Stochastic frontier model for profit efficiency of beef cattle farming during the covid 19 pandemic in West Pasaman Regency, West Sumatera Province

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Abstract. Study aimed to estimate profit efficiency and determine factors affecting the profit efficiency of beef cattle farming in West Pasaman Regency, West Sumatera Province. A survey was conducted in West Pasaman regency at October 2020. Respondents consisting of 60 beef cattle farmers were questioned using structural questionnaires. Stochastic Frontier Analysis was used to estimate profit efficiency and factors influencing profit efficiency of beef farm in West Pasaman Regency. Important factors affecting the profit efficiency of beef cattle farming business in West Pasaman Regency were feed price, cost of veterinary medicine, fixed cost, labor cost and number of cattle affecting significant to beef cattle farming profit. The average level of profit efficiency was 39.4%. Considering the importance of profit efficiency beef cattle farming there is a need for improving level of farmer’s education and experience in beef cattle farming, but farmers should be of productive age.

Keywords: Beef cattle farming, profit efficiency, stochastic frontier

1. Introduction
One of the agricultural sectors that become focus of agricultural development is the livestock sub-sector. In the last few decades, the demand for livestock products has tended to increase, along with population growth, community economic development, improvements in education levels, and changes in lifestyle. However, the emergence of the COVID-19 outbreak has caused changes in the entire economic structure including the livestock sub-sector. One of the livestock sub-sectors that are experiencing the impact is beef cattle farming. On the one hand, the government continues to strive to ensure the availability of beef, which has so far been fulfilled from imports. On the other hand, farmers hope that meat prices will be stable and will not harm/cause a loss for them. However, during this COVID-19 pandemic, they are faced with a situation where the demand for beef decreased due to decreased purchasing power because of job losses since the COVID-19 pandemic.

West Pasaman Regency is an area designated as one of the beef cattle development areas by the West Sumatra provincial government and one of the areas affected by the COVID-19 pandemic. As an affected area, it is necessary to develop an efficient and effective beef cattle farming system so that the sustainability of the beef cattle business can be maintained. The regional government of the West Pasaman Regency views beef cattle farming as an alternative for the economic empowerment of farmers amid the COVID-19 pandemic, with the hope that the farmers’ household economy can be maintained so that it can still meet their basic and education needs. Besides, it can also be a reference for policy
makers to improve the beef cattle farming system that can sustain the family economy and be sustainable.

The business pattern of beef cattle farming in West Pasaman Regency is still traditional as their beef cattle farming system still uses the intensive and semi-intensive farming systems. Therefore, the beef cattle farming still have many problem, especially in achieving optimal results. The optimal results can be achieved by implementing efficient and effective beef cattle farming patterns that are adjusted to current conditions by managing resources (production inputs) optimally to get more profits.

Based on this background, the objectives of this study was to analyses the factors that affect the efficiency of beef cattle business profits during the COVID-19 pandemic in West Pasaman Regency by using stochastic frontier analysis (SFA). This model has previously been widely used for technical efficiency in livestock farming, but not in profit efficiency. However, related to profit efficiency of beef cattle business, this model has been used by [4] that determine beef cattle profit efficiency in Botswana, profit efficiency of quail farming in Nigeria [1]. But the case in Indonesia regarding the use of SFA to determine profit efficiency in beef cattle farming have not been found, especially in West Sumatera Province.

2. Research method
This research was conducted in West Pasaman Regency during at October 2020. Data were obtained from interviews using questionnaire with farmers rearing beef cattle. 60 respondents were selected using accidental sampling technique. Profit in this analysis was obtained from difference between revenue and total cost paid in cash and noncash by farmers.

To analyze the determinant factors of the profit efficiency of beef cattle farming using parametric statistics with the Stochastic Frontier Analysis (SFA) approach. The profit frontier and inefficiency functions estimated using FRONTIER 4.1 [7]. In this study the Stochastic Frontier model of beef cattle farming business used is as follows [5, 4 and 9].

\[ \ln \Pi = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + v_i - u_i \]

Where \( \Pi \) represents the normalized profit (IDR/year), \( X_1 \) represents normalized feed price (IDR/year), \( X_2 \) represents normalized veterinary medicine cost (IDR/unit), \( X_3 \) represents the fixed cost (IDR/year), \( X_4 \) represents normalized labor cost (hours/year), \( X_5 \) represents the business scale (head), \( \beta_0 \) represents the intercept, \( \beta_i \) represents coefficient of parameter estimation, \( v_i - u_i \) represents error term (\( u_i = \) technical inefficiency effects in the model and \( v_i = \) the effect of external factors that are not modeled).

Technical inefficiency effects in this study measured referring to the formula developed by [5, 4, 9].

\[ \mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + w_i \]

where \( \mu_i \) is the technical inefficiency effect, \( Z_1 \) represents age of the farmers (years), \( Z_2 \) represents the farmer’s education (years), \( Z_3 \) represents experience of the farmers (years), \( Z_4 \) represents dummy for Business Status (\( Z_41 = 1 \), if it is main business and \( Z_42 = 0 \), if it is side business) and \( Z_5 \) represents dummy management system (\( Z_51 = 1 \), if intensive management and \( Z_52 = 1 \), Non intensive management). The one-sided generalized likelihood ratio test (LR-test) used for measuring the parameter of frontier production function and technical inefficiencies.

3. Results and discussion
3.1. Socioeconomic characteristics of the respondents
Table 1 shows the average age of beef cattle farmers was varies between 23 until 70 years old, that 35% farmers are 55-70 years old. It has indicated that quite a lot of them are above the productive age. The age of the farmer would affect physically in doing work and making decisions in running a livestock business.
Table 1. Socioeconomic characteristics of respondents.

| Socioeconomic Characteristics          | Frequency | Percentage |
|----------------------------------------|-----------|------------|
| Age (years)                            |           |            |
| 23 - 38                                | 19        | 31.7       |
| 39 – 54                                | 20        | 33.3       |
| 55 - 70                                | 21        | 35         |
| Education level                        |           |            |
| SD                                     | 27        | 45.0       |
| SLTP                                   | 12        | 20.0       |
| SLTA                                   | 20        | 33.3       |
| PT                                     | 1         | 1.7        |
| Beef cattle farmer experience          |           |            |
| 2 - 11                                 | 36        | 60.0       |
| 12 – 21                                | 19        | 31.7       |
| 22 - 31                                | 5         | 8.3        |

Education is one of the most influential factors in a farming business. It is expected that it can help the people in increasing the production of the livestock that is nurtured. Table one show that the majority of the farmers’ education level is elementary of 45% and senior high level of 33.3%. Most of the respondents had a low education level, indicating that beef cattle farmers in Pasaman Barat Regency relied more on experience and studying from other people’s farming businesses that have already existed. According to [11] low educated human resources will hinder livestock development.

The farmers with a long experience in farming generally have more knowledge than new farmers who just started the livestock farming business. Most respondents in this research study were dominated by farmers with livestock business experience for 2 to 11 years with the average for 12 years, it showed that the farmers were quite experienced in beef cattle farming because farming has become a part of the farmers’ household economy and it is hereditary.

Patterns of beef cattle farming business in West Pasaman regency is seen from the business scale, beef cattle business status in household economy and farming system.

Table 2. Patterns of beef cattle farming business.

| Patterns of beef cattle | Frequency (person) | Percentage |
|-------------------------|--------------------|------------|
| Business scale          |                    |            |
| 1 - 8                   | 48                 | 80.0       |
| 9 – 17                  | 10                 | 16.7       |
| 18 - 25                 | 2                  | 3.3        |
| Business status         |                    |            |
| Main business           | 13                 | 21.7       |
| Side business           | 47                 | 78.3       |
| Management Systems      |                    |            |
| Intensive               | 30                 | 50         |
| Semi intensive          | 30                 | 50         |

The scale of beef cattle ownership by the respondents will greatly determine the management of the business and the income that will be earned. Based on Table 2, it is known that 80% of respondents farm/raise beef cattle with a scale of ownership between 1 - 8 heads. The average number of cattle farmed is six head per farmer. This shows that the scale of the beef cattle business is still relatively small. The livestock business in West Pasaman Regency is dominated by small-scale farms. Even though the business of beef cattle farming has been very much undertaken, its management is still a secondary business and is not matched by adequate farming systems and management patterns. Table 2 shows that most or 78.3% of respondents make the beef cattle business only as a side business. The beef cattle
business is used as a side business in their farming activities such as corn farming and oil palm plantations.

The beef cattle farming systems that are commonly used are the intensive, semi-intensive, and extensive system. However, most of the farmers in West Pasaman Regency farm/raise their beef cattle with the semi-intensive and intensive systems, where 50% are farmed/raised in a semi-intensive system and 50% are farmed/raised in an intensive system.

3.2. Beef cattle farming during the COVID-19 pandemic in West Pasaman District

The economic downturn due to the wave caused by the coronavirus (COVID-19) pandemic has a broad impact on all sectors, including the beef cattle business. However, the beef cattle farming in West Pasaman Regency was not too affected by the COVID-19 pandemic. When viewed from the spread of COVID-19 in West Pasaman Regency, it is among the lowest in West Sumatra Province, namely in the 16 positions out of 19 regencies or cities in West Sumatra. Besides, beef cattle farmers do not really feel the impact of the COVID-19 pandemic on their beef cattle business, because most of them only make the beef cattle business a side business, where they sell livestock only at certain times such as Eid al-Fitr and Eid al-Adha, as well as in urgent conditions. In addition, the feed for beef cattle is sufficiently available, so it does not need to be imported from outside the region or even—country. However, farmers are aware that when viewed as a whole, what they feel in general is a decrease in purchasing power and public demand for beef so that the amount of demand for cattle also decreases. Especially if farmers have to sell their cows in a state of urgency, the” toke” or cow trader will reduce the selling price of the farmers’ cattle. In this condition, farmers do not have a good bargaining position when selling their livestock.

3.3. Profit analysis of beef cattle farming

Profit is the difference between revenue and costs within a certain period. In this study, the analysis of the beef cattle business was carried out for 1 year. Revenues in the beef cattle business consist of cash and non-cash revenue. Cash revenues come from the sale of beef cattle and non-cash is calculated based on the value added of the livestock farmed (not sold). Meanwhile, costs consist of fixed costs and variable costs.

| Component                     | Amount (IDR) | Percentage (%) |
|-------------------------------|--------------|----------------|
| **Revenue**                   |              |                |
| Beef cattle sale value        | 24,883,333   | 65,86          |
| Value added of beef cattle    | 10,641,667   | 28,16          |
| Manure sale                   | 2,258,667    | 5,98           |
| **Total Revenue**             | 37,783,667   | 100,00         |
| **Fixed Cost**                |              |                |
| Depreciation cost of cage     | 664,558      | 2,97           |
| Depreciation cost of equipment| 201,383      | 0,90           |
| Cost of breeds                | 7,500,000    | 33,51          |
| **Total Fixed Cost**          | 8,365,941    |                |
| **Variable Cost**             |              |                |
| Cost of forage feed           | 8,129,351    | 36,32          |
| Cost of concentrate           | 86,667       | 0,39           |
| Cost of cattle medicine       | 89,167       | 0,40           |
| Cost of electricity           | 112,000      | 0,50           |
| Cost of labour                | 5,437,500    | 24,29          |
| Cost of insurance             | 163,000      | 0,73           |
| **Total Variable Cost**       | 14,035,667   |                |
| **Total Cost**                | 22,383,626   | 100,00         |
| **Profit**                    | 15,400,041   |                |
| R/C Ratio                     | 1,68         |                |
The most significant spending in this cost component variable was the spending for the purchase of cost of forage feed and cost of breeds that are 36.32% and 33.51%. Most of business revenue came from cash revenues, namely 65.86%. It is because the number of cattle are reared on average 6 tails per farmer, so the farmers have the opportunity to sell most of his cattle, especially when the feast of Eid al-Fitr and Eid al-Adha or in urgent conditions. Besides the number of calves sufficiently high that an average of 71.9%.

From the calculations according to Table 3, the amount of profit earned by the farmers, which is 15,400,041/year or IDR 1,283,337/month with average farming of 6 cows or it is obtained IDR 2,566,673/head/year or IDR 213,889/head/month. The R/C ratio value obtained is 1.68. The results is not much different with [2] that report the profit of beef cattle farmers with partnership ownership system in Special Region of Yogyakarta at IDR 2,620,374/head/period for the profit of self-ownership farmers and IDR 1,904,776/tail/period for the profit of partnership farmers.

3.4. Estimation of factors affecting profits and determinants of technical inefficiency of beef cattle farming

Table 4 shows the estimation results of the stochastic frontier production function. The sigma squared (σ²) and gamma (γ) values are 28.39 and 0.999, respectively and are actual at the 99% level. Gamma indicates variation in yields caused by differences in technical efficiency.

| Variables            | Parameter | Coefficients | t-ratio |
|----------------------|-----------|--------------|---------|
| Constante            | β₀        | -25.92       | -4.54   |
| Feed Price           | β₁        | -1.418a      | -4.183  |
| Veterinary Medicine Cost | β₂    | 0.580a       | 4.225   |
| Fixed Cost           | β₃        | 0.860b       | 2.308   |
| Labor Cost           | β₄        | 0.975a       | 2.489   |
| Scale of Business    | β₅        | -1.675a      | -11.438 |

Log-likelihood OLS: -126.56
Log-likelihood MLE: -102.652
LR test: 47.82

Notes: Statistical significance levels: a1%; b5%; c10%

LR (Likelihood Ratio) value is 47.82 and greater than the critical value in the [10] Table which is 11.91, which is significant at α = 5% which means there is a technical inefficiency effect in models on a particular technology.

Table 4 shows that the variables significantly affect the profits of the beef cattle business of farmers with a confidence level of 99% (α = 0.01) are feed price, veterinary medicine cost, labour cost and scale of business. Fixed cost significantly affect the profit with confidence level of 95% (α = 0.05).

The increasing price of feed would decrease the profit. However, increasing business scale also decreases the profit. This means that more beef cattle ownership would be able to decrease the profit. Because the farmers tend to sell the cattle at a relatively young age, so the selling price is lower. [9] Found Number of cattle stock significantly affected the actual profit gained by beef cattle.

The veterinary medicines cost and labour cost have a positive and significant effect on profits (α = 0.01). Fixed cost also have a positive and significant effect on profits (α = 0.05). This means that existing resources have not been fully utilized by farmers. Therefore, those farmers can still increase the use of veterinary medicine, machines or other fixed assets, and use of labour. This will increase business productivity, so that also increasing profits for beef cattle business.

The study conducted by [4] shows that the profit model suggests that profit of smallholder beef producers can be increased through and reduction of input prices. This is particularly the case for feed prices. [1] Found the major factors affecting the technical efficiency were feed, stock size, experience and farmer’s educational level.
The results of analysis in Table 5 shows that an increase in education formal, experience and management system leads to decrease effect of inefficiency technical in the business of beef cattle farming in West Pasaman Regency or improving the efficiency of technical effort beef cattle. While age affects positively to profit efficiency beef cattle farming. The dummy variable of age and business status has a positive and significant effect. This means that the older the farmer, the more the effect of inefficiency of beef cattle farming will increase.

The results of the study [9] produce to the variables of education and the status of efforts affect negatively and significantly against in the efficiency of production enterprises livestock cattle beef in Java East, in addition to the variable other that are not included in the study this. Research [4] age affect positively towards performance of the business, where farmers are more elderly have the experience that much with Science are obtained so that can use the input more efficient.

The average of technical efficiency level achieved by the beef cattle farmers was 39.4%. Therefore, in the short run, it is possible to increase production by an average of 59, 1% by adopting efficient farming techniques.

### Table 5. Determinants of profit inefficiency among beef cattle farming.

| Variable                      | Coefficients | t – ratio |
|-------------------------------|--------------|-----------|
| Konstanta                     | 0.483        | 0.470     |
| Age (Z1)                      | 1.322*       | 3.483     |
| Formal Education (Z2)         | -9.095*      | -2.975    |
| Years of experience (Z3)      | -3.725*      | -3.404    |
| Dummy business Status (Z4)    | 0.574*       | 5.762     |
| Dummy Management System (Z5)  | -0.005       | -0.052    |

* Notes Statistical significance levels 1%

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### 4. Conclusion

The total profit gained by the farmers during Covid 19 pandemic is IDR 15,400,041/year or IDR 1,283,337/month with average number 6 heads, intensive and semi intensive farming system and still be a side business. Important factor affecting the profit efficiency of beef cattle farming in West Pasaman Regency were feed price, cost of veterinary medicine, fixed cost, labour cost and business scale. Therefore, all variable had significant affecting to the profit efficiency of beef cattle farming in West Pasaman. Technical efficiency level of beef cattle farmers was 39, 4%. The most important factor that affected the profits inefficiency was age, formal education, length of experience and dummy business Status.

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