

# Factors affecting beef demand in Türkiye for 2010-2021 and the effects of restrictions imposed during the Coronavirus disease (COVID-19) period

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## Abstract

In this study, the beef price, prices of substitute goods (lamb and chicken meat prices), change in national income and effects of COVID-19 on beef demand for the years 2010-2021 is examined using the ARDL Bounds Test Approach. The study finds that in the long run, an 1% increase in income leads to an approximately, on average, 0.54% increase in demand for beef whereas an 1% increase in beef prices results in, on average, an approximately 0.25% decrease in beef demand. Moreover it is determined that, in the long run, an increase of 1% in the price of lamb meat causes, on average, a 0.37% increase in beef demand, and an 1% increase in chicken meat prices results in on average, a 0.11% decrease in beef demand. This study also uses a dummy variable to account for COVID 19 pandemic effect on the demand of beef. According to the findings for this variable, the pandemic, reduces meat demand, on average, 11% with compared to non-pandemic period. As a result, the demand for beef is found to be affected by the income status of the consumer and the prices of the product itself and its substitutes.

**Keywords:** Ardl model, beef demand, cattle fattening, covid-19, shri (Stay-at-Home Restriction Index)

## INTRODUCTION

In many countries around the world, a set of restrictions has been in the spotlight with the COVID-19 pandemic starting from China since January 2020. Public authorities have sought to limit the spread of this infectious disease by restricting social activities and face-to-face interactions to eliminate the direct negative effects of the COVID-19 virus on human health (Snuggs & McGregor, 2021).

COVID-19, which was responsible for the death of approximately 6.7 million people as of January 01, 2023, caused radical changes in people's consumption and spending habits by keeping population mobility under control all over the world. Therefore, COVID-19 can be defined as a major disaster affecting the socio-economic structures and social behaviors of societies on a global scale (GCDL (Global Change Data Lab), 2022; Güney & Sangün 2021).

In particular, during the first half of 2020, with the effect of the epidemic, restrictions such as social distancing, limited occupancy and the ban on business activities have made most of the Hotel-Restaurant-Institutional (HRI) businesses struggling to survive (Kerr, 2021). At this point, the contraction in the sectors such as HRI, transportation (airlines), entertainment, etc., also affected the consumption of animal products negatively.

Studies in the meat industry after the pandemic, generally, focused on the changes in consumer's habits concerning about the meat consumption and problems in supply chain caused by the social distance, quarantine environment and similar existing restrictions. In this context, Bracale and Vaccaro (2020) in Italy, Martin-Neuning and Ruby (2020) in New Zealand, Laguna et al. (2020) in Spain, Aydın and Demir Ayvazoğlu (2022) and Güney and Sangün (2021) investigate the effects of post-pande-

mic consumption habits in Türkiye and the problems of change in the supply chain.

The aim of this study is to determine the change in meat demand caused by restrictions during the pandemic period and the factors affecting beef demand. The Stay-at-Home Restriction (SHRI) index [BSG (Blavatnik School of Government), 2022] and the variables affecting the demand for beef (beef price, substitute prices and income effect) at a quarterly frequency between 2010 and 2021 are examined by using the ARDL Bounds Test Approach. Thus, the factors affecting the demand for beef in Türkiye have been evaluated in a multidimensional way through the data of Turkish Statistical Institute (TSI).

The SHRI index used in the study is the index showing the level of restriction during the Covid 19 pandemic period. In this index, stay-at-home restrictions are calculated separately for each country with the help of three parameters: strictness, scope and duration (BSG, 2022).

## MATERIALS and METHODS

In this study, the beef production in terms of kilogram, product price data for beef, lamb and white meat and national income statistics data in terms of national currency (TL) are included in the study. The source of dataset is Turkish Statistical Institute (TSI, 2022a; TSI, 2022b; TSI, 2022c; TSI, 2022d; TSI, 2022e; TSI, 2022f; TSI, 2022g). This study, as mentioned above, uses quarterly frequency data cover 2010-2021 in Türkiye. The definition of the dataset can be seen at Table 1.

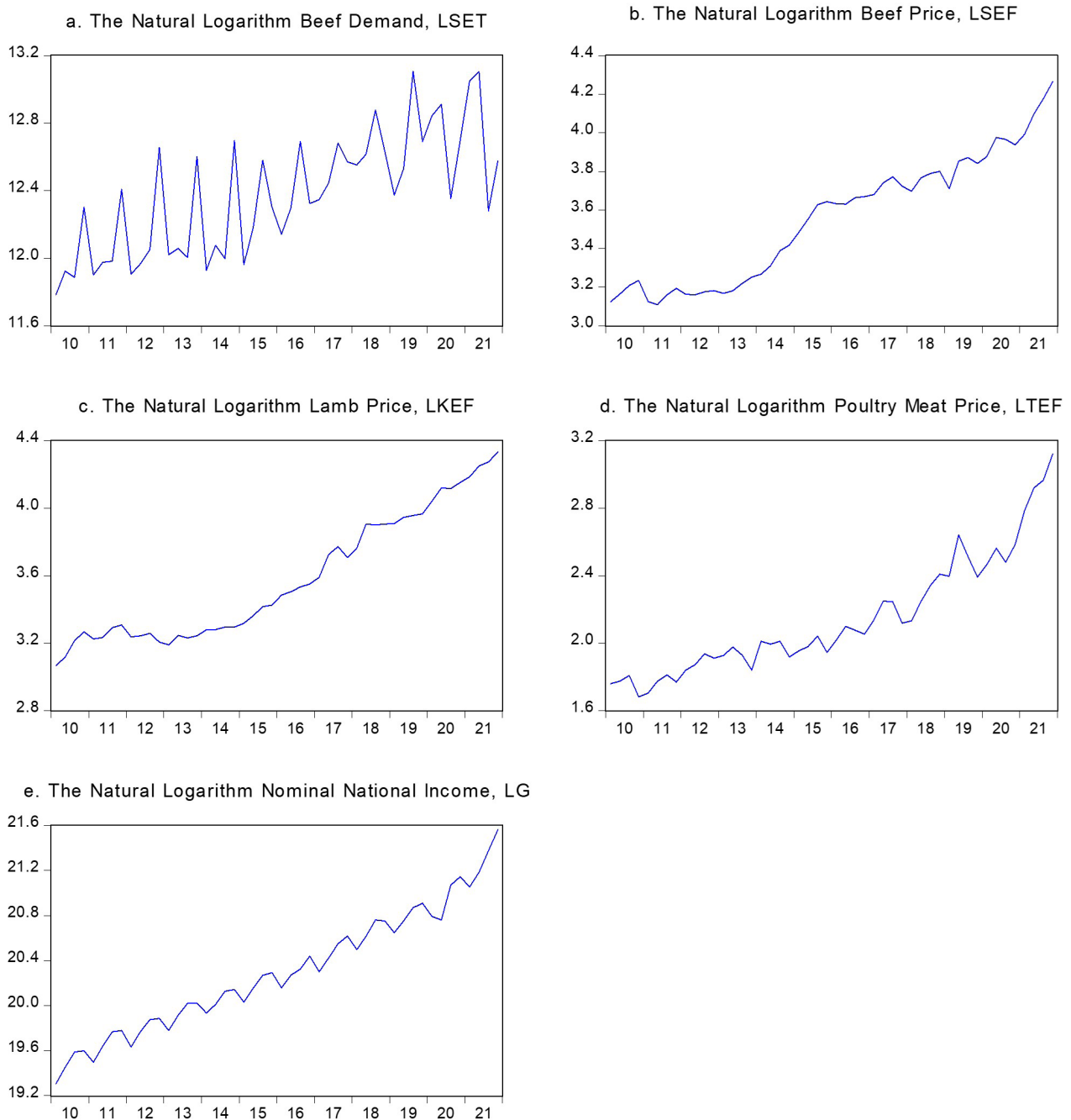
The pre-analysis data of the variables are given in Figure 1. In this study, it is found that all of the variables show trends, and are seasonal variations. By using Holt-Winter exponential smoothing method, which is a statistical technique to detect if a time series has trend and/or seasonality, the study finds that two variables

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**Table 1.** Definitions of data and variables used in the study

$$LSET\_SA = f(LSEF, LKEF, LTEF, LG\_SA, \text{Dummy 1, Dummy 2})$$

Variables	Definitions
LSET_SA	Seasonally Adjusted Natural logarithm of beef demand (Kg)
LSEF	Natural logarithm of beef price (TL)
LKEF	Natural logarithm of lamb meat price (TL)
LTEF	Natural logarithm of poultry meat price (TL)
LG	Natural logarithm of nominal national income (TL)
Dummy Variable 1 (COVID pandemic)	Dummy variable takes 1 at and after 2020 Q1, 0 otherwise
Dummy Variable 2 (Decrease in imports)	Dummy variable takes 1 only at the third quarter of 2019, 0 otherwise

**Figure 1.** Graphs of the data used in the study

(the beef demand and income variables) have seasonal components. Therefore, these two series are adjusted for seasonality using the TRAMO-SEATS method which is very common approach for desseasonalization. Thus, 'Beef demand' is called as 'Seasonally adjusted LSET (LSET\_SA) and National income variable is called as 'Seasonally adjusted LG (LG\_SA).

Afterthat, Augmented Dickey Fuller Unit Root Test (ADF) was applied to the variable under study to determine whether the series are stationary or not. If all series are stationary, time series literature suggests that Vector Autoregressive Model (VAR in short) is used to study relationship between variables. If all series become stationary after taking the first difference, Vector Error Correction Methods (VECM in short) is applied to dataset. On the other hand, if the variables are the mixed of stationary at level and after taking the first difference, ARDL is used for the further analysis of the series. Further, ARDL method does not require the unit root tests for the stationarity in advance, but all the studies in the literature run the unit root tests to make sure none of the variables integrated higher than the first degree. If any variable has a degree of integration higher than order 1, it is not appropriate to use ARDL. Instead, the preferred method is the Toda-Yamamoto method (Yamamoto, 1991). After investigation of time series properties of the variables with ADF tests, ARDL analysis method is used to investigate the cointegration relationship between the variables since as seen in the Table 2, which provides the unit root tests results, none of the variables under concern are integrated more than order 1.

Pesaran and Shin (1999) and Pesaran et al. (2001) suggest the Autoregressive Distribution Bound (ARDL) Test approach as a cointegration technique to investigate

the existence of both short run and a long run relationship. The equation for the long-term and estimations of the associated short-term parameters in the study are given below:

## RESULTS

In Figure 2, seasonally adjusted beef demand shown. When figure 2 is analysed, shows the deviation in the 3rd quarter of 2019 from the longrun trend. This is due to the increase in meat production due to the Eid al-Adha and the fall in real beef prices, which led to an increase of demand in the third quarter of 2019. Due to this sharp change, a dummy variable is included in the model for this point (Dummy 2, see Table 1 for its definition).

The results of the Augmented Dickey Fuller (ADF) test to determine the degree of integration of the relevant variables are given in Table 2. According to the results given in Table 2, the dependent variable LSET\_SA is found as a stationary variable, whereas all other variables become stationary after taking the first differences. Therefore, ARDL approach can be applied to model estimation since there are a mixture of  $I(1)$  and  $I(0)$ . Further the advantage of this method is that valid results are obtained regardless of whether the variables are  $I(1)$  or  $I(0)$  or a combination of the two.

With the ARDL bounds test, it is possible to determine both short-term relationship dynamics and long-term relationships between variables. Before interpreting the regression, results are obtained from ARDL estimations (ARDL (6, 5, 6, 0, 6), error diagnostics tests for any standard ARDL approach are conducted and the results from them along with cointegration results as short-term and long-term estimations are presented in Table 3.

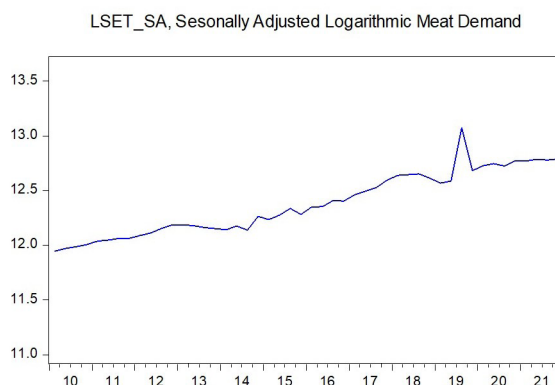
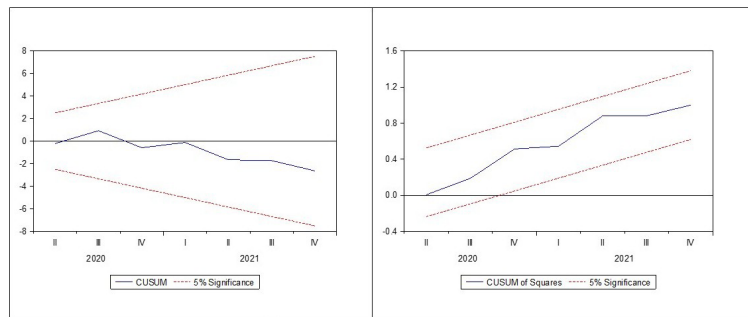


Figure 2. Graph of seasonally adjusted beef demand variable

Table 2. ADF test results for variables

Variable	Level		First Difference	
	Constant	Constant +Trend	Constant	Constant +Trend
LSET_SA	-0.5780	<b>-5.3560***</b>		
LSEF	1.0779	-1.7033	<b>-5.8949***</b>	<b>-6.1706***</b>
LKEF	2.5996	-0.9195	<b>-3.3463**</b>	<b>-8.1308***</b>
LTEF	1.2227	-1.1360	<b>-6.8510***</b>	<b>-6.8153***</b>
LG_SA	2.3125	1.5139	<b>-7.2936***</b>	<b>-7.8495***</b>

\*\*\*, \*\* and \* denote statistical significance levels of 1%, 5% and 10%, respectively. Statistically significant results are in bold.



**Figure 3.** Cusum and Cusum2 Graphs.

**Table 3.** ARDL (6, 5, 6, 0, 6) estimates and error diagnosis results

Panel A: Short-Term Parameter Estimations						
Variables	Lag Number					
	0	1	2	3	4	5
		2.9086***	2.6929***	2.3028***	1.7670***	
	-0.5781	1.3169**	-0.4872	-0.3538	0.6726**	
	0.40850	0.3348	0.0611	0.1466	-1.1460**	-0.5440
	0.7556***	-1.0036**	-1.8677***	-2.3232***	1.5439***	-0.8985***
Dummy 1	-0.1100**					
Dummy 2	0.4979***					
Panel B: Long Term Estimations						
LSEF	LKEF	LTEF	LG_SA	Constant		
-0.2475***	0.3730***	-0.1054*	0.5420**	1.1944**		
Panel C: Cointegration Test Error Correction Term and Error Diagnosis Tests						
F	ECM <sub>(t-1)</sub>	LM	Reset	Cusum	Cusum <sup>2</sup>	
5.4119***	-4.2821***	2.3032	0.537	S	S	

\*\*\*, \*\* and \* denote statistical significance levels of 1%, 5% and 10%, respectively. Statistically significant results are in bold. S and SD expressions in CUSUM and CUSUM<sup>2</sup> mean Stable and Not Stable.

In table 3, for the parameter stability CUSUM and CUSUMSQ tests are conducted and found that they are stable. For the CUSUM and CUSUMSQ graphs can be found at the Figure 3. The model specification error is tested with Ramsey RESET test and LM test is used for whether the autocorrelation is available. The Panel C of the Table 3 shows the results of this tests and, according to them, there is no specification error and autocorrelation problem in the presented model. Further the scatterplots of the residuals and their autocorrelations and partial autocorrelations, which are not presented at the study, there is no information available and the residuals are randomly distributed around a certain mean.

According to the findings from the estimation, both dummy variables in the model are statistically significant. Accordingly, while Covid pandemic restrictions has a negative impact on meat demand, the Eid al-Adha increases the demand for meat.

In the case of short run results of model estimation, all the previous cattle demand variables (the beef price, pri-

ces of substitute goods, national income) are statistically significant effects on the current cattle demand. An 1% increase in the variables from the first to fifth lag cause, on average, respectively, 2.91%, 2.69%, 2.30%, 1.77% and 0.79% approximately on beef demand.

The effect of beef prices on beef demand are statistically significant at the 1<sup>st</sup> and 4<sup>th</sup> lags. Ceteris paribus an 1% increase in beef prices one period ago reduces today's beef demand by approximately 1.32% on average, whereas an 1% increase in the four periods ago has a positive effect on beef demand. While keeping all other variables constant, an 1% increase in beef prices in four periods ago increases today's beef demand by approximately 0.67%.

From the short run parameter estimates for lamb prices, only the 4<sup>th</sup> lag is statistically significant; When all other variables are kept constant, an 1% increase in lamb prices at four period ago reduces the current demand for beef by, on average, approximately 1.15%.



From the short run parameter estimates for chicken meat prices, the model selection procedure cannot obtain any short-term estimates. All the short-term parameter estimates of income are statistically significant; however, the effects are mixed. Parameter estimates for the current period is positive, while parameter estimates for other periods are negative.

When all other variables are held constant, an 1% increase in current income increases current beef demand by, on average, approximately 0.76%. On the other hand, 1% income increases occurring one, two, three, four and five periods ago cause a decrease in beef demand and these effects are, on average, approximately 1%, 1.87%, 2.32%, 1.54% and 0.9%, respectively.

The F statistic in the first column of Panel C is the F statistic for the cointegration test. The obtained value of 5.4119 is statistically significant at the 1% significance level and shows that there is long term equilibrium among the variables. Since there are long run relationships among variables, the error correction model can be estimated. According to the findings, the error correction term (ECMt-1) is -4.2821, which is negative and statistically significant. A value greater than 1 indicates that the short-term deviations from the equilibrium disappear and converge to the long run equilibrium value within a single period (namely, a quarter).

Considering the long run results, all our parameter estimates are statistically significant and generally in line with expectations. Here, as an exception, increases in chicken prices reduces demand for beef (Table 3, Panel B). While other variables are kept constant, in the long run, an 1% increase in beef prices leads to, on an average, a decrease in the beef demand approximately 0.25%. However, the same increase in lamb prices leads to, on an average, a 0.37% increase in beef demand. Lastly while other variables are kept constant, an 1% increase in income, in the long run, leads to, on an average, an increase of, approximately, 0.54% in beef demand.

## DISCUSSION

In considering the TSI data for Türkiye, in general, between 2010 and 2021 at a quarterly frequency used in this study, the COVID-19 restrictions negatively affects the beef demand, namely, it reduces the beef demand. The decrease in this demand was occurred due to the closure of food and beverage areas such as entertainment, cafes and restaurants, especially Hotel-Restaurant-Institutional in Türkiye due to the pandemic, which causes a significant contraction in the sector. As a matter of fact, in this study, it is found that the pandemic causes a 11% decrease in meat demand in the market. In parallel with the findings of this study, reported the slaughter of cattle decreased by 33% in April and May 2020 in the USA and 60% in Canada (LMIC (Livestock Marketing Information Center), 2022; USDA (United States Department of Agriculture), 2022; Weersink, et. al. 2021). Other studies conducted in Canada reported that the possibility of not processing meat after slaughter reduces the demand for beef cattle in the market, and beef production decreased by 21% in April 2020 and 19% in May 2020 (Mallory, 2021; Rude, 2021).

However according to TSI data, the increase in beef de-

mand in Türkiye, which was 8.46% on average every year between 2010 and 2019, increased by only 0.8% in 2020 due to the pandemic, reaching 1,341,446 tons. It can be said that beef demand in Türkiye has become stationary due to the pandemic. Tuncel (2023) found a positive relationship between Meat and Milk Board (MMB) meat demand data and the pandemic restriction level. Accordingly, while the Covid-19 results in household meat demand on the one hand, on the other hand, it has a negative effect as a result of the contraction in food and beverage areas such as Hotel-Restaurant-Institutional, entertainment, cafe restaurant etc. Tuncel (2023) reports that the increase in household consumption compensated for the decline in beef demand. On the other hand, the 0.8% increase in beef demand can be attributed to household consumption. As a matter of fact, Aydın and Demir Ayvazoğlu (2022) and Güney and Sangün (2021), in parallel with the findings of this study, report that household demand for beef increased during the pandemic.

The increase in household consumption expenditures is also directly related to beef prices. As a matter of fact, during the 2020 pandemic period, the rate of increase in beef prices in Türkiye (6.9%) remained below the inflation rate in 2020 (14.6%) (TSI, 2022g). Accordingly, in real terms, the decline in beef prices in 2019 continued to a certain extent in 2020. The 'Dummy 2' used for a sudden upward shift in the third quarter of 2019 indicates that the effect of real beef prices on the demand for meat coincides with the Eid al-Adha period also.

It has been determined that the imbalances in beef supply in the USA, Canada and many European countries during the pandemic intensified at the beginning of the pandemic; after the initial shock was over, the prices in many countries followed a balanced course from the 6th month of the pandemic (BLS (Bureau of Labor Statistics), 2022; STATCAN (Statistics Canada), 2022; Weersink, et. al. 2021). In particular, the closure of meat processing facilities during the pandemic and indirectly the possibility of livestock enterprises not being able to find a channel to offer their livestock for final consumption at the end of the fattening period can be considered the main reason for the supply imbalance (LMIC, 2022; USDA, 2022; Weersink, et. al., 2021). When COVID-19 is evaluated in terms of the food sector, Nordhagen et al. (2021) conduct a study on 367 small- and medium-scale enterprises in 17 countries and they find that 84% of food companies made changes in their production volumes as a result of the COVID-19 epidemic, and they reports a complete cessation in the production in 13 % and a decrease in 82% of these enterprises.

Within the scope of this study, the price fluctuations of beef in Türkiye during the pandemic period were more stable. In Akter's (2020) research using the Stay-at-Home Restriction Index, milk, cheese and eggs, as well as oils and fats, were not affected by the stay-at-home restrictions, and he attributed the change in meat price indices to problems in the fish and seafood supply chain. Coluccia et al. (2021) report in their study that agricultural food demand problems can be solved by taking into account many parameters such as export, consumer behavior, supply chain reaction and epidemic restrictions.

A more flexible supply chain structure in Türkiye than in many western countries and less dependence on meat

packaging as well as packaged and processed food can be shown among the reasons for this situation (Akter, 2020). Indeed, hoarding behavior can lead to higher price changes in societies with a high dependence on processed food. Tuncel (2023) finds a 60.7% correlation between the level of restriction and beef demand during the Covid 19 pandemic period. He reports that this correlation is influenced by the favorable meat prices during the pandemic period, as well as the hoarding behavior that develops with herd psychology to a certain extent. Indeed, Long and Khoi (2020), in their study conducted in Vietnam during the COVID-19 pandemic, finds that consumers' perception of risk and the expectation make the products more expensive in the future due to increasing the tendency to stockpile food.

The regression results obtained within the scope of the study provide information on the elasticity of demand for beef, cross elasticities of demand for beef with substitute goods and income elasticity of beef. ARDL bounds test is used to test whether there is a long-run relationship between variables, and long and short run elasticities are calculated under the condition of the existence of a cointegration relationship (Narayan & Smyth, 2006). Accordingly, in this study, the elasticity of demand for beef is found to be 0.25% in the long run. In parallel with the finding of this study, Hatırlı et al. (2008) determines the elasticity of demand for beef as 0.20% in Türkiye. Accordingly, the elasticity of demand for beef is characterized as a necessary good.

In study determination, in terms of cross elasticity of demand, in the long run, a 1% increase in lamb prices increases the current beef demand by approximately 0.37%, whereas a 1% increase in chicken meat prices causes an average decrease of 0.11% in beef demand. Accordingly, while the substitution relationship between beef and lamb was found, the substitution relationship between chicken and beef was found to be weak. Hatırlı et al. (2008), unlike this research finding, reported that beef and chicken are substitutive and lamb meat is complementary. The difference between these two studies can be explained by the fact that chicken meat has been at the top of consumer preferences over the years and its substitution with red meat is low due to the lower price of chicken meat.

In addition, it was determined in the study that a 1% increase in current income increased the demand for beef by an average of 0.54% in the long term Saygın et al. (2018) found in their study that the income elasticity of beef was 0.32%. Accordingly, the relationship between beef demand and income elasticity coincides with the expected income elasticity level.

## CONCLUSION

As a result, a negative relationship is found between the level of restriction and the demand for beef during the COVID-19 period in Türkiye. This situation has shown that the contraction in sectors such as transportation (airlines), entertainment and similar sectors, especially HRI, and the decrease in beef demand, which emerged as an obstacle to the consumption of animal products through these channels, were compensated, to a certain extent, by encouraging an increase in household consumption with the effect of low carcass prices. However, the livestock

sector has entered into a major bottleneck since 2021 due to the contraction problem in beef consumption points during the pandemic periods and production with low carcass prices despite the increasing fattening costs of cattle breeding enterprises. At this point, in order to increase the demand for animal products, it is necessary to ensure that the demand for beef is met in a cheap way through measures to reduce production costs and to establish an appropriate economic model for the sustainability of production.

In Türkiye, instead of suppressing carcass meat prices in the market by importing meat, structural problems should be solved first. Accordingly, ensuring stability in milk prices by supporting dairy farming plays a fundamental role in stabilising meat prices. In addition, practices such as pasture improvement and development of pasture animal husbandry, reduction of calf mortality rates, support to encourage production in the domestic market instead of balancing the supply deficit with meat imports, encouragement of ovine consumption in accordance with Türkiye's realities and pasture structure should be implemented.

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## Conflict of Interest

The authors declared that there is no conflict of interest.

## Author Contributions

ST planned, designed and contributed to the literature review, data collection and writing. TTD designed the study material and conducted the analyses. PAD contributed to data collection, literature review and editing of the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

## Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

## Ethical Statement

This study does not present any ethical concerns.

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