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Short-Term Forecasting Model of Animal Food Commodities in Central Sulawesi

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ABSTRACT

Shifting patterns of community consumption from vegetable protein to animal protein encouraged high demand for animal food, so it was needed an estimate of the supply and demand for its products. Therefore, this research aimed to analyze the short-term forecasting model of the production and price of beef and broiler meat in Central Sulawesi. The research used time series data. Production data and price of beef and broiler meat were taken from 2015 - 2019. The analytical tool used was the ARIMA Box-Janskin forecasting method. The results showed a short-term forecasting model for beef production (1,0,0) and broiler meat (3,2,1). Short-term forecasting model for beef price (1,0,1) and broiler meat (1,1,1). This finding could be used as a reference in making policies related to the production and price of beef and broilers meat in order to meet the needs of the community, especially in Central Sulawesi.

Keywords:
Forecasting Model; Production; Price; Animal Food

1. Introduction

The agricultural sector was the primary sector or the mainstay sector in national economic development which was expected to be the main driver of economic development in order to realize national goals in a sustainable manner. The agricultural sector played an important role in the Indonesian economy. Its contribution to the 2015 Gross Domestic Product (GDP) was quite large, which was 12 percent (BPS, 2016). With the value of these contributions, the agriculture sector ranked third after the manufacturing sector and the sector of trade, hotel, and restaurant.

The livestock sub-sector is one of the sub-sectors in the agricultural sector. This sub-sector played an important role in order to the success of food security. In the Indonesian economy, the contribution of the livestock sub-sector in the formation of the GDP of the agricultural sector was more than 11 percent in 2015 and experienced a slight increase in 2016 (Kementerian Pertanian, 2017). Meanwhile, in terms of employment, the contribution of the livestock sub-sector continued to increase, from 6 percent in 2005 to 11 percent in 2012 (Kementerian Pertanian, 2017).

Food is one of the basic human needs. Availability of sufficient food, both its quality and quantity continued to be pursued by the government through a food security program. Shifting patterns of community consumption from vegetable protein to animal protein encouraged high demand for animal foods. Demand for animal foods such as meat, milk, and eggs tended to increase in line with population growth, economic development, changes in life patterns, increased awareness of nutrition, and improvement in community education (PUSDATIN, 2014). The meat was one of the important food sources in meeting the nutritional needs of people in Indonesia. There are two types of meat that are preferred in Indonesia, namely beef and chicken meat.

Central Sulawesi is one of the provinces that has people who consume animal foods including beef, broiler meat, and eggs. Based on 2017 data, it was stated that the production of beef and broiler meat was 4,437,814 kg and 10,777,832 kg per year, respectively. Beef and broiler meat production in Central Sulawesi fluctuated every year, while the price index paid for household consumption increased by 0.41 percent (BPS, 2017). Increasing population, urbanization, income per capita and export opportunities were driving demand for meat and other livestock products in Central Sulawesi. On the other hand, increasing productivity per unit of animal and shifting from subsistence to market-oriented, and then to commercial livestock could increase economic growth and help to improve the situation of food security (BPS, 2017).

Estimates of the supply and demand for livestock products provided a bleak picture namely the demand for beef and broiler meat has exceeded the level of production and the demand-supply gap would widen over time (Sinaga, 2015; Yogi, 2018) so that the demand and supply of beef or broiler meat became a complicated problem. Information about the demand and supply of beef or broiler meat was very important to be formulated its policy so that it could be efficacious for the development of the livestock sector. This research aimed to analyze the short-term forecasting model of production and prices of animal food commodities in Central Sulawesi with the ARIMA Box-Jenkins approach.

2. Materials and Methods

2.1. Research Site and Data

The research was conducted in Central Sulawesi from June to December 2019 by considering data availability in the period. The data collection method used the survey method. The data used were secondary data obtained through journals and relevant literature relevant. Time series data used in the form of production data and prices of beef and broiler for the last 5 years, 2015 - 2019. Time series data obtained from several agencies including the Office of Animal Husbandry and Plantation in Central Sulawesi, Central Sulawesi Food Service, and the Central Statistics Agency of Central Sulawesi.

2.2. Empirical Model

2.2.1. Autoregressive Integrated Moving Average (ARIMA) Method

This research used the ARIMA Box-Jenkins approach, some researchers said this method is very good for forecasting (Bircan and Karagoz, 2003; Nkwatoh, 2012; Rublikova and Lubyova, 2013; Sekreter and Gursoy, 2014; Dritsaki, 2016; Dritsakis and Klazoglou, 2018). ARIMA was developed by Box and Jenkins, so it is also called Box-Jenkins ARIMA. ARIMA method is a combination of refinement, regression, and

decomposition method (Batchelor, 2004, Bokhari and Feridun, 2006; Faisal, 2012). The ARIMA method is a combination of the Autoregressive (AR) and Moving Average (MA) models that formed the ARIMA model (Dickey and Fuller, 1979; Magnus and Fosu, 2011; Adamowski et.al., 2012). According to Dritsaki (2015) and Olajide et.al. (2012), this model assumes that data is generated by a random process with a form that can be explained and does not assume certain patterns in the predicted historical data.

2.2.2. Autoregressive Model

Autoregressive (AR) model forecasting is based on the function of the past observation value in a limited number. In general, the AR model is formulated as follows:

1. Beef Production and Price

For AR model forecasting of beef production is formulated as follows:

$$\mathbf{Y_t = b0 + b1_{Yt-1} + b2_{Yt-2} + ... + bp_{Yt-p} + e_t}$$

Where:

Yt	: stationary beef production
Yt-1, Yt-2, Yt-p	: past value of beef production
b0, b1, bp	: constants and coefficients of the model
et	: forecasting error

For AR model forecasting, the beef price is formulated as follows:

$$\mathbf{Y_t = b0 + b1_{Yt-1} + b2_{Yt-2} + ... + bp_{Yt-p} + e_t}$$

where:

Y_t	: stationary beef price
Y_{t-1}, Y_{t-2}, Y_{t-p}	: past value of beef price
b0, b1, bp	: constants and coefficients of the model
e_t	: forecasting error

2. Broiler Meat Production and Price

For AR model forecasting, broiler meat production is formulated as follows:

$$\mathbf{Y_t = b0 + b1_{Yt-1} + b2_{Yt-2} + ... + bp_{Yt-p} + e_t}$$

where:

Y_t	: stationary broiler meat production
Y_{t-1}, Y_{t-2}, Y_{t-p}	: past value of broiler meat production
b0, b1, bp	: constants and coefficients of the model
e_t	: forecasting error

For AR model forecasting, the broiler meat price is formulated as follows:

$$\mathbf{Y_t = b0 + b1_{Yt-1} + b2_{Yt-2} + ... + bp_{Yt-p} + e_t}$$

where:

Y_t	: stationary broiler meat price
Y_{t-1}, Y_{t-2}, Y_{t-p}	: past value of broiler meat price
b0, b1, bp	: constants and coefficients of the model
e_t	: forecasting error

2.2.3. Moving Average Model

Moving Average (MA) model forecasting based on a linear combination of past error in a limited number. The general form of this model can be written as follows:

1. Beef Production and Price

MA model forecasting of beef production based on a linear combination of past error can be written as follows:

$$\mathbf{Y_t = a0 + e_t - a1_{et-1} - a2_{et-2} - ..... - ap_{et-p}}$$

where:
Y_t : stationary beef production
et-1, et-2, et-p : forecasting errors of past beef production
a_0, a_1, a_p : constants and coefficients of the model
e_t : forecasting error

MA model forecasting of beef price based on a linear combination of past error can be written as follows:

$$\mathbf{Y_t = a0 + e_t - a1_{et-1} - a2_{et-2} - ..... - ap_{et-p}}$$

where:
Y_t : stationary beef price
et-1, et-2, et-p : forecasting error of past beef price
a_0, a_1, a_p : constants and coefficients of the model
e_t : forecasting error

2. Broiler meat Production and Price
MA model forecasting of broiler meat production based on a linear combination of past error can be written as follows:

$$\mathbf{Y_t = a0 + e_t - a1_{et-1} - a2_{et-2} - ..... - ap_{et-p}}$$

where:
Y_t : stationary broiler meat production
et-1, et-2, et-p : forecasting error of past broiler meat production
a_0, a_1, a_p : constants and coefficients of the model
e_t : forecasting error

MA model forecasting of broiler meat price based on a linear combination of past error can be written as follows:

$$\mathbf{Y_t = a0 + e_t - a1_{et-1} - a2_{et-2} - ..... - ap_{et-p}}$$

where:
Y_t : stationary broiler meat price
et-1, et-2, et-p : forecasting error of past broiler meat price
a_0, a_1, a_p : constants and coefficients of the model
e_t : forecasting error

2.2.4. The accuracy of forecasting methods
Forecasting errors made were calculated using Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percent Error (MAPE). The best forecasting method chosen was the one with the smallest MSE value (Butt, 2014; Akdağ, 2016; Malik et al., 2017; Abdulrahman et al., 2018). Furthermore, it was said that the use of MSE as a measure of accuracy because MSE more emphasizes big errors in forecasting rather than small errors. Big errors can indicate outlier.

3. Results and Discussion

3.1. Production and Price Animal Food Commodities

3.1.1. Beef Production and Price

The beef was an animal needs that was highly demanded by the population of Central Sulawesi. Each year the beef cattle population in 2016 and 2017 has increased from 320,537 tails to 353,486 tails with a growth rate of 9.73%. The number of slaughtered

livestock, especially beef from 2016 and 2017 amounted to 35,368 and 30,844 slaughterings. The number of slaughtering decreased by 4,524 but this did not make the cattle population decrease. Beef production in Central Sulawesi from 2015 to 2017 amounted to 4,884,186 kg, 5,207,468 kg and 4,541,634 kg, beef production has fluctuated during the last 3 years due to the reduction in slaughtering for productive cattle, which indeed already has laws and regulations concerning cattle that are ready to be purchased for consumption.

The availability and price of food were often volatile due to various factors, both natural phenomena (climate), market failures, as well as problems with the smooth distribution. Beef price were determined by several components of its formation, namely beef price at the producer level, stock volume, demand volume, imported beef price, and distribution costs. Beef price in the analysis period fluctuated from 2014 to 2018. The beef was animal need with the highest price in Central Sulawesi. Beef prices range in the last 4 years ranging from IDR 88,000 to IDR 110,000.

3.1.2. Broiler Meat Production and Price

The number of slaughtered broiler meat in Central Sulawesi from 2016 to 2017 was 9,469,567 and 11,527,094, respectively. The amount of slaughtering affected the population and production of broilers meat themselves. Central Statistics Agency shows that in 2016 to 2017 the number of broiler populations was 11,770,748 which has increased from 2016 (9,609,730). Not only slaughtering and population has increased, but broiler meat production has also increased where production from 2015 to 2017 respectively amounted to 7,612,993 kg, 8,854,044 kg, and 10,777,832 kg. Price is one of the elements of the marketing mix that generates revenue, costs, and provides income for the company. The price of broiler meat in Central Sulawesi was affected by major days where price increases occurred during the feast of Eid, Eid al-Adha, Christmas, and the end of the year. The increase that occurred was not so significant from month to month. Broiler meat prices from 2014 to 2018 only ranged from IDR 25,000 to IDR 31,000 per month. Broiler meat was an animal need that could still be reached by the middle class down because the price was not so expensive to consume.

3.2. ARIMA Model Animal Food Commodities

Based on the AR and MA hypothesis tests, the parameters of the ARIMA model (1,0,0) for beef production are significant, because the model has parameters with P-value < α. This means that the ARIMA model (1,0,0) was the best model for beef production forecasting. By simulating and testing of several models such as (1,1,1), (1,0,1), (1,1,0), (1,0,0), and several other models, the best model of beef prices was obtained that was (1,0,1) with the smallest MS value of 4.18 and the P-value < α. Based on the AR and MA hypothesis tests, the parameters of the ARIMA model (3,2,1) for broiler meat production are significant, because the model has parameters with P-values < α. This means that the ARIMA model (3,2,1) was the best model for broiler meat production forecasting. By simulating and testing several models such as (1,1,1), (1,0,1), (1,1,0), and several other models, the best model of broiler meat prices was obtained (1,1,1) with the smallest MS value and p-value < α.

3.3. Short-Term Model Forecasting of Animal Commodities Markets

The results of beef production forecasting by using the Minitab program shown in Figure 1.

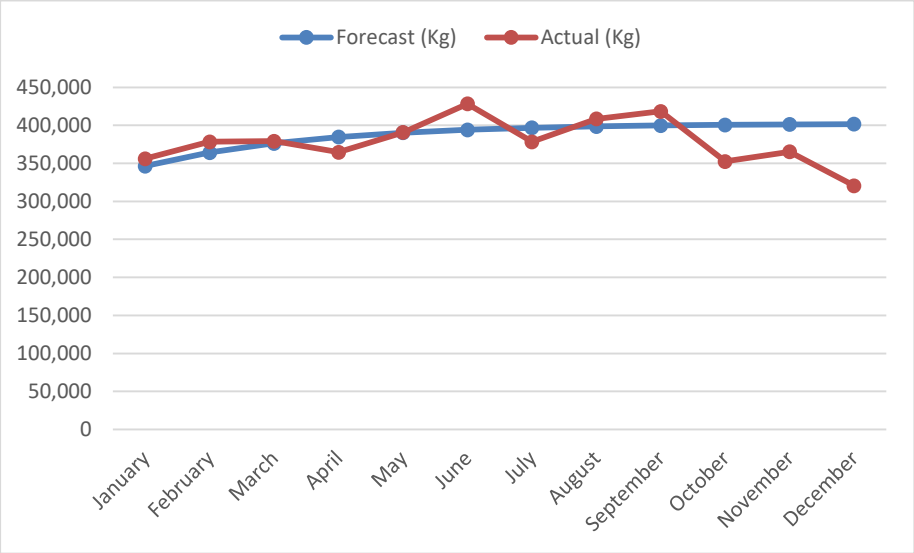

Figure 1. Results of beef production forecasting in 2020

Forecasting of beef production in 2020 increased, but not significant from month to month. This happened because of the prohibition of slaughtering productive cattle. This was also supported by the Central Sulawesi regional government program, which is a population of one million tail of cattle in 2021. Banggai Regency is the largest beef cattle producing region in Central Sulawesi. The beef cattle population in 2018 would be around 400,000 tails. Not only that, after the earthquake and tsunami that occurred in Central Sulawesi, especially in Palu City there were many of their livestock experienced stress, which caused them to become thin. The value of stable production had to be achieved by the government with a variety of economic policies and increased food production especially animal foods. This could be done by providing cattle support and capital to farmers. The results of forecasting beef price shown in Figure 2.

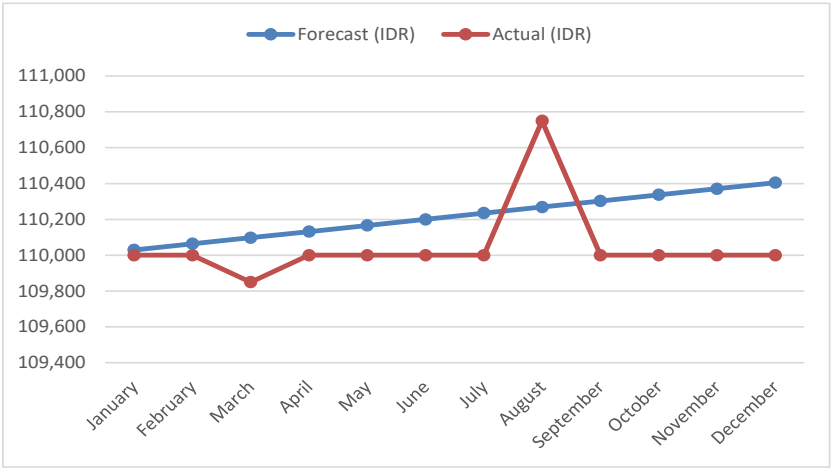

Figure 2. Results of beef price forecasting in 2020

Forecasting of beef prices in 2020 has seen an increase but was not significant. When compared with 2019 beef prices tended to be stable. Prices would increase if the demand for beef increases, this would be higher on religious days. The results of forecasting broiler meat production shown in Figure 3.

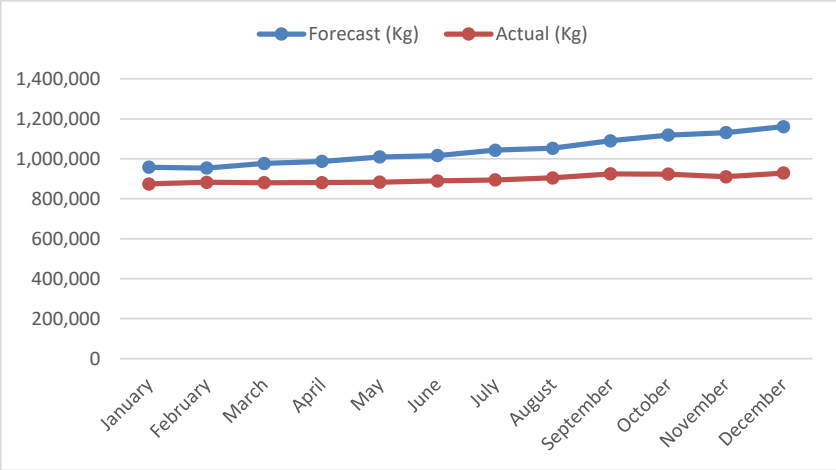

Figure 3. Results of broiler meat production forecasting in 2020

Results of broiler meat production forecasting in Central Sulawesi continued to increase. Unlike beef production, broiler meat production has fluctuated forecasting rate, where the highest forecasting rate occurred in June, September, and December 2020 of 2.63%; 3.584%; and 2.650%, respectively. This was because the demand for broiler meat increased ahead of religious days. In particular, Palu City for the needs of broiler meat has not been able to be maximally fulfilled by breeders in Palu City due to the large number of chicken coops that were destroyed by the earthquake disaster that occurred in 2018, while to rebuild the chicken farm business required a large capital. In the meantime, the need for broiler meat in Palu City still came from outside the region, namely South Sulawesi and West Sulawesi, which caused an increase in broiler meat price due to increased transportation costs and the risk of broiler dying from stress on the journey. To increase broiler meat production, the government could help breeders through the help of broiler seeds and capital. The results of forecasting broiler meat price shown in Figure 4

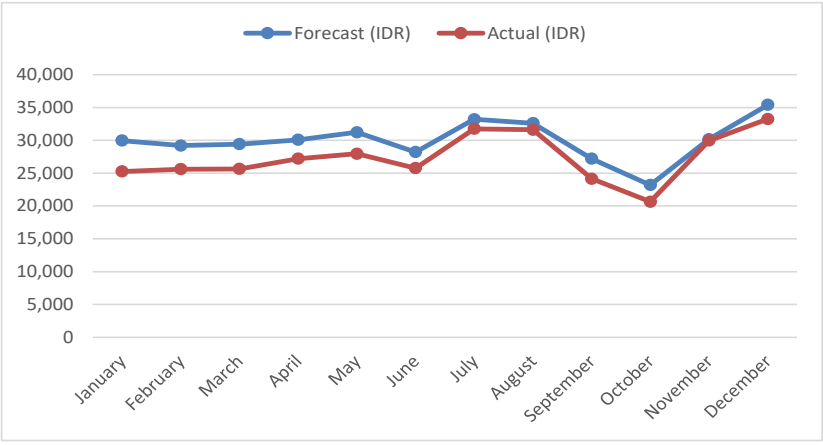

Figure 4. Results of broiler meat price forecasting in 2020

The results of broiler meat price forecasting in Central Sulawesi were fluctuating. The highest price increases occurred in July and December 2020 by 17.71% and 17.34%. This is in line with the broiler meat production forecasting in Central Sulawesi where production increased on religious days followed by an increase in selling prices of broiler meat itself.

4. Conclusion

Short-term forecasting model of animal commodity markets in Central Sulawesi for beef production (1,0.0) and broiler meat production (3,2,1) with a MAPE value of less than 20% and had the smallest MSE value. Short-term forecasting model of animal commodity markets for beef price (1,0.1) and broiler meat (1,1,1) with a MAPE value of less than 20% and had the smallest MSE value. The forecasting results of beef production and price had an upward trend in accordance with population growth. Beef price had a stable trend except on religious days. Broiler meat production and price tended to increase, this was due to increased demand. This finding could be used as a reference in making decisions, especially in making policy related to the production of beef and broiler meat in order to meet the needs of the community, especially in Central Sulawesi, thus prices could also be controlled.

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