of Indonesian Sugar Price (DINSP) responded positively to the change of French Sugar Price (DFSP) in general. There is an indication the Indonesian sugar price in certain period give positive shock to the French sugar price because of sugar demand channel. Indonesia as one of the biggest sugar importer in the world with 240 million people and around 5.2 million ton sugar consume every year has its own “demand pull” to other sugar producer and exporter countries like France. Indonesia and France also the member of International Sugar Association (ISA), where there is price information that shared between the members.

The shock from the change of exchange rate of Brazilian Real/US\$ responded negatively to the change of French Sugar Price. This is an indication that Brazilian exchange rate depreciation (the nominal value increase) makes sugar export (supply of Brazil sugar) increase. If the supply of sugar increases, then the price of sugar in Brazil would decrease. After that, because of the co-movement between sugar price in Brazil and sugar price in France, so in the end, if price of sugar in Brazil decreased then the price of sugar in France would decrease also.

Moreover, the shock from the change of exchange rate of Euro/US\$ responded negatively to the change of French Sugar Price. If the exchange rate of Euro/US\$ depreciates (the nominal value increase) then sugar competitiveness of sugar producer countries that usually use Euro exchange rate (like France) will increase. The competitiveness of French sugar price increase because the depreciation of Euro makes French sugar price is cheaper compare to world sugar price. So, there is an indication of negative indirect effect from the change of exchange rate of Euro/US\$ to French sugar price.

The shock from the change of oil price responded positively by the change to French sugar price in some periods (2<sup>nd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, and 8<sup>th</sup> periods). This is an indication that oil price has a positive effect to French sugar price through production cost channel. If the price of oil increase than the price of French sugar price would increase in certain periods of time. In the other hand, the shock from the change of oil price responded negatively to the change of French sugar price in some periods (3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> periods). This indicates that oil price has an indirect effect to the French sugar price through ethanol as renewable energy form by sugar beet. When the oil price increased, then the ethanol price would increase also. This situation would make sugar price as a raw material of ethanol increase in early period of time, but after that when the supply of sugar increased, then the sugar price (French sugar price) would decrease again.

The shock from the change of gold price responded negatively to the change of French sugar price. This indicates that there is an indirect effect between gold price and French sugar price through commodity market channel. Both of these commodities were sold in commodity market. So there is a tendency to trade-off between gold and sugar commodity prices. The same result was found in the relation between Brazilian and Indian sugar prices with gold price.

Finally, the shock from the change of interest rate responded positively to the change of French sugar price in 2<sup>nd</sup>, 5<sup>th</sup>, 9<sup>th</sup> and 12<sup>th</sup> periods. In the other hand, the change of



interest rate responded negatively to the change of French sugar price in 3<sup>rd</sup>, 7<sup>th</sup>, and 10<sup>th</sup> periods. There is an indication that the change of interest rate gives positive shocks to the change of French sugar price because of production cost channel. If interest rate is increased, then the production cost of French sugar would increase. In the end, French sugar price would increase also. The negative shock of interest rate from the change of interest rate to the change of French sugar price was happened because of demand channel (the same result with interest rate shock to Brazilian sugar price).

#### 4) Analysis of IRF for Indonesian Sugar Price (see Fig. 4)

The existence of shock from the change of Brazilian Sugar Price (DBSP) responded positively to the change of Indonesian Sugar Price (DINSP) in general. Brazil as one of the biggest sugar exporter and producer in the world could give an indirect price effect to the Indonesian sugar price like it give an indirect effect to Indian and French sugar price also. If the sugar price in Brazil increased, then the world sugar price would increase. This situation would make Indonesian sugar price increase. There is an indication of co-movement in price between Brazilian and Indonesian sugar price.

Then the shock of the change of Indian Sugar Price (DISP) responded positively to the change of Indonesian Sugar Price (DINSP). There is an indication that the change of Indian sugar price gives positive shock to the change of Indonesian sugar price because of an indirect price channel.

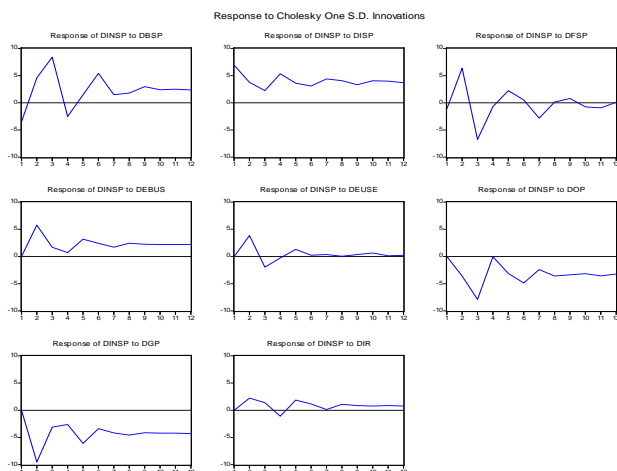


Fig. 4. Impulse Response Function Indonesian Sugar Price (DINSP).

After that, the shock of the change of French Sugar Price (DFSP) responded positively to the change of Indonesian Sugar Price (DINSP) in 2<sup>nd</sup>, 5<sup>th</sup>, and 9<sup>th</sup> periods. In the other hand, the shock of the change of French sugar price responded negatively to the change of Indonesian sugar price in 3<sup>th</sup>, 7<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> periods. There is an indication that the French sugar price in certain period gives positive shock to Indonesian sugar price because of sugar co-movement in commodity price. Indonesia and France also the member of International Sugar Association, where there is price information that shared between the members. The shock of the change of French sugar price responded negatively to the change of Indonesian sugar price indicates that in some periods of time there is also demand channel that affect to price. When the price is increased, in some level the demand tend to decrease. If demand of sugar is decreased, then Indonesian sugar price would decrease also.

The shock from the change of exchange rate of Brazilian Real/US\$ responded positively to the change of Indonesian Sugar Price. This condition is hard to explain because usually the shock of the change of Brazilian Real/US\$ responded negatively to Brazilian, France and Indian sugar price. But this is one of the indication that Indonesia as one of the biggest sugar importer country has its own characteristics responding the shock of the change of exchange rate Brazilian Real/US\$. Indonesian sugar policy protecting their sugar markets makes Indonesian sugar price has different response compared to Brazilian, France and Indian sugar price.

Other interesting find is the shock from the change of oil price responded negatively to the change of Indonesian sugar price in general. The result is difficult to answer because usually oil price has positive effect to sugar price in Brazil, Indian and France. The condition in Indonesia is different because the government subsidized the retail petrol price with fix price Rp.4,500/litre (July 2013 increase become Rp.6,500/litre) compare to international petrol price around Rp.9,500/litre. So if the International oil price increased, although Indonesia is one of the biggest oil importing country, but the effect to Indonesian sugar price is not positive.

Then the shock from the change of gold price responded negatively to the change of Indonesian sugar price. This indicates that there is an indirect effect between gold price and Indonesian sugar price through commodity market channel. Both of these commodities were sold in commodity market. So there is a tendency to trade-off between gold and sugar commodity prices. The same result where found in the relation between Brazilian, Indian and French sugar prices with gold price.

Finally, the shock from the change of interest rate responded positively to the change of Indonesian sugar price in general. There is an indication that the change of interest rate gives positive shocks to the change of Indonesian sugar price because of production cost channel. If interest rate is increased, then the production cost of Indonesian sugar would increase. In the end, Indonesian sugar price would increase also.

#### B. 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.

Base on the Table I, can be concluded that Brazilian sugar price has the biggest percentage to explain the variability of Indonesian sugar price (96.34 percent). Indian sugar price also the biggest percentage to explain the variability of Indonesian sugar price (96.29 percent). Then Indonesian sugar price also the biggest percentage to explain the variability of Indonesian sugar price (98.56 percent). These three results indicate that there are other factors besides other countries sugar price, exchange rate, oil price, gold price and exchange rate that can explain more about the variability of Brazilian, Indian and Indonesian sugar prices. Another important finding is that Brazilian, Indian and Indonesian government indicates to protect their sugar industry from macroeconomic shock through sugar price policy/program. Brazilian government

give sugar price subsidy, price that taken by sugar producer is higher than international price (domestic sugar price higher than export sugar price). On the other hand, Indian and Indonesian government decided domestic sugar floor price on sugar mills for basis of sugar cane price in farmer. On the contrary, France as a member of European Union, still on going to liberalize the protected European sugar market [18].

That is one of the explanations why the variability of French sugar price can be explained by the French sugar price only 8.34 percent. One of the reasons that Brazilian sugar price can explained the variability of French sugar price about 89.56 percent is Brazil the market leader of sugar producer and exporter country.

TABLE I: FORECAST ERROR VARIANCE DECOMPOSITION AFTER 12 PERIODS (WEEKS)

	DBSP	DISP	DFSP	DINSP	DEBUS	DEUSE	DOP	DGP	DIR
DBSP	<b>96.34</b>	0.17	1.80	0.14	0.30	0.26	0.13	0.81	0.03
DISP	0.44	<b>96.29</b>	0.11	0.71	0.05	0.70	0.49	1.02	0.14
DFSP	<b>89.56</b>	0.34	8.34	0.06	0.67	0.33	0.17	0.46	0.02
DINSP	0.23	0.29	0.14	<b>98.56</b>	0.11	0.02	0.23	0.36	0.02

## VI. CONCLUSION

This study is probably the first attempt to examine the dynamic relationship between Brazilian Sugar Price, Indian Sugar Price, French Sugar Price, Indonesian sugar price, nominal exchange rate between Brazilian Real and US\$, nominal exchange rate between US\$ and Euro, International Oil Price, International Gold price, and London Interbank Offered Rate /LIBOR in a Vector Error Correction Models analysis setting. We employed innovation accounting with Impulse Response Function (IRF) and Variance Decomposition (VDCs) calculation on weekly variable data ranging from February 2007 to November 2012 to understand how the sugar price in producer countries responded if there was a shock from macroeconomics variables and to know the composition of other variables that could explain the variability of sugar price in producer countries.

The empirical results of IRF analysis in general provided strong evidence of the shock from Indian sugar price, Indonesian sugar price, exchange rate Brazil Real/US\$, exchange rate US\$/Euro and gold price responded negatively by Brazilian Sugar Price. This indicates that macroeconomic shocks have negative effect to Brazilian sugar price through demand side. Also the shock from exchange rate Brazil Real/US\$, exchange rate US\$/Euro and gold price responded negatively to Indian Sugar Price. The interesting part is that the shock from Brazilian sugar price, Indonesian sugar price, Oil Price and Interest Rate responded positively to Indian sugar price. This indicates that there is co-movement between Brazilian sugar price, Indonesian sugar price and Indian sugar price [12]. This finding is similar with research by Lescaroux [19] but the co-movement happened only in the short run. Moreover the oil price and interest rate has positive effect to Indian sugar price through production cost channel. Then the shock from Brazilian sugar price and Indonesian sugar price responded positively to French sugar price. This also indicates that sugar prices in sugar cane producer countries tend to move in the same direction. After that the shock from exchange rate Brazil Real/US\$, exchange rate US\$/Euro and gold price responded negatively to French Sugar Price. This indicates that there is trade-off between gold commodity market, money market and sugar commodity market. The last result of ADF, in general the

shock from Brazilian sugar price, Indian sugar price, exchange rate Brazil Real/US\$, exchange rate US\$/Euro, and interest rate responded positively by Indonesian sugar price. This indicates that Brazilian and Indian sugar price give positive effect to Indonesian sugar price through indirect price channel. Then the interest rate shock give positive effect to Indonesian sugar price through production cost channel. After that, the shock from oil price and gold price responded negatively to Indonesian sugar price. The other interesting thing is shock from oil price do not give positive effect to Indonesian sugar price because the Indonesian government subsidized the retail petrol price.

The empirical results of VDCs analysis in general explained that each of the sugar prices in producer countries (Brazil, India and Indonesia) has the biggest percentage to explain the variability of their own sugar price (above 96 percent). This indicates that Brazilian, Indian and Indonesian government protect their sugar industry from macroeconomic shock through sugar price policy/program. The interesting part is the variability of French sugar price can be explained to the French sugar price only just 8.34 percent. This indicates that France as a member of European Union still on going to liberalize the protected sugar market.

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