Determinants of Cost Inefficiency and Farmer Performance in Broiler Contract Farming


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ABSTRACT

The broiler industry plays an important role in meeting the growing demand for animal protein. Ensuring favorable farming conditions are needed to maintain the meat supply, and theoretically, this can be improved through the implementation of Contract Farming (CF). CF grants farmers the privilege to predict quantities, prices, and reduce production risks. However, one of the key challenges in establishing CF is the cost efficiency and performance of farmers. This study aims to develop a cost function for farmers, identify factors contributing to inefficiency, and evaluate farmer performance. The purposive sampling method is employed to select broiler farmers participating in contract farming as the sample for this study. Primary data were collected through surveys. Stochastic frontier cost analysis is utilized to derive a broiler cost function while examining the causes of farm inefficiency and their relationship with farmers’ performance variables. The results indicate that the broiler cost function is significantly influenced by labor costs, the price of day-old chickens, feed expenses, and harvest tonnage. Meanwhile, the inefficiency effect is substantially influenced by farmer age, education, household size, experience, and mortality ratio (MR). Reducing the MR can increase broiler yield, directly improving cost efficiency and, thus farmers’ income. Nonetheless, a comprehensive approach that includes training, monitoring, feedback, and incentivization is needed to enhance farmer performance in broiler contract farming.

Keywords: broiler; efficiency; farmer performance; mortality ratio; stochastic frontier cost function

INTRODUCTION

The Indonesian economy heavily depends on the poultry sector. The Indonesian Feed Producers Association, locally known as Asosiasi Produsen Pakan Indonesia (APPI/GPMT), claims that the industry can produce 65% of Indonesia’s animal protein needs, employs 12 million people (10.63% of the country’s workforce), and is worth over 34 billion USD (31.22% of the country’s total investment in agriculture, forestry, and fishing) (Wright & Darmawan, 2017). Based on data from the Indonesian Central Bureau of Statistics, 3,426,042 tons of broiler chicken were produced in 2021, a rise of 6.43% from 2020. Concurrently, the global demand for animal protein is rising due to the expanding world population. The fact that broiler chicken meat is less expensive than other animal protein sources, the business plays a crucial part in meeting the demand for animal protein. Despite its relatively lower prices, broiler chicken meat remains popular among consumers (Sugiharto, 2022).

Predictions stated that the broiler sector will expand, but starting a firm requires a substantial upfront investment (Haryuni & Fanani, 2017). Meanwhile, Big firms’ presence has been crucial in enabling Indonesia to develop a rising level of supply independence and technical modernization. According to estimates, industrial farms produce 60% of the world’s poultry (closed housing system), with the other 40% going to small and medium-sized producers (open housing system) (Brockotter, 2017).

Independent farmers who are not affiliated with any larger poultry enterprise have a much smaller position. According to the Indonesian Public Poultry Association (PINSAR Indonesia), the proportion of independent farmers’ market share has decreased from 70% in 2008 to 18% in 2016, while the total of independent farmers has decreased from 100,000 to 6,000 (Wright & Darmawan, 2017). To cope with the high capital need in broiler farming, a partnership model can help farmers regarding capital and product absorption in the market. Moreover, Wijayanto et al. (2014) stated that the amount of capital needed to establish a broiler farm is one reason farmers often engage in partnerships.

One critical issue surrounding the contract farming scheme is the technical performance of farmers (Tapsir et al., 2011). The survival of broiler contract farmers significantly depends on their profitability and perfor-
mance. The sustainability of this industry relies on three key factors: effectiveness, the ability to overcome challenges in the competitive market, and the competitiveness of those engaged in this business (Majid & Hassan, 2014). According to Samarakoon & Samarasinghe (2012), while mortality is an inherent part of broiler production, growers should implement customized management programs to minimize its overall impact on flock performance. Farmer performance can cause inefficiency in broiler farming, which will cause disadvantages for both parties (the farmer and the company). Thus, farmer performance is essential to analyze to improve policy recommendations and cost efficiency.

Assessing cost inefficiency as well as farmer performance holds significant importance in the context of broiler contract farming. The primary reason is its ability to enable farmers to optimize profits by identifying areas where costs can be reduced. This, in turn, can improve financial outcomes and establish a more sustainable business model (Hansen et al., 2019; Kramer & Porter, 2011). By monitoring farmer performance and cost inefficiency, companies can identify potential risks and proactively address them before they escalate into major issues, thereby ensuring efficient risk management (Kayikci et al., 2022; Settembre-Blundo et al., 2021). In summary, the evaluation of farmer performance and cost inefficiency plays a critical role in ensuring profitability, quality, and sustainability within the realm of broiler contract farming.

Research on factors that influence broiler cost have been discussed by Baracho et al. (2019), Pakage et al. (2014), and Emokaro & Emokpaie (2018). Ali et al. (2014), Areerat-Todsadee et al. (2012), Etuah et al. (2020), and Ullah et al. (2019) have studied the determinant of cost efficiency in broiler farming. The effectiveness of broiler farming has been extensively studied around the world using two frontier approaches (parametric stochastic frontier analysis (SFA) as well as non-parametric data envelopment analysis (DEA), each of which has distinct benefits and downsides, but not many discuss specifically cost function. Majid & Hassan (2014) conducted a study on farmer broiler performance using the mortality ratio as one of its indicators. Moreover, Myeki et al. (2022) also stated that the determining factors for the efficiency types were evaluated using the mortality rate. However, their study did not address the aspect of cost efficiency. Additionally, the study did not estimate farmer performance in contract farming in relation to cost inefficiency. Therefore, this paper aims to bridge this research gap by incorporating the mortality ratio as a proxy for farmer performances and its influence on cost function efficiency in broiler farming. The utilization of the chicken mortality ratio as a proxy for assessing farmer performance in broiler farming represents an innovative approach in evaluating the efficiency of the broiler farming cost function. Although the significance of the mortality ratio as an independent variable in broiler farming studies has been acknowledged, its application as a measure of farmer performance is relatively recent. Traditional methods for evaluating farmer performance have typically relied on various metrics, such as the index performance (IP) or the feed conversion ratio (FCR). Through examining the correlation between the mortality ratio and cost function efficiency, this study brings attention to the crucial role of effective management practices in the success of broiler farming partnerships. Furthermore, these findings can provide valuable insights for decision-making within the broiler farming industry.

**METHODS**

**Data**

This research was conducted in 2022, utilizing the purposive method to select the research area, which includes Jember, Banyuwangi, and Lumajang. These regions are significant regions of broiler sectors in Indonesia. Meanwhile, aligning with the research objectives, the purposive method was also employed to select only broiler farmers participating in CF as the sample to examine their performance and its impact on cost inefficiency. The total number of samples collected was 150, distributed as follows: 49 farmers from Jember, 52 from Lumajang, and 49 from Banyuwangi. Primary data were collected through surveys directly from the broiler farmers, ensuring a first-hand source of information.

**Analytical Procedure**

The frontier cost function is used to determine broiler cost function inefficiency. The frontier measure of cost efficiency indicates that efficient firms operate precisely on the cost frontier (Etuah et al., 2020). In this context, performance refers to the minimization of costs involved in producing a particular product, considering the input price vector and other external factors that define the operational environment (Kumbhakar & Lovell, 2000). Consequently, the degree to which a farm or firm deviates from its cost frontier represents its cost inefficiency (Lovell, 2008).

Following Kumbhakar & Lovell (2000), the implicit stochastic cost frontier model can be represented by the following equation:

\[ C = (f(y,w;\beta)\exp(v))\exp(v+u) \]  

(1)

Here, \( C \) denotes the total cost, \( y \) signifies the output level, \( w \) represents the vector input prices, and \( \beta \) is the vector of estimated parameters. So that \( f(y,w;\beta)\exp(v) \) describes the minimum frontier cost, \( v \) denotes the random effect beyond the variable, and \( u \) reflects the level of cost inefficiency.

A functional form is required to distinguish between the two error terms to estimate the model accurately. Various functional forms commonly used include the Cobb-Douglas, constant elasticity of substitution, quadratic, normalized-quadratic, generalized Leontief, and trans-log functions. However, for the purpose of simplicity, this study opts for the Cobb-Douglas (log-linear) functional form instead of more intricate alternatives. This choice offers practical advantages in statistical estimations. Given the available technology, producer-specific cost efficiency (CE) scores can be computed by calculating the ratio of observed cost (C.obs) to...
the matching minimum cost ($C^{\text{min}}$). This calculation can be expressed as (Etuah et al., 2020):

$$CE = \frac{C^{\text{obs}}}{C^{\text{min}}} = \frac{f(y,w;\beta) \exp\{u\}}{f(y,w;\beta) \exp\{-v\}} = \exp\{u\}$$  \hspace{1cm} (2)

CE can range from 0 to 1, with 1 denoting a cost-effective farm. As was before demonstrated, $u$ stands for cost inefficiency.

The stochastic cost frontier model for the broiler farms in the study area can be explicitly defined by utilizing the Cobb-Douglas (log-linear) functional form as follows:

$$C = \beta_0X_1^{\beta_1}X_2^{\beta_2}X_3^{\beta_3}Y^{\beta_4}\exp\{v+u\}$$  \hspace{1cm} (3)

Where $X_{1,3}$ and $Y$, respectively, are labor cost, day old chick cost (DOC), feed cost, and harvest tonnage of chicken. $C$ is the total cost, $\beta_1$ is the constant, $\beta_{1,4}$ are coefficients for each independent variable. The Cobb-Douglas model equation is not yet linear, necessitating a transformation into a linear form to facilitate the calculation process. Additionally, our analysis focuses on the measure of $C$ per 1000 birds, which allows for the identification of inefficiencies and efficiencies within the system.

$$\ln C = \beta_5 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln Y$$  \hspace{1cm} (4)

Along with the fundamental stochastic cost frontier model, there is a need for an inefficiency model that can account for the influence of socioeconomic variables on farmers. The inefficiency model ($U_i$) is formulated as follows:

$$U_i = \delta_0 + \sum_{n=1}^{5} \delta_n Z_{ni}$$

The inefficiency model ($U_i$) is employed to gauge the cost-related inefficiencies of farmer-i, with its unit of measurement expressed in monetary units (IDR). $Z_i$ represents farmers’ age, $Z_2$ represents farmer education, $Z_3$ represents household size, $Z_4$ represents farmer experience, and $Z_5$ represents Mortality Ratio (MR) as the indicator of farmer performance. These explanatory variables, such as age, education, household size, experience, and mortality, are included in the inefficiency model, consistent with previous studies examining efficiency at the farm level, e.g. (Dziwornu & Sarpong, 2014; Etuah et al., 2020; Ezeh et al., 2012; Oji & Chukwuma, 2007; Tuffour & Oppong, 2014; Udho & Etim, 2009). Excluding the mortality ratio, the remaining variables are believed to reduce inefficiency.

Furthermore, we have introduced additional variables for this study to enhance our understanding of farm-level disparities in cost inefficiency. The presence of a mortality ratio is used as a farmer performance indicator based on our preliminary discussion with the broiler contracting firm. Contracting firms can’t control farmers daily, including the input investment such as DOC given to farmers. The mortality ratio becomes an indicator of broiler farmer performance, as stated by Jamhari (2006). Various factors affect the mortality ratio leading to unbalanced information from the farmer and contracting broiler sides. Moreover, this will lead to social trust and distrust in the farmer (Azadi et al., 2019; Mao et al., 2022) and in broiler firms that provide a contract. Table 1 shows a detailed description of the variables included in the analysis.

### RESULTS

The analysis of the primary data collection results (Table 2) reveals that the majority of farmers’ expenses in broiler production are attributed to feed costs, accounting for 53.63% of the total expenditure (calculated using the average costs per annum). The age range of respondents is between 20-70 years, with an average family member of 4 people. Respondents get an education up to high school on average. The average farmer’s experience in broiler farming is 6.58 years, with an average mortality ratio of 4.77%.

Coelli (1996) mentioned that there are three steps in estimating frontier cost function, which starts with ordinary least square estimation (OLS) and continues with maximum likelihood estimation (MLE). Our model

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**Table 1. Description of variables used on cost function efficiency estimation of broiler farming in Jember, Lumajang, and Banyuwangi in 2022**

<table>
<thead>
<tr>
<th>Code</th>
<th>Factors</th>
<th>Description</th>
<th>Units</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Total cost</td>
<td>Total cost of broiler farming process</td>
<td>IDR</td>
<td>Interview</td>
</tr>
<tr>
<td>$X_1$</td>
<td>Labor cost</td>
<td>Total cost on labor used by farmer</td>
<td>IDR</td>
<td>Interview</td>
</tr>
<tr>
<td>$X_2$</td>
<td>Day old chick (DOC) cost</td>
<td>Total cost on DOC purchase by farmer</td>
<td>IDR</td>
<td>Interview</td>
</tr>
<tr>
<td>$X_3$</td>
<td>Feed cost</td>
<td>Total cost on feed provided by farmer</td>
<td>IDR</td>
<td>Interview</td>
</tr>
<tr>
<td>$Y$</td>
<td>Harvest tonnage of chicken</td>
<td>Total harvest of chicken</td>
<td>Kg</td>
<td>Interview</td>
</tr>
<tr>
<td>$Z_1$</td>
<td>Age</td>
<td>Farmers age in the year when the research was conducted</td>
<td>Year</td>
<td>Interview</td>
</tr>
<tr>
<td>$Z_2$</td>
<td>Education</td>
<td>Farmer formal education</td>
<td>Year</td>
<td>Interview</td>
</tr>
<tr>
<td>$Z_3$</td>
<td>Household size</td>
<td>The total number of farmers family members</td>
<td>Person</td>
<td>Interview</td>
</tr>
<tr>
<td>$Z_4$</td>
<td>Experience</td>
<td>Farmers experience in the year when the research was conducted</td>
<td>Year</td>
<td>Interview</td>
</tr>
<tr>
<td>$Z_5$</td>
<td>Mortality Ratio (MR)</td>
<td>The ratio of broiler chicken obtain mortality obtain by subtracting the number of docs coming in and the number of harvested chickens per head, divided by the total doc and multiplied by the percent</td>
<td>%</td>
<td>Interview</td>
</tr>
</tbody>
</table>

Source: own elaboration, 2022
has completed all the classical assumptions to achieve the best linear unbiased estimation (BLUE). The normal P-Plot shows that the data are spread along the line. Based on these results, it can be stated that the data used are usually distributed. Table 3 shows the values of VIF for all independent variables are below 10, and the tolerance value is more than 0.1. This indicates that the model is free from multicollinearity disturbances. The Durbin-Watson is 0.979 (d), producing a value of (4-d) of 3.021. The value is greater than the du value (1.802); this indicates that the model is free from autocorrelation disturbances. The Scatterplot obtained shows that the data do not form a certain pattern meaning the data are free from heteroscedasticity (as seen in Figure 1).

Adj R² value is 0.737, meaning that 73.7% of the diversity of the dependent variable can be explained by the diversity of the independent variables in the model. In contrast, the diversity of the other variables outside the model explains the rest. F value shows a significance of 0.000 (probability value <0.05); this shows that the independent variable jointly influences the dependent variable.

**DISCUSSION**

Table 4 presents the maximum-likelihood estimates, estimated standard errors, and statistical significance thresholds of the stochastic cost frontier. The coefficients of all variables demonstrate the anticipated positive trends, suggesting that higher input costs or output levels correspond to the increased production costs. This observation aligns with previous research (Etuah et al., 2020; Pakage et al., 2014; Subardin et al., 2018). The labor cost, cost of a day-old chick, and feed cost are statistically significant, at least at a 90%-95% confidence level, confirming that the above variables are essential cost elements in broiler production. In the estimated cost function of Cobb-Douglas, the regression coefficient reflects the coefficient of elasticity (Subardin et al., 2018). Hence, the value implies that an increase of 1% relative to output labor cost, then in almost absolute terms, would increase the total cost by 0.0535%, and so does the other variables relations with each of the coefficients.

Table 5 presents farm-specific cost inefficiency scores. The findings reveal that approximately 88% of farmers have an inefficiency score below 32%, indicating that most farms operate near their cost-efficiency frontier. This aligns with the findings of previous studies (Etuah et al., 2020; Hassan, 2021). The overall inefficiency

![Figure 1. The Scatterplot of broiler farming in Jember, Lumajang, and Banyuwangi in 2022](image-url)

Table 2. Descriptive statistic of variables of frontier cost function analysis on broiler farming in Jember, Lumajang, and Banyuwangi in 2022

<table>
<thead>
<tr>
<th>Factors</th>
<th>Units</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost</td>
<td>IDR</td>
<td>150</td>
<td>450,958,168.00</td>
<td>429,296,945.10</td>
</tr>
<tr>
<td>Labor cost</td>
<td>IDR</td>
<td>150</td>
<td>2,242,222.68</td>
<td>2,085,694.99</td>
</tr>
<tr>
<td>Day old chick (DOC) cost</td>
<td>IDR</td>
<td>150</td>
<td>68,037,303.56</td>
<td>60,550,999.93</td>
</tr>
<tr>
<td>Feed cost</td>
<td>IDR</td>
<td>150</td>
<td>241,865,520.60</td>
<td>218,344,468.10</td>
</tr>
<tr>
<td>Harvest tonnage of chicken</td>
<td>Kg</td>
<td>150</td>
<td>63,271.57</td>
<td>562,174.84</td>
</tr>
<tr>
<td>Age</td>
<td>Year</td>
<td>150</td>
<td>42.52</td>
<td>10.92</td>
</tr>
<tr>
<td>Education</td>
<td>Year</td>
<td>150</td>
<td>9.42</td>
<td>4.16</td>
</tr>
<tr>
<td>Household size</td>
<td>Person</td>
<td>150</td>
<td>3.78</td>
<td>1.25</td>
</tr>
<tr>
<td>Experience</td>
<td>Year</td>
<td>150</td>
<td>6.58</td>
<td>5.59</td>
</tr>
<tr>
<td>Mortality ratio (MR)</td>
<td>%</td>
<td>150</td>
<td>4.77</td>
<td>3.52</td>
</tr>
</tbody>
</table>

Source: Own elaboration (calculate using the average over a one-year period).

Table 3. Statistical test on ordinary least square estimation of broiler cost function in Jember, Lumajang, and Banyuwangi in 2022

<table>
<thead>
<tr>
<th>Variables</th>
<th>Collinearity statistics</th>
<th>Durbin Watson</th>
<th>E-Value signification</th>
<th>Adjusted R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tolerance</td>
<td>VIF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor cost</td>
<td>0.751</td>
<td>1.331</td>
<td>0.979</td>
<td>0.000</td>
</tr>
<tr>
<td>Day old chick (DOC) cost</td>
<td>0.408</td>
<td>2.454</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed cost</td>
<td>0.561</td>
<td>1.782</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest tonnage of chicken</td>
<td>0.678</td>
<td>1.455</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: own elaboration.
scores range from 0.056 to over 0.605, with a mean inefficiency score of 0.242. This suggests that, on average, broiler farms are 24.2% cost inefficient, indicating room for improvement in their cost management systems. Notable cost reductions can be achieved by enhancing efficiency without introducing novel production technologies.

Determinants of farm-specific cost inefficiencies can be seen in Table 6. The positive coefficient for age suggests that older farmers tend to exhibit higher levels of cost inefficiency in their farm operations. Meanwhile, negative coefficients are found in education, household size, experience, and mortality ratio. Household sizes have a negative coefficient meaning that the increase in household size will decrease cost inefficiency. As stated in Ali & Flinn (1989) and Ezeh et al. (2012) research, larger households may utilize family labor, which helps reduce labor costs and creates a formidable basis for improved efficiency.

Education and years of experience in broiler production enhance farmers’ understanding of resources and procedures, enabling them to utilize production inputs and achieve cost savings efficiently. This, in turn, enhances their critical thinking abilities. For instance, farmers with such knowledge can determine the optimal brooding temperatures, timing of feedings, lighting conditions, and vaccination schedules for the birds. This finding supports the conclusions reported by Ike & Ugwumba (2011); Udho & Etim (2009) that farmer’s experience and education significantly increases efficiency in poultry production. Moreover, Adeoti (2004) asserts that prolonged engagement in a specific occupation enhances experience and productivity, thereby reducing inefficiency among farmers.

The mortality ratio (MR) value is used to indicate farmer performance in broiler farming. Farmer performance directly influences cost inefficiency in the process of broiler farming. The result is found in the study where MR has negative coefficients, which means the increase in MR will decrease farmer inefficiency. Further, we can state that farmer efficiency is increasing; the result supports the research conducted by Galanopoulos et al. (2006), Nguyen et al. (2018), and Ojo (2003). Decreasing MR can increase broiler yield, directly af-
fecting the cost efficiency as farmers get more income. Myeki et al. (2022) also stated that the determinants for the efficiency types were assessed using variable mortality rate, which found that the variable had a negative association, indicating that more death rates in reared broiler birds tend to lead to technical and economic inefficiencies.

CONCLUSION

The broiler cost function is significantly affected by the cost of labor, day old chicken, feed, and harvest tonnage. At the same time, the inefficiency effect is significantly caused by farmer age, education, household size, experience, and mortality ratio. Therefore, this study makes a valuable contribution to the body of literature by employing the stochastic frontier cost function, which incorporates the effects of cost inefficiency and allows for the estimation of cost inefficiency in small-scale broiler production while recording the mortality ratio as an indicator of farmer performance. The findings of this research have significant implications for ensuring the profitability, quality, and sustainability of broiler businesses. To enhance overall effectiveness and profitability, providing farmers with adequate training and support is crucial, enabling them to improve their education and experience in farm management. Furthermore, reducing the mortality ratio can be achieved through regular monitoring and feedback on farmer performance. These measures are essential for promoting the long-term success and sustainability of broiler farming operations.

CONFLICT OF INTEREST

There is no conflict of interest with any financial, personal, or other relationships with other people or organizations related to the material discussed in the manuscript.

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