Interpolation of beef price in Malang City during Eid Al-Adha 2017

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Abstract. The large demand for cows during Eid Al-Adha was likely to affect the beef prices. The current research aimed to create an interpolation of beef prices in Eid Al-Adha so that the researchers could predict the range of beef prices in Malang city (Malang and Batu cities as well as Malang districts), East Java, Indonesia. The results of this study suggested that the range of beef prices in Malang city was relatively stable between IDR 105,000 and IDR 115,000. The results also showed that the government had successfully maintained the price. However, the government needed to pay more attention to Batu city since it was found that the price in that area was higher than any other areas in Malang.

1. Introduction

Besides goats, cows are one of the most influential ruminants in Indonesia since Indonesian people love consuming the meat. Generally speaking, most of Indonesian food contains beef such as rendang, bakso, steaks, abon and many more. Rendang, Minangkabau food-West Sumatra, is a popular food in the world [1]. While bakso (Indonesian meatballs) can be easily got everywhere and it is also made from beef with no fat [2]. Interestingly, both are listed in 40 favorite foods of Indonesia and rendang was the most delicious food in the world [3]. That is why the demand for beef in Indonesia is high.

To meet the need of beef, which is very high, the beef production must be high as well. The data from BPS showed that the Indonesian beef production was 497,669 tons in 2014 and was 524,109 tons in 2016. See Figure 1 [4].
In 2017, Indonesia had run a deficit in beef production. Based on BPS data, the prognosis of beef production was 354,770 Tons, while the need for beef was 604,968 Tons. Therefore, importing beef or even cows was the only solution to meet the other 30% - 40% of the need [5].

In Indonesia, the demand for beef will extremely increase in Ramadhan to Eid Al-Fitr and Eid Al-Adha since most Indonesians are Muslim. The prognosis of beef production in Ramadhan to Eid Al-Fitr in 2017 was 62,400 Tons while the need was 106,407 Tons. To meet the need, the governments decided to import beef, feedlot cows, substitute beef with imported buffalo meat in BULOG [6]. That caused the increased beef price during those days. In some areas in Jakarta the price reached Rp. 130,000. However, the average beef price in East Java in Eid Al-Fitr July 2017 was just about Rp. 107,348. If compared to that of East java in June 2017 which was Rp. 105,768, it can be said that the increase was not that big or stable.

Another event causing the increase of beef price was Eid Al-Adha, it is an event when Muslim people sacrifice their livestock animals, in Indonesia they could be cows or goats, which is then shared to those in need. Furthermore, it is an important annual event in Islam [7]. One of the verses conveying the message is in the letter of Al-Kautsar verse 2.

“So pray to your Lord and sacrifice [to Him alone]”

The large demand of cows during Eid Al-Adha possibly causes the change of beef price. Thus, the current research aimed to create an interpolation of beef price in Eid Al-Adha so that we could predict the range of beef prices in Malang city (Malang and Batu cities as well as Malang districts), East Java, Indonesia.

2. Materials and methods
This research used secondary data, which were beef prices from Malang markets obtained from a survey by Department of Industry and Commerce of East Java. Besides prices from Malang markets, prices from some other markets near Malang were also used in order to get better results in the interpolation process. Table 1 shows the list of markets whose prices were used in the research.
Table 1. List of the Markets

| Area                | Market                        |
|---------------------|-------------------------------|
| Batu City           | Batu City Main Market         |
| Batu City           | Gentengan Market              |
| Batu City           | Selecta Market                |
| Malang City         | Blimbing Market               |
| Malang City         | Tawangmangu Market            |
| Malang City         | Oro-Oro Dowo Market           |
| Malang City         | Klojen Market                 |
| Malang City         | Madyopuro Market              |
| Malang Regency      | Lawang Market                 |
| Malang Regency      | Singosari Market              |
| Malang Regency      | Karangploso Market            |
| Malang Regency      | Kepanjen Market               |
| Malang Regency      | Turen Market                  |
| Blitar Regency      | Wlingi Market                 |
| Pasuruan Regency    | Sukorejo Market               |
| Kediri Regency      | Pamenang Market               |
| Lumajang Regency    | Pasirian Market               |
| Mojokerto Regency   | Mojosari Market               |
| Jombang Regency     | Ploso Market                  |

The data of beef prices that were finally used were the results of a survey conducted on September 1, 2017 which was Eid Al-Adha. Before analyzing the interpolation, the coordinates of the markets had to be found first.

Again, the researchers had just obtained the data from a few markets. That is why an interpolation was important to predict the beef prices for the areas which we had taken the samples from. Surface interpolation technique in geographic information system (GIS) is a powerful tool to predict the surface value [8]. This very technique was the one used to predict the beef prices in other locations we did not know. In fact, there are various methods of interpolation, such as; Distance Weighting, Global Polynomial Interpolation, Radial Basis Functions, Local Polynomial Interpolation, kriging interpolation and empirical bayesian kriging [9]. Kriging method is of some types, that is, simple kriging, ordinary kriging and universal kriging. There are some semivariogram which can be used in all types of kriging method. They are circular, spherical, tetraspherical, pentaspherical, gaussian, rational quadratic, hole effect, k-bessel, j-bessel and stable.

All researches using interpolation must have a different method that fits most with the research condition(s). A previous study, for example, compared the accuracy of kriging to that of IDW to predict the value of groundwater arsenic concentrations in Texas. The results showed that IDW outperformed kriging [10]. Another comparative study also involved IDW and kriging but another method was involved, which was Multiquadric. It was about noise mapping in Isparta, Turkey. The results suggested that Kriging was the best method [11]. The other research used a lot more methods which were inverse distance weighting (IDW), local polynomial interpolation (LPI), radial basis function (RBF), ordinary kriging (OK) and Empirical Bayes kriging (EBK) to figure out the spatial distribution of soil organic carbon (SOC). It turned out then that the best method was Kriging by using RMSE as the comparison value [12]. In order to get the best interpolation method for the current research, the researchers used RMSE value. The one that was of the greatest RMSE value meant that it had the best prediction value compared to the other methods.

RMSE formula is as follows:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(x_i-y_i)^2}{n}}$$

(1)

X represents the observed value in i location, y represents prediction value of i location and n represents the number of locations being observed.
3. Results and discussions

Below are the results of obtaining the data from the Department of Industry and Commerce on September 1, 2017 and the coordinates of the market locations:

Table 2. Beef prices in Malang Raya on September 1, 2017.

| Coordinate | Area               | Market                  | Beef Price / Kg |
|------------|--------------------|-------------------------|-----------------|
| X          | Y                  |                         | 1-Sep-17        |
| 112.5325   | -7.88236           | Batu City               | IDR 115,000.00  |
| 112.5223   | -7.86902           | Batu City Main Market   | IDR 115,000.00  |
| 112.5263   | -7.82044           | Batu City               | IDR 115,000.00  |
| 112.6372   | -7.94007           | Malang City             | IDR 110,000.00  |
| 112.6289   | -7.95985           | Malang City             | IDR 110,000.00  |
| 112.6227   | -7.9631            | Malang City             | IDR 110,000.00  |
| 112.6347   | -7.97286           | Malang City             | IDR 115,000.00  |
| 112.669    | -7.97412           | Malang City             | IDR 110,000.00  |
| 112.6951   | -7.83004           | Malang Regency          | IDR 107,000.00  |
| 112.6645   | -7.89418           | Malang Regency          | IDR 110,000.00  |
| 112.5937   | -7.8934            | Malang Regency          | IDR 106,000.00  |
| 112.5708   | -8.12886           | Malang Regency          | IDR 108,000.00  |
| 112.6898   | -8.16584           | Malang Regency          | IDR 108,000.00  |
| 112.3253   | -8.0758            | Bitar Regency           | IDR 115,000.00  |
| 112.7208   | -7.71718           | Pasuruan Regency        | IDR 100,000.00  |
| 112.19     | -7.76471           | Kediri Regency          | IDR 95,000.00   |
| 113.1133   | -8.2125            | Lumajang Regency        | IDR 105,000.00  |
| 112.557    | -7.51536           | Mojokerto Regency       | IDR 100,000.00  |
| 112.2258   | -7.45167           | Jombang Regency         | IDR 98,000.00   |


The cheapest beef in Malang on September 1, 2017 was IDR 106,000 and it was in Karangploso market while the most expensive one was IDR 115,000 and it was from markets in Batu areas. Some markets near Malang were selling beef below IDR 100,000. They were Jombang market (IDR 95,000) and Ploso market (IDR 98,000). Based on those data, the average price of beef in Malang city was IDR 110,692. This price was not significantly different (the difference was just IDR 599) from that of in Eid Al-Fitr (July 25, 2017) which was IDR 110,133.

The results of analyzing the best method to figure out the spatial distribution of beef in Malang city using RMSE can be seen in Table 3.

Table 3. RMSE result.

| Methods                              | RMSE     |
|--------------------------------------|----------|
| Inverse Distance Weighting           | 5369.679 |
| Global Polynomial Interpolation      | 6548.449 |
| Radial Basis Functions               | 4660.953 |
| Local Polynomial Interpolation       | 5504.958 |
| **Ordinary Kriging**                 |          |
| - Semivariogram Circular             | 4701.221 |
| - Semivariogram Spherical            | 4677.612 |
| - Semivariogram Tetraspherical       | 4645.248 |
| - Semivariogram Pentaspherical       | 4619.12  |
| - Semivariogram Gaussian             | 4893.398 |
| - Semivariogram Rational Quadratic   | 4539.018 |
| - Semivariogram Hole Effect          | 5389.598 |
| - Semivariogram K-Bessel             | 4918.642 |
| - Semivariogram J-Bessel             | 5486.04  |
| - Semivariogram Stable               | 4917.964 |
| **Empirical Bayesian Kriging**       |          |
| - Semivariogram Linier               | 4647.535 |
| - Semivariogram Power                | 4585.678 |
| - Semivariogram Thin Plate Spline    | 5915.902 |
The best interpolation method to predict beef prices in Malang in Eid Al-Adha was Ordinary Kriging with Semivariogram Rational Quadratic. RMSE resulted by using the method was 4539.018.

In this method, the semivariogram rational quadratic resulted nugget value as much as 4164260 with the range of 0.7932133 and the partial sill was 50266767.101. in this case isotropy with sector type 8 sectors was used. The results of ordinary Kriging interpolation can be seen in Figure 2.

In figure 2, it can be seen that beef price in Malang city during Eid Al-Adha was between IDR 105,000 and IDR 115,000. Batu city was the area with the highest beef price that reached IDR 115,000. If compared to that of Eid Al-Fitr, it can be said the beef price in this Eid Al-Adha 2017 was not significantly changed and remained stable.

4. Conclusion
The range of beef price in Malang during Eid Al-Adha was relatively stable between IDR 105,000 and IDR 115,000. The results also showed that the government had successfully maintained the price. However, the government needed to pay more attention to Batu city since it was found that the price in that area was higher than any other areas in Malang.

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