Research Article

Determination of the causal relationship between beef prices and the consumer price index in Turkey*

Ahmet Cumhur AKIN[1],**, **Mustafa Bahadır ÇEVRİMLİ**[2], **Mehmet Saltuk ARIKAN**[3], **Mustafa Agah TEKİNDAL**[4]

[1]Department of Animal Health Economics and Management, Faculty of Veterinary Medicine,
Mehmet Akif Ersoy University, Burdur, Turkey
[2]Department of Livestock Economics and Management, Faculty of Veterinary Medicine, Selçuk University, Konya, Turkey
[3]Department of Animal Health Economics and Management, Faculty of Veterinary Medicine, Fırat University, Elazığ, Turkey
[4]Department of Biostatistic, Faculty of Veterinary Medicine, Selçuk University, Konya, Turkey

Abstract: The rising prices of beef meat have recently restricted its accessibility for consumers who need to consume it for a balanced and healthy diet. Speculations have been made about the increase in beef meat prices being one of the major factors underlying the increase in the consumer price index (CPI). In this scope, the causal relationship between the monthly average prices of beef and the rate of year-on-year change in the CPI for the period between January 2005 and February 2018 was analyzed in the study. Since time series data were used, the augmented Dickey–Fuller and Phillips–Perron tests were conducted to find out whether the series were stationary. Nonstationary series were made stationary by taking their difference. After conducting unit root test on the series, a vector auto regression model was developed, and the causality between the variables was tested by the Granger Causality Analysis. The results of the Granger Causality Analysis indicate that the monthly average price of beef and the rate of year-on-year change in the CPI are causally related at a level of 5% and 10%. In conclusion, the monthly data of the CPI and the beef prices between January 2005 and February 2018 are causally related at a significance level of 1%.

Key words: Beef prices, causality, consumer price index, granger analysis, vector auto regression analysis

1. Introduction
Sufficient consumption of main foods in a healthy and timely manner is of great importance for the physical and mental development of human beings. Developed countries are able to sell food products to their consumers at affordable prices, complying with the quality and hygiene standards, thanks to their well-established food markets.

Any increase in food prices adversely affects the regular consumption of foods by low-income consumers [1,2], leading to changes in the dietary preferences of the society [3,4]. It is reported that exogenous food price shocks in developing countries significantly contribute to the inflation process, and that food products constitute a larger portion of the products in the Consumer Price Index (CPI) in such countries [5]. Food prices pose a serious risk for inflation, which is also stated in the inflation report prepared by the Central Bank of the Republic of Turkey

[6]. Additionally, numerous studies conducted in Turkey emphasize that food prices lead to considerably increased inflation [2,6,7]. Although food prices that create inflationary pressures seem to be in favor of producers in the short term, they affect the whole society in the medium and long term [2].

Food products are considered to be a major source of the recent inflation spikes. Among the food products, beef meat is held responsible for the inflation due to its high price [8]. The increasing demand for beef meat and the global pressures on climate change have pushed up wholesale and retail prices of meat products across the world [9]. In Turkey input costs have increased steadily [10] and import policies applied to meet the demand for beef meat failed to prevent price increases, but caused the price increases to accelerate due to the decrease in production in the long term [11]. It is highlighted that the price spikes are a dominant factor that affects the consumer price index and

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* This manuscript was presented as oral presentation in the 1st International Health Science and Life Congress (IHSLC 2018), 02-05 May 2018, Burdur.

** Correspondence: acumhurakin@mehmetakif.edu.tr

makes it harder to predict [2]. On the other hand, the lack of policy measures to overcome the effects of the economic crises over the years has caused beef meat production to decrease [12]. While retail beef prices rose by 130% between 2005 and 2013, retail mutton prices increased by 154% and the forage prices by 115%. The increases in the prices of beef meat were higher than the increases in the CPI, which was 118% in the same period [13].

Considering that the phenomenon of inflation is a common problem of current economies, it is of great importance to determine the direction and extent of the relationship between inflation and relative price volatility [14]. Defining the relationship between beef meat prices and inflation will allow better assessment of the increases in inflation. According to the theory of causality, in explaining the causal relationship between two variables, we check whether the lagged values of one of the variables contribute to the explanation of the current value of the other variable [15]. In this context, the Granger causality analysis is a method of analysis that is widely used in studies on stockbreeding [16,17].

The purpose of this study is to test the causal relationship between the monthly average prices of beef and the rate of year-on-year change in the CPI for the period between January 2005 and February 2018 using the Granger causality analysis, thereby presenting the causation between the consumer prices of beef and the CPI.

2. Materials and methods

2.1. Dataset
In order to test the causality between the prices of beef and the CPI, the monthly average prices of beef and the rate of year-on-year change in the CPI for the period between January 2005 and February 2018 were used as the dataset for the study [18]. The datasets of the average prices of beef used in the analyses were obtained from the weekly bulletin of the Meat and Milk Board (MMB) [19].

2.2. Analysis method
The causal relationship between the monthly average retail price of beef and the rate of year-on-year change in the CPI for the period between January 2005 and February 2018 was analyzed in the study. Since time series data were used, the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests were conducted to find out whether the series were stationary. Nonstationary series were made stationary by taking their difference. After conducting unit root test on the series, a vector auto regression model was developed, and the causality between the variables was tested by the Granger causality analysis. All tests were conducted on using the econometric analysis software program Eviews 6 [20].

In stationary series, the data fluctuate around a constant mean. Hence, in order to tell whether a series is stationary, it is necessary to display the graph of the series that shows its change over time [21].

Before starting the Granger causality analysis, the lag values of the variables should be determined, and the structure of the dataset should be examined to determine its lag value. If the variables have annual data, the lag value is equal to 1. If the data are semiannual, quarterly, or monthly, the lag value to be used is 2, 4, or 12, respectively. The Granger causality analysis is used to test the presence and direction of a causal relationship between two variables [21].

In the present study, the models used in the causality analysis are as follows:

$$Beef\ldots_t = Y_0 = \sum_{i=1}^{m} y_i Beef\ldots_{t-1} + \sum_{i=1}^{m} \theta_i CPI_{t-1} + \vartheta_t$$

(1)

$$CPI_t = \varphi_0 = \sum_{i=1}^{m} \varphi_i CPI_{t-1} + \sum_{i=1}^{m} \theta_i Beef\ldots_{t-1} + \varepsilon_t$$

(2)

The null hypothesis is $\sum_{i=1}^{m} \beta_i = 0$, meaning that CPI_{t-i} CPI_{t-m} lagged variables are not involved in the relationship, and that there is no causal relationship in the direction from the CPI between January 2005 and February 2018 to the beef prices between January 2005 and February 2018. The alternative hypothesis is $\sum_{i=1}^{m} b_i \neq 0$, meaning that a causality in the direction from the CPI to the beef prices between January 2005 and February 2018 exists [22].

3. Results
Figure 1A illustrates the change in the beef prices between January 2005 and February 2018. It is clear that the variables do not follow a stationary course during the periods under consideration. By applying the ADF test (Figure 1B), the time series of the beef prices between January 2005 and February 2018 was made stationary.

The first difference of the data was taken to make the time series of the beef prices between January 2005 and February 2018 in Figure 1B stationary. The series became stationary after its first difference was taken.

Figure 2A illustrates the change in the CPI between January 2005 and February 2018. It is clear that the series does not follow a stationary course during the periods under consideration. By applying the unit root test (Figure 2B), the time series of the CPI between January 2005 and February 2018 was made stationary.

The first difference of the data was taken to make the time series of the CPI between January 2005 and February 2018 in Figure 2B stationary. The series became stationary after taking its first difference.
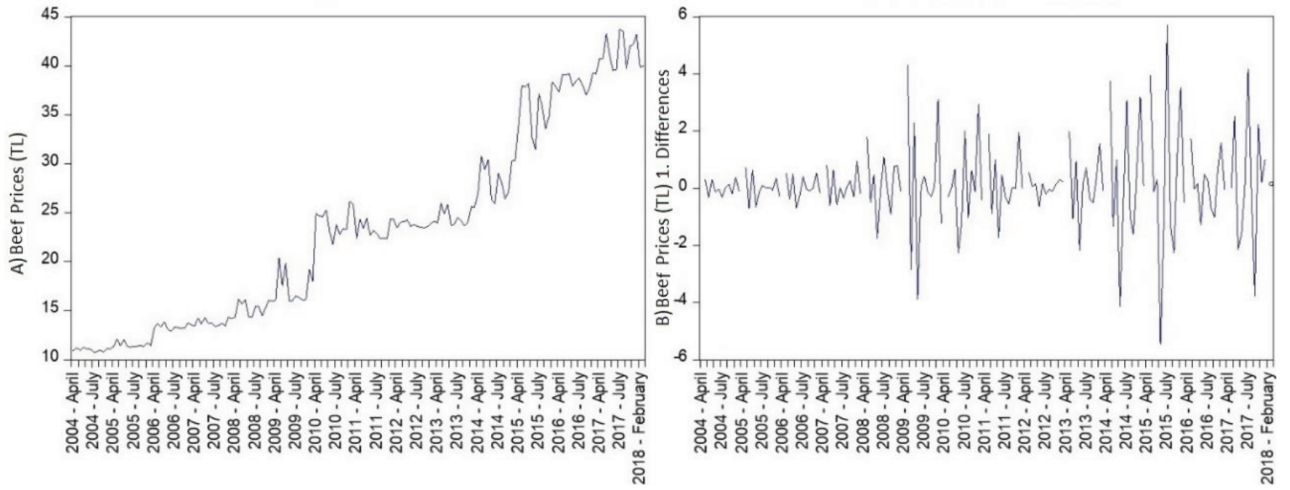
Figure 1. Checking the stationarity of the beef prices (A) between January 2005 and February 2018 (monthly closing prices) using the ADF test (B).
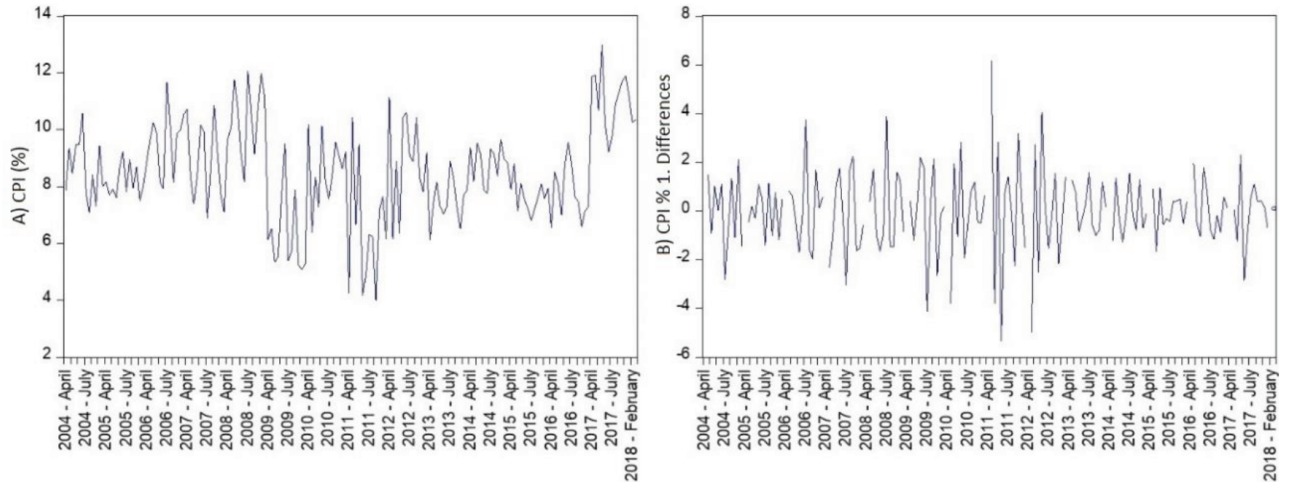

Figure 2. Checking the stationarity of the CPI (A) between January 2005 and February 2018 using the ADF test (B).

Results of the ADF and PP unit root tests indicate that the time series data of the CPI between January 2005 and February 2018 became stationary after taking its first difference. Results of the unit root tests for the beef prices between January 2005 and February 2018 are given in Table 1.

ADF and PP test values of the time series data of the beef prices between January 2005 and February 2018 after taking its first difference are significant at a significance level of 1%, 5%, and 10%, respectively. The values in the parentheses are the optimal lag lengths.

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Results of the causality analysis conducted on the data whose stationarity was confirmed using the unit root test are given in Table 2.

Considering the presence and direction of the causal relationship between MMB's beef prices between January 2005 and February 2018 and the beef prices between January 2005 and February 2018 that are analyzed according to the Turkish Statistical Institute's CPI data and the CPI values between January 2005 and February 2018, we can reach the following conclusion.

The results of the Granger causality analysis indicate that the monthly average price of beef and the rate of year-

Table 1. Unit root tests for the beef prices and CPI between January 2005 and February 2018.

Variable	Level value	First difference	Level value	First difference
	ADF		PP	
Beef Prices	−8.346559 (12)	−3.471192 (12)	−10.60378 (12)	7.712876 (12)
CPI	−0.280632 (12)	−4.539879 (12)	−3.511212 (12)	−10.60378 (12)

Table 2. Results of the Granger causality test.

Null hypothesis	No. of observations	F statistics	Probability value
Beef meat is not reason for the CPI	157	3.092227	0.024
CPI is not reason for the beef meat	157	4.946716	0.00392

on-year change in the CPI are causally related at a level of 5% and 10%. The CPI and the beef prices are causally related at a significance level of 1%.

4. Discussion

A study maintaining that food inflation is affected by both supply- and demand-side factors reports that there is a positive long-term relationship between food inflation and the variables such as inflation expectation, GDP per capita, support prices, food import and food export [23]. Another study reports that the agricultural inflation is significantly reflected in the food inflation and aggregate CPI inflation, confirming the presence of the positive relationship [24]. It is underlined that the major factor that has recently restricted the rate of decrease in inflation in Turkey is the high food prices, and that a significant upward trend is observed in the food prices due to both negative supply shocks and the effects of the exchange rate [7]. It is noted that the effect of inflation on the prices of agricultural products is positive in developed countries and negative in developing countries as in Turkey [25]. Another study conducted in Turkey reports that there is a long-term relationship between agricultural and food uncertainty and inflation, and that the uncertainties in agricultural product and food prices have a positive effect on inflation [6]. In a study analyzing the effect of inflation rate on the prices of agricultural products, this effect was analyzed for developing countries using the data for the period 1980–2007 and the panel smooth transition regression method, and the results indicated that the effect of inflation on the prices of agricultural products was positive during periods of low inflation and negative during periods of high inflation [25]. In Turkey, the contribution of food inflation to overall inflation is high and has been around 3–4 points since 2013. It is reported that 3.11 points, that is, 40% of the overall inflation, which was 8.17% in 2014, arose out of food inflation [26]. Another study highlights that a 1% increase in food consumer price index results in a 0.79% increase in inflation [2].

Generally speaking, the above-mentioned studies focusing on the relationship between food prices and inflation underline the effect of food prices on inflation. However, they address the effect of food prices on inflation rather than their mutual interaction as we do in our study. One of the major aspects of this study is that it identifies the level of effect that both factors have on each other and determines the direction of the effects. As a result of the statistical analysis, a causal relationship was found between 5% and 10% of the beef price to the CPI and 1% of the CPI to beef price.

A study conducted in Turkey found that both the producer prices of beef and feed prices had increased by 17 times. It reported that based on the inflation-adjusted current prices both feed and beef prices had decreased by 20% and 21% in the period between 1998 and 2017, respectively [27]. As is evident from this study, the fact that prices actually decreased when they were adjusted for inflation although the current prices were high supports the view that the most dominant factor underlying the increase in the beef price is inflation.

The production of main products, and particularly foods of animal origin, by intensive production methods rather than through use of natural resources leads to increases in production costs in Turkey. The recent upward trend in the costs stem from the high dependency of production on import substitute products, the increases in the price of energy and fuels, and the high cost of feed, a major input in the stockbreeding sector, in the intensive production model.

However, the beef meat sector faces a great risk as the government has failed to take measures in favor of the producers, particularly aimed at reducing the costs in the

production of beef meat, and the increase in imports does not allow production planning in the sector and a sustainable production by local producers. The decreasing total production of beef meat in Turkey for the last 3 years indicates the extent of this risk.

Recently, speculations have been made about the increase in beef meat prices being one of the major factors underlying the increase in the CPI in Turkey. The results of this study, conducted to validate this view and present the causality between the change in the CPI and the beef meat prices, suggest that the effect of the CPI on the beef meat prices is, contrary to popular belief, more significant.

The causal relationship between the beef meat prices and the CPI for the period under consideration was found to be significant at a significance level of 5% and 10%. In this context, one can say that the effect of beef prices on the CPI cannot be overlooked and that beef has an effect on inflation, albeit slightly.

However, the presence of a causal relationship between the CPI and beef prices at a level of 1% suggests that contrary to popular belief CPI has more effect on beef prices than beef prices have on the CPI. Hence, we can say that beef meat prices are affected by the CPI rather than affecting it. There are numerous studies focusing on the relationship between food prices and inflation, which usually highlight that food prices have an effect on inflation [6,23,24,28,29].

In conclusion, the steps to be taken by authorities that steer the sector's future development to prevent the increasing prices of beef meat and foods of animal origin need to be supported by such kind of analyses. In order to make a sound assessment, the overall basket of goods should be addressed with specific focus on similar products, rather than assessing the individual commodities that have an effect on the CPI. Such an approach will prevent targeting of a single product, allowing more effective decisions to be taken and sustainable policies to be formulated.

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