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Economic Impact of Sugarcane in Indonesia: An Input-Output Approach

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ABSTRACT
Sugarcane revitalization is both a challenge and an opportunity in Indonesia. Demand for sugar tends to increase from year to year that fulfilled by domestic production and imports. Thus, it is necessary to increase domestic sugarcane competitiveness to balance national sugarcane production and consumption. This study's objectives were (1) to determine the forward linkage and backward linkage of sugarcane in Indonesia, and (2) to know the output, income, and employment multiplier. The linkages and multipliers of sugarcane were calculated by the input-output analysis of 66 sectors from 1975 to 2005 by Statistics Indonesia (BPS). Estimation values for 2010, 2015, and 2020 are obtained from the linear forecasting method. T-test was used to compare linkages and multipliers between sugarcane and the average of all sectors in the economy. The results showed that the backward linkage, output, and employment multiplier of sugarcane were lower than the average of all sectors in the economy. Besides, the forward linkage of sugarcane was equal, and the income multiplier was higher than the average of all sectors in the economy.

Keywords : linkage, multiplier, sugarcane, Indonesia

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INTRODUCTION

Sugarcane is one of Indonesia's strategic commodities, especially as the sugar industry's primary raw material. After experiencing a heyday in the 1930s with production reaching 3.1 million tons and exports of 2.4 million tons, the domestic sugar industry experienced ups and downs (Susilowati & Tinaprilla, 2020). Sugarcane production up to 2018 had an upward trend, but imports of refined sugar also increased reaching at 101,018 tonnes (FAO, 2020). This shows that domestic sugarcane production has not yet met industrial demand in Indonesia.

Increasing sugar imports can be both a challenge and an opportunity for Indonesia, especially in increasing domestic production, to reduce imports. According to (Susila & Sinaga 2016), the government has

implemented various policies to overcome this, including policies on input and output prices, extensification, intensification, and trading arrangements. The government has also targeted sugar self-sufficiency since 2007, but this has not been achieved until recently (Arifin, 2008). In evaluating the potential of sugarcane in Indonesia, research related to the linkage and multiplier is needed to see this commodity's competitiveness. Competitiveness indicators are usually measured by the Policy Analysis Matrix (PAM), such as research by Isaskar et al. (2010), Kurniawan (2016), and Hadfina et al. (2017). Also, several competitiveness studies using the Revealed Comparative Advantage (RCA) method include research conducted by Latruffe (2010), Kumar (2015), and Sheetal et al. (2020). Research on competitiveness using the input-output approach is still not widely carried out. This study is expected to provide an overview of sugarcane's role in the national economy and provide policy recommendations for increasing sugarcane productivity. Thus, this study aims to (1) determine the forward linkage and backward linkage of sugarcane in Indonesia, and (2) know the multiplier of output, income, and labor.

METHODS

This study used secondary data from BPS, namely the Indonesian Input-Output table from 1975 to 2010, with a classification of 66 sectors. Because the data were only available until 2010, data for 2015 and 2020 were predicted using linear forecasting using Microsoft Excel. Sectoral linkages and multipliers measured sugarcane's contribution to the Indonesian economy were analyzed using the PYIO computer program. The results were then compared with the average of all economic sectors using the one-tailed t-test using STATA. The calculation formula in the Input-Output analysis was as follows:

Sectoral linkages

Sector linkages consist of forward linkage and backward linkage, with the following formula (Guo & Planting, 2000):

1. Input coefficient matrix [A]

$$A = a_{ij} = \frac{x_{ij}}{x_j}$$

where:

a_{ij} = the input coefficient of sector *i* by sector *j*

x_{ij} = the use of input sector *i* by sector *j* (in rupiah)

X_j = total input sector to *j* (in rupiah)

2. Leontief matrix [I-A^d]

$$[A^d] = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{n3} \end{bmatrix}$$

$$B = [\, I - A^d \,]^{-1}$$

where:

B = bij = Leontief inverse matrix

A^d = Domestic input coefficient matrix

$[I-A^d] =$

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & \dots & -a_{1n} \\ -a_{21} & (1-a_{22}) & \dots & -a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ -a_{n1} & -a_{n2} & \dots & (1-a_{nn}) \end{bmatrix}$$

$$B = b_{ij} = \begin{bmatrix} b_{11} & b_{12} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & b_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ b_{n1} & b_{n2} & \dots & b_{nn} \end{bmatrix}$$

3. *Forward Linkage*

$$b_{i.} = \sum_{j=1}^{n} b_{ij}$$

where:

bi. = *Forward Linkage*

bij = Leontief inverse matrix

4. *Backward Linkage*

$$b_{.j} = \sum_{i=1}^{n} b_{ij}$$

where:

bi. = *Forward Linkage*

bij = Leontief inverse matrix

Multiplier Effect

In this study, the multiplier effects analyzed were output, income, and employment, with the formula (Nazara, 2005):

1. Output Multiplier

$O_j = \sum_{i=1}^{n} b_{ij}$

where:

O_j = sector output multiplier *j*

b_{ij} = output multiplier of sector j

2. Income Multiplier

$H_j = \sum_{i=1}^{n} a_{n+1,i} b_{ij}$

where:

H_j = income multiplier of sector *j*

b_{ij} = Leontief inverse matrix

$a_{n+1,i}$ = income coefficient

3. Employment Multiplier

$E_j = \sum_{i=1}^{n} w_{n+1,i} b_{ij}$

where:

E_j = employment multiplier of sector *j*

b_{ij} = Leontief inverse matrix

$w_{n+1,i}$ = employment coefficient

According to (Ross 2017), the t-test is carried out with the following calculations:

$$t = \frac{\bar{X} - \mu}{s/\sqrt{n}}$$

where:

$\bar{X}$ = sample mean

μ = population mean

s = standard deviation

n = number of samples

Conclusion criteria: if alpha is less than 10%, H0 is rejected, whereas if alpha is greater than 10%, H0 fails to be rejected.

RESULTS AND DISCUSSION

Forward Linkage

In the input-output model, the forward linkage impacts the production by a particular sector, having two economic effects on other sectors in the economy. There will be an increase in output in that sector and an increase in supply because it becomes an input for other sectors, thus indicating a particular interconnected sector with its downstream sector (Miller

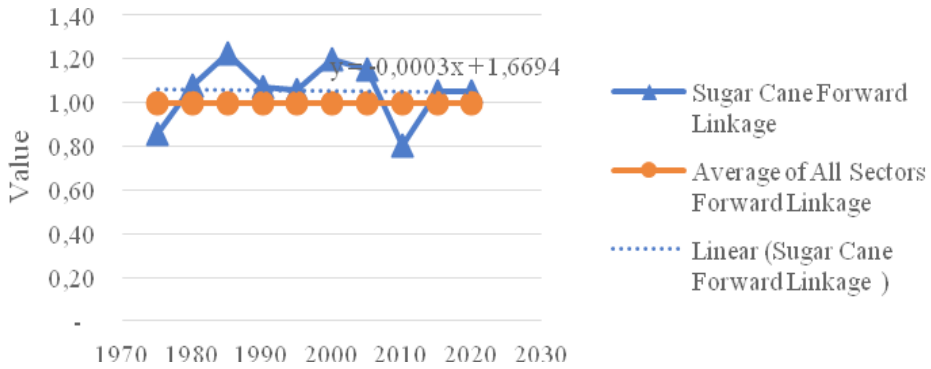

Figure 1. Sugarcane and average of all sectors' forward linkage.
Source: BPS secondary data analysis, 2020.

& Blair, 2009). Sectors with higher forward linkages than other sectors mean that their production is relatively more influencing other sectors (Guo & Planting, 2000). Thus, this sector can become a crucial sector in the economy.

In 2005-2010 the value of forwarding linkage was higher than the average for all sectors in Indonesia. It is supported by the results of the t-test, which shows that the value of the forward linkage of sugarcane is the same as the average forward linkage of all sectors in Indonesia (Table 1). It could be due to a government program, namely the National Sugar Production and Productivity Acceleration Program. According to Sulaiman et al. (2019), the National Sugar Production and Productivity Acceleration Program were established in 2003–2008, where production and consumption were targeted to balance 3.1 million tons per year.

Based on Figure 1, it is known that from 1975 to 2020, the value of sugarcane forward linkage in Indonesia was higher than the average value of forwarding linkage for all sectors in Indonesia, with a relatively constant trend. In 1975 and 2010, the sugarcane forward linkage values stayed below the average value for all sectors. This was because the program to increase sugarcane production had only been established through Presidential Instruction (Inpres) No. 9 of 1975, namely the People's Sugarcane Intensification (TRI) program involving the Village Unit Cooperative (KUD). The KUD acted as the executor of the program that will channel credit and regulate the supply of sugarcane to sugar factories in its area and establish the Logistics Agency (BULOG) as the only institution which controls the stabilization of domestic sugar prices (Sulaiman et al., 2019). In 2010, the government only imposed a five percent import duty for the first two years for new investment and refinery industries that expanded their business following the Minister of Finance (Import Duty Calculation, 2010). Sugar self-sufficiency, revitalization of KUD to support agricultural input, the active role

Table 1. One Sample t-test on sugarcane and average of all sectors' forward linkage

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Forward Linkage	10	1.055	0.04	0.13	0.96	1.15
Ho: mean = 1; Ha: mean ≠ 1; t = -9.86; Pr(T > t) = 0.22^{ns}						

Source: BPS secondary data analysis, 2020

of BULOG to stabilize prices, and tax relief for the new sugar industry would increase the competitiveness of will price and quality (Takii & Narjoko, 2012). The increase in forward linkage will depend on cheaper and higher quality local inputs, thus the government need to encourage industries to switch from imported inputs to local inputs. The government policy particularly KUD was not relevance with the existing condition. Nowadays, government rearrange KUD as village-owned enterprises (BUMDES) but basicly the system of BUMDES is like KUD that is managed in the village level. BUMDES has been having integrated system because of the fund from goverment. Farmer can be easier to borrow the capital from BUMDES so they can manage the farm more efficent and productive.

Backward Linkage

Backward linkage is a production impact by a particular sector which has two types of economic effects on other sectors in the economy, namely an increase in production from that sector and demand for its input sector or a type of interconnection of specific sectors with the upstream sector (Miller & Blair, 2009). Sectors with higher backward linkages than other sectors indicate that their production is relatively more influencing other sectors (Guo & Planting, 2000). This sector can be said to be a priority sector in the economy.

The one-sample t-test shows that the backward linkage value of sugarcane was lower than the average backward linkage value of all sectors in Indonesia and constant from year to year (Table 2). The highest backward value in 1985 was 0.97, while the lowest value was 0.83 in 1995. It could be due to the fact that in 1985 the national sugarcane production was relatively high, namely around 22,621,168 tons, and there were no imports of sugarcane in Indonesia (FAO, 2020). The high domestic production has boosted

The multiplier value of sugarcane output was lower than the average backward linkage demand for sugarcane in Indonesia. In contrast, in 1995, sugarcane production was around 28,998,800, but sugarcane imports also reached 333,734 tonnes (FAO, 2020). The availability of Indonesian sugarcane, which was fulfilled from imports, would not affect the demand for sugarcane input. It could rise if domestic production increased. Farm production should be supported by government policy such as price policy, subsidies and tax relief for the

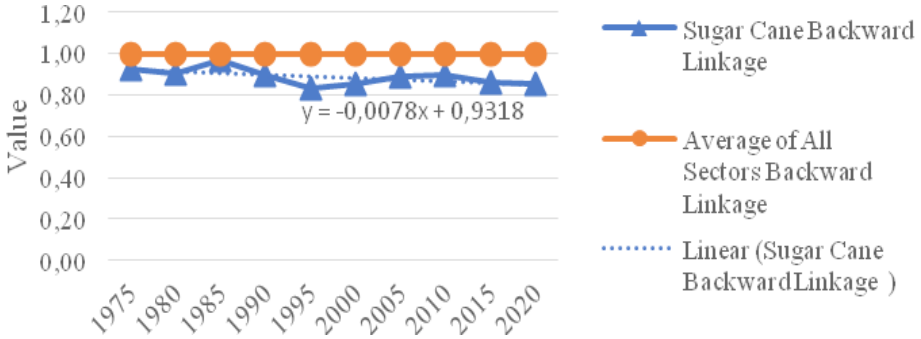

Figure 2. Sugarcane and average of all sectors' backward linkage.
Source: BPS secondary data analysis, 2020.

Table 2. One Sample t-test on sugarcane and average of all sectors' backward linkage

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Backward Linkage	10	0.89	0.01	0.04	0.89	0.92
Ho: mean ≥ 1; Ha: mean < 1; t = -14.13; Pr(T < t) = 0.00***						

Source: BPS secondary data analysis, 2020

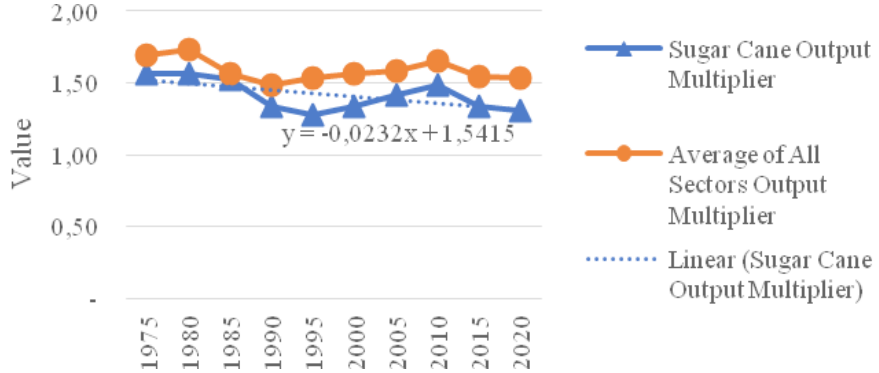

Figure 3. Sugarcane and average of all sectors output multiplier.
Source: BPS secondary data analysis, 2020.

Table 3. One Sample t-test sugarcane and average of all sectors' output multiplier

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Output Multiplier	10	1.41	0.03	0.11	1.33	1.49
Ho: mean ≥ 1.59; Ha: mean < 1.59; t = -25.01; Pr(T < t) = 0.00***						

Source: BPS secondary data analysis, 2020

input of sugar industry Government policies such as product prices, subsidies and taxes that also could be improved forward linkage were needed to support the domestic production.

Output Multiplier

According to Nazara (2005), an output multiplier is a total output produced by the economy to meet changes in one unit of money, the final demand for a particular sector. An increase in final demand in a

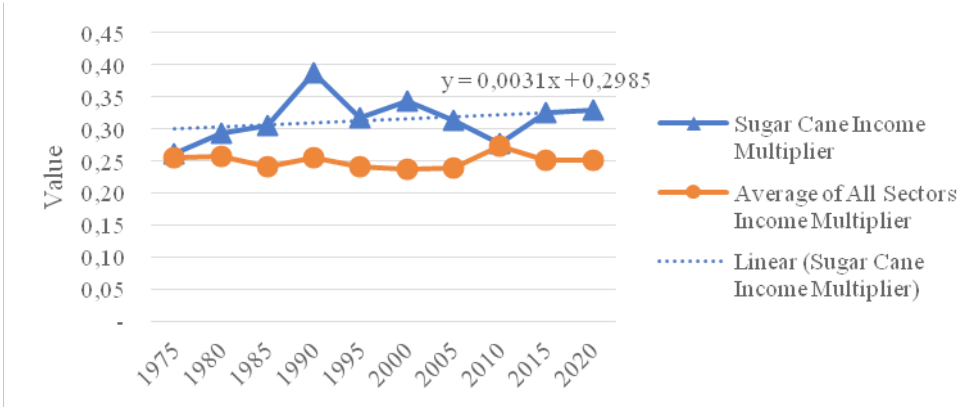

Figure 4. Sugarcane and average of all sectors income multiplier.
Source: BPS secondary data analysis, 2020.

Table 4. One Sample t-test sugarcane and average of all sectors' income multiplier

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Income Multiplier	10	0.32	0.01	0.03	0.29	0.34
Ho: mean ≤ 0.25; Ha: mean > 0.25; t = -3.07; Pr(T > t) = 0.00***						

Source: BPS secondary data analysis, 2020

particular sector will increase the sector's production output and increase other sectors' output.

value of all sectors in Indonesia, and the trend is decreasing from year to year (Table 3). According to Toharisman and Triantarti (2016), the annual growth of sugar demand had averaged at 4.3%. The trend of Indonesian sugarcane production was also positive (FAO, 2020). However, Indonesia's sugar imports tent to increase (Hairani et al., 2014). It led to a low multiplier output of sugarcane because the demand was fulfilled through imports. In 2017-2018 Indonesia became the largest sugar importer globally (Sulaiman et al., 2019).

Income Multiplier

The household income multiplier is also often referred to as the income effect of the Input-Output model. The multiplier figure's value for a sector's household income shows the total household income created due to an additional one unit of final demand money in that sector (Nazara, 2005).

The average sugarcane income multiplier value was higher than the average backward linkage value of all Indonesia sectors and has a relatively constant trend (Table 3). It can be due to the high income of sugarcane farming, which was relatively high in price. According to Pudjiastuti & Kembauw (2017), until 2012, the coefficient

of variance in Indonesia's sugar price was 0.8, the highest compared to other commodities. Furthermore, Hanani et al. (2013) state that an increase in domestic sugar prices by 10-30% will increase producers' welfare.

Employment Multiplier

The job opportunity multiplier was the amount of job opportunity created by a increase in the demand for output from a particular sector by 1 unit. Thus, employment opportunities can determine a particular sector's labor needs at the regional and national levels (Miernyk, 1966).

The trend of labor multiplier in both sugarcane and all economic sectors tent to decline. The average sugarcane multiplier value was the same as the average backward linkage value of all sectors in Indonesia. According to Perwitasari & Sari (2013), the decline in the agricultural sector workforce multiplier decreased from 1975 to 2005 due to technology changes towards mechanization. Many workers switched to the non-agricultural sector, causing a shortage of workers in the agricultural sector (Rachmat 2016). It was because jobs in the agricultural sector, such as sugarcane farming, were considered heavier. In addition, job opportunities and wages in the non-agricultural sector are preferable.

CONCLUSION AND SUGGESTION

Sugarcane forward linkage in Indonesia was the same as the average forward linkage of all economic sectors, while backward

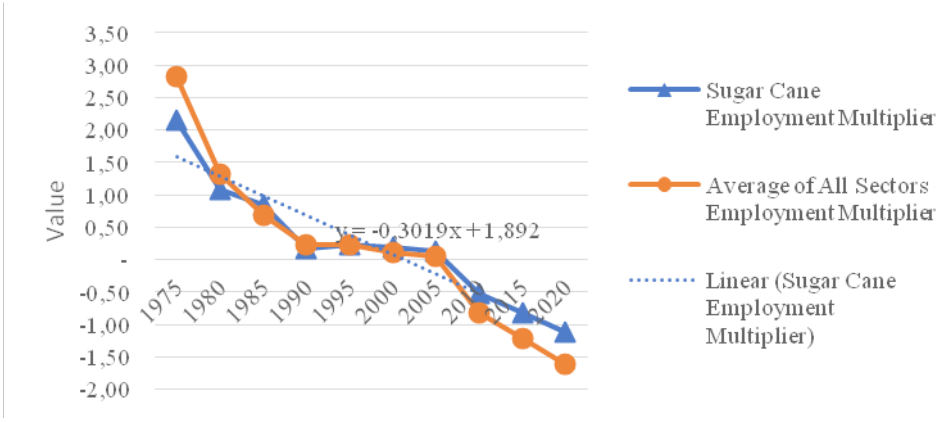

Figure 5. Sugarcane and average of all sectors employment multiplier.
Source: BPS secondary data analysis, 2020.

Table 5. One Sample t-test sugarcane and average of all sectors' employment multiplier

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Employment Multiplier	10	0.23	0.30	0.96	-0.47	0.92
Ho: mean = 0.18; Ha: mean ≠ 0.18; t = 0.30; Pr(T > t) = 0.87^{ns}						

Sumber: BPS secondary data analysis, 2020

sugarcane linkage was lower than the average backward linkage of all economic sectors. It is an indication that sugar fulfillment is not only from domestic production but also from imports. It is also consistent with the output multiplier value, which is still lower than the average output multiplier of all economic sectors. On the other hand, the income multiplier was higher than the average income multiplier for all the economic sectors. Thus, domestic production is required to be developed to encourage the development of both the upstream and downstream industries. Besides, it could also increase the multiplier of job opportunities, which was still lower than the average multiplier of job opportunities in all sectors of the economy due to low labor wages constraints. Increasing domestic sugarcane production can be carried out with government intervention by establishing policies such as sugar self-sufficiency, optimizing BUMDES to support agricultural input, the active role of BULOG to stabilize prices, and tax relief for the new sugar industry. Based on the backward linkage analysis results where sugarcane was below the average of other sectors, serious efforts are needed to improve the upstream sugarcane sector and extensification efforts, including introducing superior clone seeds and high-yield cultivation technology.

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