Performance of cocoa beans production modelling in Indonesia

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Abstract. Cocoa beans production Indonesia has decline in recent years but demand for cocoa beans relatively increase. This research aims to analyse the modelling of cocoa beans production in Indonesia. This research used secondary data from 2005-2018, with simultaneous equation models. The results of this research indicate that the production of cocoa beans has a positive relationship with land area, international price of cocoa beans and lag of cocoa beans production, while the price of domestic cocoa beans has a negative relationship with cocoa beans production. Domestic demand for cocoa beans has a positive relationship with domestic price of cocoa beans and the cocoa processing industry. Domestic price of cocoa beans has a positive relationship with domestic demand for cocoa beans, international price of cocoa beans and lag domestic price of cocoa beans, while cocoa beans production has a negative relationship with domestic cocoa bean prices.

1. Introduction
Indonesia is one of the largest cocoa producing countries in the world. Indonesian cocoa beans are famous for their delicious taste and don't melt easily, this is because Indonesian cocoa beans have a melting point of 36-39°C [1]. Indonesian cocoa beans are very suitable to be used as raw material for processing various kinds of chocolate foods. The domestic market for cocoa beans in Indonesia is not free from various problems. Although Indonesia is known as the largest cocoa producing country, the production of cocoa beans in Indonesia has decreased significantly caused by attacks pests and diseases such as cacao pod borer and pod rot disease. In addition, according to [2], cocoa beans production decreases due to the aging of the cocoa plants, unconventional harvesting and changing weather and climate. The decline in cocoa beans production is in contrast to the development of land area for cocoa plants, where the area of cocoa plantations is increasing [3]. Supposedly, the wider land can produce higher production, but the phenomenon that occurs is not in accordance with the desired expectations. Not only in terms of quantity, the quality of cocoa beans in Indonesia is still low. There are still many cocoa beans in the country that are not fermented. Generally, farmers want to get profit from selling cocoa beans quickly without having to wait for the fermentation process, whereas if the farmers do fermentation, the price of cocoa beans offered will be higher.

In 2010, The government of Indonesia has implemented an export tax on cocoa beans from 0% to 15%. While there is no tax for the exports of processed cocoa products. The objective of this policy is to reduce exports of cocoa beans and increase exports of processed cocoa products. So it is hoped that
farmers prefer to process cocoa beans first before exporting them in order to get added value [4]. After the implementation of the export tax for cocoa beans, the number of cocoa processing industries began to increase. The cocoa processing industry in Indonesia continues to develop and increase its capacity, therefore the demand of cocoa beans in Indonesia has also increased especially for industrial raw materials. However, the low production of cocoa beans in Indonesia has not been able to meet the high demand for cocoa beans. Finally, Indonesia imports cocoa beans from abroad, but what must be considered is the number of imports made by Indonesia continues to increase. If this continues, the competitiveness of Indonesian cocoa beans will decline in the world market.

The price of cocoa beans in Indonesia can affect the domestic market for Indonesian cocoa beans. Based on the theory of demand, if the price of a good increases, the demand will decrease, and vice versa if the price decreases, the demand will increase. Meanwhile, the supply theory has a straight relationship with price, where when the price rises, the supply will increase, and vice versa if the price falls, the supply will decrease. In fact, the phenomenon that occurs of cocoa beans in Indonesia is contrary to the theory of demand and supply. Domestic cocoa beans have a fairly high price. However, the high price of domestic cocoa beans has not been able to increase cocoa beans production. In addition, even though the domestic price of cocoa beans is high, the demand for cocoa beans in the country remains high.

Therefore, based on the above description, it is necessary to carry out an analysis of the domestic market for cocoa beans in Indonesia to determine how the domestic cocoa beans market conditions are viewed from the side of production, demand and price of domestic cocoa beans.

### 2. Methodology

This research using secondary data from article journals, Indonesian Central Bureau of Statistics (BPS), and annual statistical data from various institutions in the form of time series for the years 2005-2018. The method used in this research is the 2 SLS (Two Stage Least Square) method with a simultaneous equation model that can provide a real picture and strengthen the descriptive method. The model specifications used in this study are described as follows:

\[
Q_{st} = c_0 + c_1 L_{at} + c_2 P_{it} + c_3 P_{dt} + c_4 Q_{st-1} + e \\
\text{where:} \\
Q_{st} : \text{Production of cocoa beans (ton/year)} \\
Q_{dt} : \text{Domestic demand for cocoa beans (ton/year)} \\
P_{dt} : \text{Domestic price of cocoa beans (IDR/ton/year)} \\
P_{it} : \text{International price of cocoa beans (USD/ton/year)} \\
L_{at} : \text{Land Area of cocoa (Ha/year)} \\
\text{Nip}_{t} : \text{Cocoa processing industry (Unit/year)} \\
Q_{st-L} : \text{Lag the production of cocoa beans (ton/year)} \\
P_{dt-L} : \text{Lag the domestic price of cocoa beans (IDR/ton/year)} \\
e : \text{error term}
\]
3. Results and discussion

3.1. Cocoa beans production

Indonesia is known as the largest cocoa producing country in the world, but it cannot be denied that the productivity of cocoa produced is still low. There are several factors that affect the decline in cocoa bean production in Indonesia, including the attack of cocoa pod borer (CPB), non-intensive maintenance, poorly maintained garden conditions, inconsistent harvests resulting in fluctuating productivity, old cocoa plant age, and climate and the weather that is always changing [2]. In addition, government policies that only focus on expanding the planted area without paying attention to the quality of cocoa are also one of the problems that underlie the decline in cocoa bean production in Indonesia. The following is a comparison of the amount of cocoa bean production, land area, domestic price of cocoa beans and international price of cocoa beans from 2005-2018.

![Cocoa beans production and land area in Indonesia 2005 – 2018.](image)

Based on figure 1, cocoa bean production in Indonesia tends to fluctuate and even has a significant decline since 2011-2018. In 2017, cocoa bean production in Indonesia reached its lowest point of 585,200 tons. In addition, the growth of cocoa bean production in Indonesia shows a negative value of -1.64%. The decline in cocoa bean production has resulted in a lower supply of cocoa beans in the country so that the cocoa processing industry has to import raw materials from abroad. If there is an imbalance between the growth in demand for cocoa beans in the country and the growth in production of cocoa beans, then Indonesia may change from a cocoa bean exporting country to an importing country for cocoa beans.

The land area for cocoa shows a fluctuating value and even tends to increase in the area of cocoa cultivation in Indonesia. From 2005-2012 there was an increase in the area of cocoa land each year. Then from 2013-2018 there was a decrease in the area of cocoa land, but it can be said that the area of cocoa land is still higher than in previous years. The land area for cocoa showed a growth of 2.62%. The availability of wider cocoa land should provide more opportunities to produce higher cocoa bean production. However, the lack of attention from the government and farmers to the growth of cocoa bean production has resulted in a decline in cocoa bean production in Indonesia. According to [5], the increase in cocoa land area was due to the change of land from non-cocoa commodities to cocoa commodities.

Domestic prices are usually directly proportional to international prices. If the international price of cocoa beans increases, the domestic price of cocoa beans will also increase. However, the thing that must be considered is that the international price of cocoa beans is related to the exchange rate, so the domestic price of cocoa beans is also related to the exchange rate. If IDR exchange rate weakens, the domestic price of cocoa bean tends to be more expensive.
3.2. Price and demand of cocoa beans

Along with the increase in the cocoa processing industry and the installed capacity of the processing industry, the domestic demand for cocoa beans has increased. This is in accordance with the government's policy objectives in implementing export tax on cocoa bean exports in Indonesia in 2010, which in this policy the government wants to suppress the export of cocoa beans abroad so that the cocoa processing industry can improve its performance to obtain added value from cocoa. Then resulting in a surge demand for cocoa beans in the country. The following is a comparison of the amount of demand for cocoa beans in the country, the cocoa processing industry and the domestic price of cocoa beans from 2005-2018.

Based on Figure 3, domestic demand for cocoa beans has tended to increase from 2010-2018. Price of domestic cocoa beans has fluctuated in price but tends to increase every year. This can be seen from 2005-2018 when the price of domestic cocoa beans continued to increase. Only in 2012 and 2015 saw...
a decline in the price of domestic cocoa beans from the previous years, namely IDR 18,297,000/ton and IDR 23,335,000/ton, respectively. The decline of the domestic price of cocoa beans in the two years was not so great that it can be said that the price of domestic cocoa beans is quite high. Meanwhile, the price of domestic cocoa beans has grown by 8.95%. Based on the theory of the law of demand, if the price of a good is high, the demand for that item will decrease. However, it is suspected that the phenomenon that occurs in the domestic cocoa commodity shows that domestic demand for cocoa beans remains high even though the price of domestic cocoa beans is also high.

Price of cocoa beans in Indonesia is one of the factors that affect exports, imports, production and demand for cocoa beans in the country. The price of cocoa beans in the country shows the price that must be paid by consumers to buy cocoa in Indonesia. According to [6], if there is a decline in the price of cocoa beans in the country, the cocoa processing industry will increase domestic demand for cocoa beans to produce processed cocoa products. On the other hand, for farmers, if there is a decline in the price of cocoa beans in the country, there will be a decrease in the planted area for cocoa so that the production and productivity of cocoa will decrease. This occurs because farmers are not interested in producing more cocoa beans when the price of cocoa beans is low. Domestic prices are usually directly proportional to international prices. If the international price of cocoa beans is high, it will increase the price of cocoa beans in the country.

### 3.3 Analysis of factors affecting cocoa bean production in Indonesia

In this study, the cocoa beans production equation in Indonesia is influenced by land area (La_t), international price of cocoa beans (Pi_t), domestic price of cocoa beans (Pd_t) and lag of cocoa bean production (Qs_L). The results showed the coefficient of determination (R-square) of 0.7186, which means that the production of cocoa beans (Qs_t) in Indonesia can be explained by these factors of 71.86%, while the rest is explained by other variables outside the equation model. Statistically cocoa land area (La_t), international cocoa bean prices (Pi_t), domestic cocoa bean prices (Pd_t) and lag of cocoa bean production (Qs_L) simultaneously have a significant effect on cocoa bean production variables in Indonesia.

### Table 1. Estimation of factors affecting cocoa bean production in Indonesia.

| Equation                        | “R-sq” | F-Stat |
|---------------------------------|--------|--------|
| Cocoa Beans Production (Qs_t)   | 0.7186 | 5.745  |

|                      | Coef.  | Std. Err. | T-Ratio | P-Value |
|----------------------|--------|------------|---------|---------|
| Land Area (La_t)     | 0.0005 | 0.1498     | 0.0035  | 0.997   |
| International Price of Cocoa Beans (Pi_t) | 59.623 | 30.11     | 1.980 | 0.048 |
| Domestic Price of Cocoa Beans (Pd_t) | 0.0121 | 0.0031   | -3.852 | 0.000 |
| Lag of cocoa beans production (Qs_L) | 0.0520 | 0.0740 | 0.7032 | 0.482 |
| cons                 | 765800 | 139200    | 5.500   | 0.000 |

Cocoa land area has a positive relationship with cocoa bean production, that is if the land area increases, the cocoa beans production will increase. Land area (La_t) has a coefficient value of 0.0005, which means that each land area increases by one hectare, it will increase the production of cocoa beans by 0.0005 tons/year. This is in accordance with the theory and the expected value of this equation. The results of this study are supported by [2] which states that the variable area of cocoa land has a positive relationship with cocoa bean production. Where the resulting coefficient is 1.153, indicating that if the variable area of land increases, it will increase the production of smallholder cocoa beans by 1.153 percent. The planted area for cocoa is quite high and increases every year, but
the yield obtained is decreasing or getting low. According to [7], the problem underlying this decline in production lies in the Indonesian government policy which only focuses on expanding the planted area without seriously paying attention to the quality of the cocoa plant. Cocoa pod borer (CPB) attack is the biggest factor in the decline in cocoa production in Indonesia. This attack will cause an 80% loss in cocoa production.

The international price of cocoa beans (\(P_i\)) has a coefficient value of 59.623, which means that each international price of cocoa beans increases by one dollar, it will increase the production of cocoa beans by 59.623 tons/year. The international price of cocoa beans has a positive relationship with cocoa bean production, that is, if the international price of cocoa beans increases, then the production of cocoa beans will increase. This is in accordance with the theory and the expected value of this equation. According to [8] commodities traded in international trade generally use an intermediary currency in the US Dollar. Therefore, commodity prices on world markets are inversely related to the US dollar exchange rate, including cocoa. If the US dollar exchange rate weakens, the world cocoa bean price tends to strengthen, whereas if the US dollar exchange rate strengthens, the world cocoa bean price tends to weaken (increase). When the US Dollar strengthens, exporters can still benefit from the weakening of the IDR, because if the IDR weakens, the amount of cocoa bean exports will increase, thus encouraging higher cocoa production. However, for local farmers in Indonesia, this phenomenon may not have much of an impact, even though the world price of cocoa beans is weakening, the production of cocoa beans in Indonesia is still widely used to meet domestic demand.

The domestic price of cocoa beans has a negative relationship with the production of cocoa beans, that is if the price of cocoa beans in the country increases, then the production of cocoa beans will decrease. Based on estimation each domestic price of cocoa increases by one IDR, it will reduce the production of cocoa beans by 0.012166 tons/year. The results in this study are not in accordance with the theory and the expected value of this equation. Where it should be in accordance with the theory, the domestic price of cocoa beans has a positive effect on cocoa production, that is if the price of cocoa beans in the country increases, it will increase the production of cocoa beans. However, in this study a negative value was obtained. Based on the research results of [9] it is stated that the price of domestic cocoa beans has a positive effect but does not have a significant effect on cocoa production. The estimated coefficient value of the domestic cocoa bean price variable is 0.07, which means that if there is an increase in the price of domestic cocoa beans by 1%, it will increase cocoa production by 0.07%. An increase in the price of cocoa beans will increase the interest of farmers to increase their income as this provides more incentives for producers, thus encouraging farmers to produce more cocoa. The discrepancies in the results of this study can be explained by differences in the combination of variables used in the analysis or the data sources used. The phenomenon that occurs is that although the domestic price of cocoa beans is high, the production of cocoa beans produced is low and tends to decline.

The lag of cocoa beans production (\(Q_{stL}\)) had a coefficient value of 0.052052, which means that each cocoa bean production in the previous year increased by one ton, it will increase the cocoa bean production by 0.052052 tons/year. The lag in cocoa bean production has a positive relationship with cocoa bean production, that is, if the lag in cocoa bean production increases, then the cocoa bean production will increase. This is in accordance with the theory and the expected value of this equation. Based on the results of the t-test statistical analysis with a probability value at the level of \(\alpha = 10\%\), the value is 0.482. This means that the lag of cocoa bean production has no significant effect on cocoa bean production in Indonesia.

### 3.4. Analysis of factors affecting domestic demand for cocoa beans

The equation for domestic demand for cocoa beans is influenced by the domestic price of cocoa beans (\(P_d\)) and the cocoa processing industry (\(N_{ip}\)). The results showed that the coefficient of determination (R-square) was 0.8864, which means that domestic demand for cocoa beans (\(Q_{st}\)) could be explained by these factors at 88.64%, while the rest was explained by other variables outside the equation model.
Table 2. Estimation of factors affecting domestic demand for cocoa beans.

| Equation                  | "R-sq" | F-Stat |
|---------------------------|--------|--------|
| Domestic Demand for Cocoa Beans (Qd,) | 0.8864 | 42.915 |

| Variable                              | Coef.    | Std. Err. | T-Ratio | P-Value |
|---------------------------------------|----------|-----------|---------|---------|
| Domestic Price of Cocoa Beans (Pd,)   | 0.011473 | 0.0057    | 1.982   | 0.047   |
| Cocoa Processing Industry (Nip,)       | 36634    | 16930     | 2.164   | 0.030   |
| _cons                                 | -280060  | 188900    | -1.483  | 0.138   |

The domestic price of cocoa beans (Pd,) has a coefficient value of 0.011473 which means that each domestic price of cocoa beans increases by one IDR, it will increase domestic demand for cocoa beans by 0.011473 tons/year. The domestic price of cocoa beans has a positive relationship with the demand for cocoa beans in the country, that is if the domestic price of cocoa beans increases, the demand for cocoa beans in the country will increase. This is not in accordance with the theory and the expected value of this equation. Based on the results of the t-test statistical analysis with a probability value at the level of α = 10%, the value is 0.047. This means that the price of cocoa beans in the country has a significant effect on the demand for cocoa beans in the country. Based on the theory of demand, the higher the price, the lower the demand. The results of this study are not in accordance with this theory, where the results obtained show that the domestic price of cocoa beans has a positive effect on domestic demand for cocoa beans, which means that the results of this study are contrary to the theory of demand. However, this can be explained in accordance with the phenomena occurring in the Indonesian cocoa beans market. It can be seen that there are various consumers of cocoa beans, some come from households and also the cocoa processing industry. In the household, the purchasing power depends on the price, if the price is high then the purchasing power will decrease. Meanwhile, for the cocoa processing industry, since the implementation of the export tax, the cocoa processing industry in Indonesia has grown so that the demand for domestic cocoa beans has increased. To meet the need for raw materials, the processing industry will continue to buy cocoa beans even though the domestic price of cocoa beans is high. Because if the raw materials are insufficient, the cocoa processing industry cannot produce. Therefore, no matter how high the price of cocoa beans in the country will not reduce the demand for cocoa beans, so that the demand for cocoa beans in the country remains high.

The Cocoa Processing Industry (Nipt) has a coefficient value of 36634, which means that each domestic cocoa processing industry increases by one unit, this will increase domestic demand for cocoa beans by 36634 tons/year. The domestic cocoa processing industry has a positive relationship with the demand for cocoa beans in the country, that is if the domestic cocoa processing industry increases, the domestic demand for cocoa beans will increase. This is in accordance with the theory and the expected value of this equation. Based on the results of the t test statistical analysis with a probability value at the level of α = 10%, the value is 0.030. This means that the domestic cocoa processing industry has a significant effect on domestic demand for cocoa beans. The results of this study are supported by the results of research from [10] which states that the relationship between the variable number of soybean processing industries on soybean demand is positive. This indicates that the higher the number of soybean processing industries will increase domestic demand for soybeans.

3.5. Analysis of factors affecting the domestic price of cocoa beans

In this study, the domestic price equation for cocoa beans is influenced by cocoa bean production (Qs), domestic demand for cocoa beans (Qd), international cocoa bean prices (Pi), and lag in domestic cocoa bean prices (Pd,L). The results showed the coefficient of determination (R-square) of 0.9652, which means that the domestic price of cocoa beans (Pd,) in Indonesia can be explained by these factors of 96.52% while the rest is explained by other variables outside the equation model.
Cocoa bean production ($Q_s$) has a coefficient value of -3.6568 which means that every one tonne of cocoa production increases, it will reduce the price of cocoa beans in the country by IDR 3,656.8 / ton. The production of cocoa beans has a negative relationship with the domestic price of cocoa, that is if the production of cocoa beans increases, the domestic price of cocoa beans in the country will decrease. This is in accordance with the theory and the expected value of this equation. Based on the results of the t-test statistical analysis with a probability value at the level of $\alpha = 10\%$, the p value is 0.628. This means that the production of cocoa beans has no significant effect on the domestic price of cocoa beans. According [11] which states that domestic cocoa production has a negative parameter to the price of domestic cocoa beans. This means that if Indonesian cocoa production decreases by 1%, the domestic cocoa price will increase by 0.659%. Therefore, the results of this study are consistent with previous theories and research.

Domestic demand for cocoa beans ($Q_d$) has a coefficient value of 17.292, which means that each domestic demand for cocoa beans increases by one ton, it will increase the price of cocoa beans in the country by IDR 17,292/ ton. Domestic demand for cocoa beans has a positive relationship with the price of cocoa beans in the country, that is, if the demand for cocoa beans in the country increases, the domestic price of cocoa beans will increase. This is in accordance with the theory and the expected value of this equation. Based on the results of the t-test statistical analysis with a probability value at the level of $\alpha = 10\%$, the p value is 0.000. This means that the demand for cocoa beans in the country has a significant effect on the domestic price of cocoa beans. According [11] it is stated that the demand for domestic cocoa beans has a positive effect on the price of domestic cocoa beans. If the demand increases by 1%, the domestic cocoa price will increase by 0.431%. The higher of the demand, the producer will increase the amount of production so that prices tend to rise when the demand increases. Therefore, the results of this study are in conformity with the results of previous studies. The international price of cocoa beans ($P_i$) has a coefficient value of 898.96, which means that each international price of cocoa beans increases by one dollar, it will increase the domestic price of cocoa beans by IDR 898.96/ton. The international price of cocoa beans has a positive relationship with the domestic price of cocoa beans, that is if the international price of cocoa beans increases, the domestic price of cocoa beans will increase. This is in accordance with the theory and the expected value of this equation. Based on the results of t-test statistical analysis with a probability value at the level of $\alpha = 10\%$, the value is 0.283. This means that the international price of cocoa beans has no significant effect on the domestic price of cocoa beans. According [11]; T[12] it is stated that the international price of cocoa beans positively affects the price of domestic cocoa beans. The coefficient value shows a value of 0.155, which means that if the international price of cocoa beans increases by 1%, the price of domestic cocoa beans will increase by 0.155%. Therefore, the results of this study are consistent with the results of previous studies.

### Table 3. Estimation of factors affecting domestic price of cocoa beans.

| Variable                      | Coef.  | Std. Err. | T-Ratio | P-Value |
|-------------------------------|--------|-----------|---------|---------|
| Cocoa beans production ($Q_s$) | -3.6568| 7.543     | -0.4848 | 0.628   |
| Domestic demand for cocoa beans ($Q_d$) | 17.292    | 3.979     | 4.345   | 0.000   |
| International price of cocoa beans ($P_i$) | 898.96    | 837.6     | 1.073   | 0.283   |
| Lag Domestic price of cocoa beans ($P_{dL}$) | 0.45508  | 837.6     | 4.613   | 0.000   |
| cons                          | 2160600 | 0.09866   | 0.3453  | 0.730   |

"R-sq" = 0.9652, F-Stat = 62.405
The lag of the domestic price of cocoa beans (PdL) has a coefficient value of 0.45508, which means that each domestic price of cocoa beans in the previous year increased by one IDR, it will increase the domestic price of cocoa beans by IDR 0.45508/ton [13]. The lag of the domestic price of cocoa beans has a positive relationship with the domestic price of cocoa beans, that is if the lag of domestic price of cocoa beans increases, the price of cocoa beans in the country will increase. This is in accordance with the theory and the expected value of this equation. Based on the results of the t-test statistical analysis with a probability value at the level of α = 10%, the p value is 0.000. This means that the lag of domestic price of cocoa beans has a significant effect on the domestic price of cocoa beans.

4. Conclusion
Cocoa beans production has a positive relationship with land area, international price of cocoa beans and lag of cocoa bean production, while domestic price of cocoa beans have a negative relationship with cocoa beans production. Statistically, only international price of cocoa beans and domestic price of cocoa beans have a significant effect on cocoa beans production. Domestic demand for cocoa beans has a positive relationship with domestic price of cocoa beans and the cocoa processing industry. Statistically, these two variables have a significant effect on domestic demand for cocoa beans. Domestic price of cocoa beans has a positive relationship with domestic demand for cocoa beans, international price of cocoa beans and lag of the domestic price of cocoa beans, while cocoa beans production has a negative relationship with domestic price of cocoa beans. Statistically, only the demand for cocoa beans in the country and the lag of the domestic price of cocoa beans have a significant effect on the domestic price of cocoa beans.

Government should be able to make policies regarding cocoa intensification by rehabilitating or rejuvenating old cocoa, controlling pests and diseases, using superior seeds and so on so that production can meet domestic demand for cocoa beans. Apart from the quantity aspect, the quality of cocoa beans must also be considered. To increase price of local price cocoa, government must give training how to dry cocoa well at farmer. The role of cocoa cooperative in rural areas also needs to be increased to ensure that farmers can sell their product. The quality of Indonesian cocoa beans is still low due to the lack of farmers carrying out fermentation, therefore it is necessary to provide counselling or training to farmers on good cocoa cultivation techniques from upstream to post-harvest so that the cocoa beans produced are large and high quality and the price of cocoa beans obtained also high.

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