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Market risk assessment on poultry industry using Monte Carlo simulation

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Abstract. One of risk in poultry industry is fluctuations in the selling price of live bird. This study aims to (1) calculate the cost of production and cost structure, (2) calculate the profit and loss, (3) measure the market risk of the farms. The study was done on 3000 population broilers farm at some district on East Java province. Value at risk and Monte Carlo simulation methods used to measure business risk. Research result define that the production cost of live bird production from farm is Rp 14338/kg and the selling price is Rp 15476/kg. The highest percentage of cost structure is feed cost. Feed cost reach 74% of total production cost. Simulation results show that broiler farm have a probability of loss risk of 54, 27%, categorize as high risk.

1. Introduction

Indonesian chicken meat consumption reached 1.6 million tons per year in 2015 [1]. Indonesians spent 1, 85 percent of their income on meat and 62% of which is poultry. Indonesians consumption of poultry meat was reach 3650 kg per-capita on 2013[2]. The broilers are grown in company farms owned by the large integrators (10 percent), contract farms (70 percent), and independent farms (20 percent). The average farm size is small, with a capacity for 5000-20000 birds [3]. The broiler farms have various risks. The business risks include social, political, economic, technological and environmental aspects [4]. Risk from the economic aspect is caused by several factors: (1) fluctuation of live bird selling price that is difficult to predict, (2) supply chain actor activity on the downstream sector, and (3) fluctuation of production input price. In a certain period of time there is a quite significant difference between the prices of live bird selling price at farmers with selling price at end consumers. Selling price formed by market price. If the market price is below cost of production then there will be a loss for farmer.

The purpose of this research is to calculate the production cost per kilogram, profit and loss for a 3000 population farm, and estimate the business risk of independent farm. The location of the research is broiler farms located in East Java (Mojokerto, Gresik, Jombang, and Lamongan). Data collection was done by direct observation, deep interview, and collected historical data. Risk assessment done by VaR method. Value at Risk (VaR) simulation is a statistical risk measurement method that estimates the maximum possible loss of a portfolio at a certain level of confidence [5]. VaR is a method of

estimating potential maximum losses in certain periods with certain confidence levels and in a normal market [6].

Currently the Indonesia government has been finalizing the regulation to stabilize the price of live bird and reduce the fluctuations by define a minimum price policy or the lowest selling price policy of live bird. This policy try to prevent farmers from lose. However, broiler is a livestock model. While farmers are prohibited from selling chickens at low prices, the farmer must continue to keep the chickens and need more cost for feed, then farmer losses will be bigger. Measurement of business risks for broiler farm needs to be done to know the amount of risk and estimate the probability of losses.

2. Literature review

Risk is defined as an event that has an unfavorable impact, difficult to accept or even unacceptable [7]. Currently, risk assessment is an important research theme because risk is always present as an important issue for the industry [8]. The role of risk management in financial firms has evolved into the use of complex econometrics and uncertainty models in finance [9]. The interaction between all the interconnected risks in the logistics chain is known as the Supply Chain Risk Management (SCRM) concept. The SCRM definition was first provided by Juttner [10]. SCRM is an effort to identify and manage supply chain risk, through coordination among supply chain members, to reduce overall supply chain vulnerability. Supply chain risk management is defined as a risk mitigation process through collaboration, coordination and implementation of risk management tools among partners, to ensure long-term benefits from supply chain actors.

Recent years, the industry experienced violent incidents, health crises and natural disasters. This incident has a major impact on the industrial economy. Risk management becomes an important topic in the world of logistics chain. The risk is related to uncertainty in the supply chain industry [11]. Then the method of financial risk analysis method developed rapidly. Especially for agribusiness, the risk dependence on natural factors is high due to uncertainty.

The market price is determined by the balance of supply and demand. Therefore, the accuracy of supply and demand data is required to maintain the balance of live bird selling price. The market price of live bird from farmer is determined from the amount of supply and the amount of market demand. Government role is needed on the regulation of the supply and demand of live birds to avoid price fluctuation. Government policies on import permits for chicken breeders should be reviewed to regulate the supply of domestic stock. The number of GGPS (Great Grand Parent Stock) imported determines the amount of DOC production and live bird. The imbalance on supply and demand on broiler meat happens in Indonesia in 2014. Over supply on live bird give impact on live bird selling price. Problem of falling selling price in 2014 occurs because the number of imports of the GGPS is more than it should be. Oversupply live chicken in 2010 is still 31.27% of national consumption, but in 2013 reached 55.08%, then in 2014 reached 65.75% [12].

3. Research method

This study attempts to calculate the cost of production per kg of chicken meat from farmers, determine the level and the probability of loss of farmers. The research object is an independent farmer (has no partnership with feed mill industry) in several districts in East Java. The research methods are:

- Production cost estimation done by deep interview to 20 independent farmers of around 3000 population broiler farm. The interview questions are related to the production cost on growth of 3000 doc (day old chick) to average body weight of 2.05 kg when harvested.
- Profit and loss probability value was done by compare the production cost (from step one) to the adjusted selling price of live bird. The selling price data was obtained from year 2014 to 2015. The probability value is based on selling price real condition and constant production cost.
- Business risk calculation done by Value at Risk method to estimate the probability of loss from simulation on selling price for long periods. It is different from step 2, the probability

value is estimate from a simulation process. Value of market price and production cost on 2014 and 2015 was inputted into the software and simulated by Monte Carlo.

VaR can measure maximum losses that may occur on the desired time period. The advantage of VaR is that this method focuses on the downside risk and independent assumption of the returns distribution. The figures obtained from the measurements represent aggregate or comprehensive accounting results of business risks. Monte Carlo simulation is known as simulation sampling or Monte Carlo Sampling Technique. This simulation uses the existing data sampling (historical data) to identified distribution pattern of data. Simulation of Monte Carlo will generate random numbers based on the distribution of input data and calculate the probability of the event to be known [13]. This method can be divided into several stages: (a) Define probability distributions from past data, (b) Convert the distribution into cumulative frequency, (c) Create a random number or a random number, (d) Conducting simulations with random numbers analyzing the simulation output.

4. Result and Discussion

4.1. Production cost estimation

The structure of production cost consists of (1) investment cost (costs to build farm and purchase of production facilities), (2) direct raw materials cost (cost of purchasing DOC, chicken feed, and vitamins), (3) labor costs (salaries of workers), (4) other fees/overhead cost (cost of purchasing chaff, heating for the cage, electricity, water medicine). The value of each component of broiler farm production cost is given in table 1. Food consumption ratio (FCR) assumed in 1.6.

Table 1. Estimation of production cost in broiler farm

Cost item	Value	Price /unit (Rp)	Total (Rp)
Investment cost (farm and equipment)	370 m^2		85000000
Investment cost per growing period	30 days		4250000
Direct material cost			
DOC	Rp 3000	4500	13500000
Feed *			
— **Pre-Starter (1 - 18 days old)**	Rp 1500/kg	6700	10050000
— **Starter (19 – 25 days old)**	Rp 4500/kg	6600	29700000
— **Finisher (25 – harvest time)**	Rp 3500/kg	6400	22400000
Medicine and vitamin			568763
Total direct material cost			76218763
Total of overhead cost			1452500
Total of labor cost			1850000
Total production cost/growth period			83771263
Chick in population	Chick in		3000
Percentage of Mortality	5 %		150
Population harvest (f - g)			
Average Body Weight	Kg/chick		2,05
Total harvest/growth period (h x i)	kg		5843
Margin of Production cost (e / j)	Rp/kg		14338
Selling price *	Rp/kg		15476
Revenue per period (j x l)	Rp/period		90418530
Profit per period (m - e)	Rp/period		6647267
Profit per kg (n / j)	Rp/kg		1138

Table 1 explains that the estimation of production cost for broiler farm 3000 population is Rp 83771263. The investment cost use assumption of live time 5 year and 4 times period of growth per

year. The farm gain profit per period about 6.6 million in a certain selling price (Rp 15476). Selling price is average of selling price in 2014 and 2015. In fact, the selling price is highly fluctuated per month during 2014 and 2015. In 2014 lowest selling price was Rp 12263, happened on March 2014, while the highest selling price was Rp 17514, happened on August. The gap between the highest and the lowest selling price was Rp 4776. The gap is more than 30 % of the lowest price. Table1 also show the cost structure of production cost on broiler farm. The composition of broiler farm production cost is given in the figure 1.

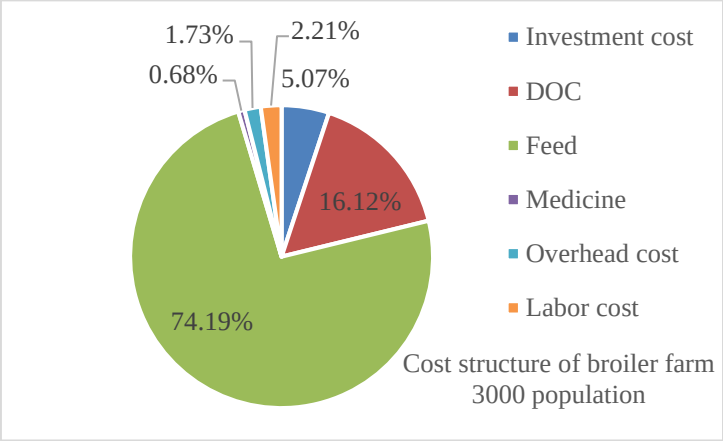

Figure 1. Cost structure of 3000 population broiler farm

Figure 1 shows that the cost of feed has highest percentage of all production cost, it reach 74%, then, followed by doc cost 16% and labor cost 5%. These three components already reach 95% of total production cost on broiler farm 3000 population.

4.2. Profit – Loss Estimation

The risk of broiler farm came from highly fluctuated on live bird selling price. Figure 2 show the fluctuation of selling price on 2014 and 2015 (in Rp per kg). Determine the market risk of farm done by a simple simulation based on historical data and based on simulation by *crystal ball* software (Monte Carlo simulation) which generates random value according to distribution pattern of historical data inputted.

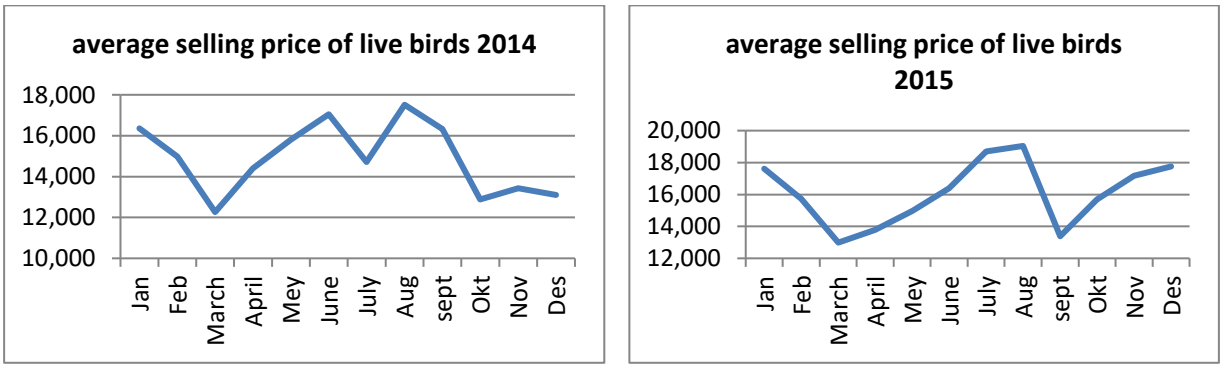

Figure 2. The live bird selling price fluctuation in 2014 and 2015

We make a simulation based on production cost data on table 1, and assumed that all of production component cost are constant, then we adjust the selling price of live bird using the real selling price of live bird on figure 2. After the simulation, some indicator of business risk was

identified and shown on table 2. Table 2 shows that the probability to loss on 2014 is 33% and 25% on 2015. Total losses on 2015 also lower compare to total losses on 2014.

Then, the simulation was continued with Monte Carlo method. Before the simulation, we determine the distribution pattern assumption of input variables. These input variables are data revenue and total production cost per month of 2014 to 2015. Already identified that the distribution of data from revenue and production cost are *uniform* distribution. The result of simulation is given on figure 3. It can be seen that the probability of loses was 54.27%. The value quite difference with the simple simulation result (33% on 2014 and 25% on 2015). The forecast value is given on table 3.

Table 2. Simple simulation based on historical data of selling price

Month	Selling price 2014	Revenue	profit/lose 2014	Selling price 2015	Revenue	profit/lose 2015
Jan	16362	95604668	11833405	17610	102895074	19123811
Feb	14974	87491059	3719796	15724	91872761	8101498
March	12263	71652470	(12118793)	12986	75874553	(7896710)
April	14407	84181196	409933	13794	80600491	(3170772)
May	15813	92395026	8623763	14964	87435562	3664299
June	17039	99560831	15789568	16389	95762694	11991431
July	14712	85962241	2190978	18694	109228867	25457604
August	17514	10233218	18560922	19041	111259078	27487815
Sept	16328	95403497	11632234	13376	78153109	(5618154)
Oct	12874	75222594	(8548669)	15682	91628457	7857194
Nov	13431	78476950	(5294313)	17171	100332191	16560928
Dec	13093	76504560	(7266703)	17759	103766864	19995601
Total loss			(33228478)			(16685636)
Total Profit			72760599			140240181
Average profit/period			6063383			11686681
Probability			0.33			0.25

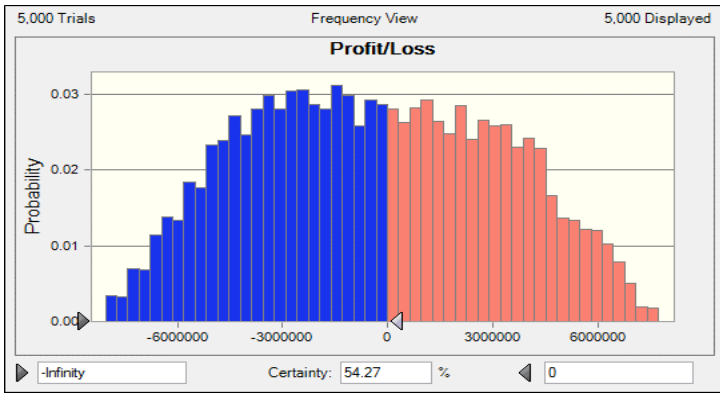

Figure 3. Diagram of lose probability

Table 3. Forecast value

Statistics	Forecast values
Trials	5,000
Mean	-382,98983
Standard	3,565,39050
Variance	12,712,009,450,73
Minimum	-8,061,20532
Maximum	7,726,63771

The simulation result on table 3 shows the minimum range is Rp 8061205 in negative value, it means there will be a possibility of breeder suffering loss at that value. But there is also the possibility of making a profit of Rp 7726637, that is the maximum range. The average amounts of farm will loss of Rp 382989. However, the standard deviation value is quite large because the duplication of data per

generate random (5000 data) is only based on 24 data. Simulation does not guarantee optimal results but can guarantee that the results will be close to optimal.

Poultry agribusiness system is a series of activities that unite natural resources, human resources, financial resources and technology resources to process poultry through a biological and industrial process to become a product that can meet human needs and wants [14]. Agribusiness system can be mapped into several subsystems that are: Upstream off-farm subsystem, cultivation subsystem (On-farm), processing subsystem (downstream off-farm), marketing subsystem (downstream off-farm) and supporting services subsystem (supporting institution). The five sub-systems each consist of several supply chain groups that are interconnected and have a role in the poultry agribusiness system [15]. All of sub-system on poultry agribusiness gives influence to market risk. The systemic and holistic study is needed to form a brief understanding on poultry business supply risk management.

Poultry farm face some risk such as biological risk, safety risk for worker and economic risk. Farm has risk profile on introduction of pathogens, subsequent development of disease, and spread of pathogens to other farms. Farm intensive apply in biosecurity measures appropriate to the level of risk of virus incursion. Many research on that field and became the focus of some organization [15]. Similarly, the study on risk of security and safety also has done a lot [16]. On the other hand, the economic risk for poultry farm received less attention. The risk caused by fluctuation on population which hard to controlled.

In developed countries, price stability is well maintained because the information system and population data collection already good enough. Farms in developed countries are farms with large populations. Developed countries in the world such as Australia, the European Union, Canada and the United States have used Livestock Identification and Traceability System (LITS) as Livestock Management System to monitor the national stock of livestock supply. LITS is a livestock management system that has the basic components of animal identification system and the system tracks the existence or movement of animals along the supply chain to the final destination. All supply chain actors, from government to industry players, must work together in implementing and running the system. The LITS system is managed directly by the government and is run by all stakeholders or actors in the livestock industry chain. The Government has the authority to ensure that all stakeholders can comply, support the implementation of the system and help to run the system [17].

Currently the Indonesian government has been analyzing a regulation to stabilize chicken price with minimum price policy or lowest selling price policy of chicken. This policy is intended to keep farmers from losing. But what should be observed further is the nature of broiler products as a live stock. If the breeder is prohibited from selling at a low price, while the selling price is formed by the market mechanism, the farmer must continue to keep the chicken and need more money to feed. Thus, the losses at the farmer level will be greater. If the broiler should be stored as stock frozen meat, cold storage technology is not owned at the farmer level. The lowest price policy can't protect the people's farms. Need more concrete regulatory efforts such as the study of broiler chains distribution due to the high value-added process, occurred in distribution and trading activities. The length of the distribution chain also formed the price of broiler.

5. Conclusion

The margin of production cost per kg of broiler farm population 3000 in one growth period is Rp14338/kilogram of live bird. The biggest percentage on cost structure is feed cost and day old chick cost. The probability of loses by simple simulation based on historical data of live bird selling price is 33% in 2014 and 25% in 2015, categorize at high risk. While, the probability of losses based on Monte Carlo simulation is 54.27%. The average profit per growth period from simple simulation was Rp 6.06 million and from Monte Carlo was Rp 7726637. Consider the finding of the result, can be conclude that the value from Monte Carlo simulation not yet give a good prediction on indicators of broiler farm risk assessment. Market risk can be reduced by price stability, it need good information system on farm population data collection.

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