CHAPTER 10

AN ANALYSIS OF THE RELATIONSHIP BETWEEN RED MEAT PRODUCTION AND PRICES IN TURKEY USING THE ALMON MODEL

Asst. Prof. Dr. Emine BERBEROĞLU[1],
Hüseyin USLU[2]

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[1] Asst. Prof. Dr. Tokat Gaziosmanpaşa University, Faculty of Agriculture, Department of Animal Science, Tokat/Türkiye, emine.berberoglu@gop.edu.tr, orcid id: 0000-0002-7318-2728
[2] Tokat Gaziosmanpaşa University, Institute of Graduate Studies, Department of Animal Science, Tokat/Türkiye, h.uslu80@hotmail.com, orcid id: 0000-0002-2642-1175

1. INTRODUCTION

The rapidly increasing global population and the scarcity of natural resources have further underscored the growing importance of adequate and balanced nutrition for the protection and improvement of public health. Ensuring a healthy diet depends on obtaining essential food nutrients from both plant-based and animal-based sources. This situation directly affects the effectiveness of agricultural and livestock policies in countries, making it necessary to optimize individuals' access to essential food products in terms of both quantity and cost. Animal-derived foods stand out due to their high-quality proteins and essential amino acids. In particular, red meat contains protein, omega-3, iron, zinc and vitamin B12 (Ekmekcioglu et al., 2018). Research indicates that an adult should consume approximately 70 grams of protein per day, with around 40% of this amount ideally obtained from animal-based sources. In this context, red meat consumption is vital not only for human health and growth and development processes but also for providing the eight essential amino acids that are critical for brain development.

With the continuous growth of the world population, the strategic importance of food resources has been steadily increasing. This is because per capita food consumption is widely recognized as one of the fundamental indicators of a country's level of development. In developed countries, measures aimed at meeting the nutritional needs of a growing population in a balanced and healthy manner are considered among the primary policy priorities, with particular emphasis on increasing the share of animal-based proteins in total consumption. In Turkey, where the population is rising rapidly, the increase in per capita income has also led to a growing demand for animal products. To meet this rising demand, it has become essential to further develop the livestock sector and to enhance productivity per animal.

The livestock sector in Turkey occupies a strategic position in terms of both its economic contributions and its social impacts. This sector, which plays a vital role in human nutrition, ranks second in the country's agricultural production after crop farming and serves as a critical sub-sector in meeting society's demand for animal-derived protein. At the same time, it fulfills a fundamental function in satisfying the growing demand for milk and meat. Beyond addressing individuals' nutritional needs, the livestock industry makes significant contributions to the national economy by providing raw materials for the manufacturing sector, supporting subsidiary industries, and creating extensive employment opportunities. Within this context, the red meat sector stands out as a priority area in terms of both production volume and nutritional significance. According to TURKSTAT data, red meat production and the number of slaughtered animals in Turkey have followed a fluctuating pattern but displayed an overall upward trend in the long term. In 2004, cattle slaughter reached 2.6 million head, yielding 488.6 thousand tons of beef, while sheep slaughter amounted to 10.7 million head, with 190.1 thousand tons of mutton produced. Goat and buffalo meat production stood at 52.5 thousand tons and 4.9 thousand tons, respectively, highlighting the dominant role of beef and mutton in total red meat output. In the early period, total production decreased by 2.6% in 2004, increased slightly by 0.2% in 2005, and showed a limited rise in 2006. During this time, beef production experienced a modest increase, whereas small ruminant production declined, largely due to drought and rising feed costs that constrained output. From 2007 to 2009, production recovered, with total red meat output growing by 5.5%, 4.1%, and 2.2%, respectively. After 2010, the sector entered a phase of rapid growth; total production rose by 3.9% in 2010, 10.2% in 2011, and 10.1% in 2012. This expansion was directly linked to the increase in cattle stock, import restrictions on meat, and the implementation of producer incentives. Growth in small ruminant production was also recorded, with mutton and goat meat output reaching 236.2 thousand tons and 59.5 thousand tons, respectively, by 2013. The expansion phase continued after 2015: cattle slaughter increased from 3.7 million to 4.86 million head, and beef production rose from 862 thousand tons to 1.33 million tons. Small ruminant production also increased, with mutton output up by 27% and goat meat by 25%. The growth persisted through 2020-2021, reaching 1.46 million tons of beef, 385.9 thousand tons of mutton, and 94.6 thousand tons of goat meat in 2021. In 2022-2023, red meat production reached record levels: in 2023, cattle slaughter totaled 5.81 million head, with 1.67 million tons of beef produced, while mutton and goat meat output stood at 569 thousand tons and 129 thousand tons, respectively. However, 2024 data indicate a significant decline in red meat production. Cattle slaughter dropped to 5.08 million head, and beef production fell to 1.48 million tons, while mutton, goat, and buffalo meat production decreased by 10.5%, 22.8%, and 10.4%, respectively. This decline reflects the impact of rising production costs, feed price fluctuations, and shrinking producer incomes on the sector. In this context, enhancing livestock production particularly red meat output is crucial not only for food security but also for achieving broader economic and social development objectives in Turkey.

The main objective of this study is to analyze the dynamic relationship between red meat production and prices in Turkey by employing the Almon Distributed Lag Model using annual data for the period 1994-2024. In this context, the study is structured into six main sections. Following the introduction, the second section provides a detailed examination of red meat production in Turkey over time through descriptive tables, focusing on variables such as the number of live animals, the number of slaughtered animals, the amount of meat produced, and the rates of change in red meat production. The third section is devoted to a review of the relevant literature, presenting previous studies conducted on the subject. The fourth section outlines the data and methodology employed in the analysis. In the fifth section, the empirical analysis is conducted, and the findings are discussed in detail. Finally, the sixth section presents the overall conclusions of the study, summarizing the key results and offering a general evaluation.

2. ANALYSIS OF RED MEAT PRODUCTION IN TURKEY BY PERIOD

In Turkey, red meat production, as one of the most strategic components of the agricultural production structure and food supply security, has been directly influenced by both structural transformations and macroeconomic fluctuations during the period 2004-2024. Although overall production volumes generally exhibited an upward trend throughout this period, notable fluctuations occurred across different years. These variations were shaped not only by changes in livestock policies, input and feed costs, climatic conditions, and import regulations, but also by the combined effects of these external factors.

The data presented in Table 1 illustrate the annual changes in cattle, buffalo, sheep, and goat populations in Turkey over the same period. This information provides an important perspective for analyzing the structural evolution of the livestock sector, shifts in production dynamics, and the cyclical nature of sectoral growth. In 2004, the total livestock population amounted to

41.98 million head, with sheep (25.2 million) and cattle (10.07 million) representing the dominant components of production. Goat and buffalo populations were comparatively smaller, at 6.6 million and 103.9 thousand head, respectively. Between 2004 and 2009, the total livestock population declined significantly, reaching 37.69 million head. This reduction can be associated with structural disruptions in the agricultural sector during the mid-2000s, a declining rural population, rising feed costs, and the diminished role of small ruminant farming. In particular, the 2008 global economic crisis increased agricultural input costs, negatively affecting producer behavior and making it more difficult for small-scale farms to sustain their operations.

Table 1: Number of Live Animals in Turkey by Year (2004-2024, Heads)

Years	Cattle	Buffalo	Sheep	Goat	Total
2004	10.069.346	103.900	25.201.155	6.609.937	41.984.338
2005	10.526.440	104.965	25.304.325	6.517.464	42.453.194
2006	10.871.364	100.516	25.616.912	6.643.294	43.232.086
2007	11.036.753	84.705	25.462.293	6.286.358	42.870.109
2008	10.859.942	86.297	23.974.591	5.593.561	40.514.391
2009	10.723.958	87.207	21.749.508	5.128.285	37.688.958
2010	11.369.800	84.726	23.089.691	6.293.233	40.837.450
2011	12.386.337	97.632	25.031.565	7.277.953	44.793.487
2012	13.914.912	107.435	27.425.233	8.357.286	49.804.866
2013	14.415.257	117.591	29.284.247	9.225.548	53.042.643
2014	14.223.109	122.114	31.140.244	10.344.936	55.830.403
2015	13.994.071	133.766	31.507.934	10.416.166	56.051.937
2016	14.080.155	142.073	30.983.933	10.345.299	55.551.460
2017	15.943.586	161.439	33.677.636	10.634.672	60.417.333
2018	17.042.506	178.397	35.194.972	10.922.427	63.338.302
2019	17.688.139	184.192	37.276.050	11.205.429	66.353.810
2020	17.965.482	192.489	42.126.781	11.985.845	72.270.597
2021	17.850.543	185.574	45.177.690	12.341.514	75.555.321
2022	16.851.956	171.835	44.687.888	11.577.862	73.289.541
2023	16.421.256	161.749	42.060.470	10.302.940	68.946.415
2024	16.824.208	162.051	44.080.584	10.822.084	71.888.927

Source: TURKSTAT, (2025a).

From 2010 onwards, the livestock sector in Turkey exhibited a clear recovery trend. During this period, the cattle population rose to 11.37 million, reaching 12.39 million in 2011, representing roughly a 10% increase in a short span. This growth reflects the impact of government interventions, including livestock support programs, the importation of breeding animals, and credit incentives. Sheep and goat populations also showed upward trends during the same period, with the total number of live animals reaching 55.83 million by

2014, marking a notable increase compared to previous years. Between 2015 and 2017, the expansion continued across the sector. The cattle population rose to 15.94 million, and the total livestock population reached 60.42 million. This growth mirrored the expansion in red meat supply and increased milk production capacity. After 2018, the upward trend in livestock numbers accelerated, and by 2021 the total population had reached 75.55 million, representing the highest level in the past two decades. Notably, the sheep population exceeded 45 million, indicating a resurgence in small ruminant farming and greater diversity in meat supply. However, a decline in total livestock numbers was observed in 2022 and 2023. By 2023, the total had fallen to 68.95 million, primarily due to rising feed and energy costs, increases in input prices driven by exchange rate fluctuations, and narrowing producer profit margins. This situation highlights how unsustainable cost increases have undermined the stability of the livestock sector. By 2024, a modest recovery became evident. The cattle population reached 16.82 million, sheep 44.08 million, and goats 10.82 million, bringing the total livestock count to 71.89 million. This development suggests that the sector entered a rebalancing phase following the contraction experienced in 2023.

Table 2 presents the number of cattle, buffalo, sheep, and goats slaughtered in Turkey from 2004 to 2024, along with the corresponding meat output for each species. The table provides a clear view of how the structure of red meat production has evolved, illustrating species-specific production patterns and the overall transformation of supply over time. In 2004, approximately 2.6 million cattle were slaughtered, yielding 488.6 thousand tons of beef. In the same year, 10.7 million sheep were slaughtered, resulting in 190.1 thousand tons of meat. The share of goat and buffalo meat was relatively small, at 52.5 thousand tons and 4.9 thousand tons, respectively. These figures indicate that in the early 2000s, beef and sheep meat dominated Turkey’s red meat production, while buffalo and goat meat played a secondary role.

Table 2: Number of Slaughtered Animals and Meat Production Amount (2004-2024)

Years	Cattle		Buffalo		Sheep		Goat	
	Number of Slaughtered Animals (Heads)	Meat Production Amount (Tons)	Number of Slaughtered Animals (Heads)	Meat Production Amount (Tons)	Number of Slaughtered Animals (Heads)	Meat Production Amount (Tons)	Number of Slaughtered Animals (Heads)	Meat Production Amount (Tons)
2004	2.599.490	488.556	27.586	4.952	10.725.580	190.105	2.837.242	52.460
2005	2.558.207	491.560	25.060	4.629	10.731.398	190.539	2.801.617	50.492
2006	2.620.559	514.042	23.867	4.442	10.704.436	187.236	2.748.395	48.906
2007	2.713.989	549.513	22.916	4.347	10.792.554	191.428	2.755.379	50.712
2008	2.797.426	581.497	21.494	4.128	10.826.034	192.647	2.706.994	50.254
2009	2.826.190	608.183	20.111	4.019	10.477.951	188.496	2.487.218	46.240
2010	2.932.054	647.067	19.126	3.785	9.691.041	186.121	2.244.760	42.846
2011	3.126.378	710.652	19.127	3.780	10.700.807	210.171	2.391.246	44.840
2012	3.421.960	790.034	19.967	4.027	10.755.777	220.359	2.841.307	53.133
2013	3.457.477	798.784	21.465	4.580	11.194.725	236.186	3.273.444	59.532
2014	3.525.209	815.674	23.899	5.004	11.991.640	238.670	3.681.199	63.711
2015	3.706.346	862.098	25.713	5.300	12.808.697	249.863	4.097.340	69.757
2016	3.993.893	956.180	27.663	5.470	13.277.503	266.675	4.346.611	75.322
2017	4.334.034	1.093.841	29.476	5.868	13.244.903	262.825	4.346.713	77.794
2018	4.844.711	1.281.234	32.389	6.515	14.133.170	291.179	4.392.427	82.839
2019	4.856.517	1.330.169	35.695	7.150	14.546.576	316.170	4.513.264	87.126
2020	4.812.902	1.341.446	40.929	8.424	15.801.021	345.639	4.692.010	90.443
2021	5.134.441	1.460.719	51.925	10.831	17.125.163	385.933	4.907.371	94.555
2022	5.480.489	1.572.747	62.285	13.586	21.563.828	489.354	6.112.179	115.938
2023	5.811.698	1.670.606	69.597	15.386	25.437.813	569.066	6.753.478	128.989
2024	5.077.812	1.483.042	59.965	13.781	22.573.686	509.539	5.117.030	99.532

Source: TURKSTAT, (2025a,b).

Between 2004 and 2009, there was a steady increase in both cattle slaughter numbers and beef production in Turkey. By 2009, cattle slaughter reached 2.83 million heads, with beef output rising to 608.2 thousand tons. In contrast, sheep and goat slaughter declined noticeably during this period, reflecting the decreasing economic appeal of small ruminant farming and structural changes in rural production. Starting in 2010, the red meat sector entered a period of structural expansion. Cattle slaughter was recorded at 2.93 million heads, producing 647 thousand tons of beef. In 2011 and 2012, meat production continued to rise, reaching 710.6 thousand tons and 790 thousand tons, respectively. This growth was mainly driven by the expansion of the cattle population, restrictions on meat imports, and government incentives supporting domestic production. During the same period, slaughter numbers for small ruminants also increased, with sheep meat reaching 236.2 thousand tons and goat meat 59.5 thousand tons by 2013. The period from 2015 to 2019 stands out as a time of rapid growth in Turkey's red meat production. Cattle slaughter rose from 3.7 million in 2015 to 4.86 million in 2019, while beef production jumped from 862 thousand tons to 1.33 million tons, an increase of approximately 55%. Production of small ruminant meat also increased, with sheep meat rising from 249.9 thousand tons to 316.2 thousand tons, and goat meat from 69.7 thousand tons to 87.1 thousand tons. This trend reflects a combination of rising population, changing consumption habits, and strong demand for meat. Between 2020 and 2021, production continued to grow. By 2021, beef production had reached 1.46 million tons, sheep meat 385.9 thousand tons, and goat meat 94.6 thousand tons. This increase coincided with ongoing government support for livestock and expanded slaughtering capacity. However, rising cost inflation and higher feed prices posed challenges to sustaining this growth. In 2022 and 2023, Turkey's red meat production peaked. By 2023, cattle slaughter reached 5.81 million heads, producing 1.67 million tons of beef. Sheep and goat meat production also rose to 569 thousand tons and 129 thousand tons, respectively, marking record levels in the country's red meat sector. Nevertheless, data from 2024 indicate a notable decline. Cattle slaughter fell to 5.08 million heads, with beef production decreasing to 1.48 million tons. Sheep, goat, and buffalo meat production also declined. This downturn can be attributed to rising production costs, pressure on feed prices, and shrinking profit margins for producers.

Table 3 shows the change rates in red meat production, highlighting that the 2004-2006 period experienced modest but steady growth. In 2004, total output declined by 2.6% compared to the previous year, while a slight increase of 0.2% was observed in 2005. During this period, beef production trended slightly upward, whereas buffalo, sheep, and goat meat production declined. The reduction in small ruminant meat, in particular, reflects production constraints caused by drought and rising feed costs. The years 2007-2009 represented a phase of relative recovery. Total red meat production rose by 5.5% in 2007, 4.1% in 2008, and 2.2% in 2009. Beef production increased steadily, while the decline in sheep and goat meat slowed. This expansion in red meat supply helped temporarily stabilize prices. The 2010-2012 period stands out as a key phase of notable growth in Turkey's red meat sector. Total production grew by 3.9% in 2010, 10.2% in 2011, and 10.1% in 2012. This rapid increase was closely associated with post-2010 policies, including liberalization of meat imports, incentives for breeding animal imports, and fattening support programs. Notably, the double-digit growth in beef production was the primary driver of the overall rise in red meat output.

Table 3: Red Meat Production and Change Rates (2004-2024)

	Meat Production Amount (Tons)					Change Compared to the Previous Year (%)				
Years	**Cattle**	**Buffalo**	**Sheep**	**Goat**	**Total**	**Cattle**	**Buffalo**	**Sheep**	**Goat**	**Total**
2004	488.556	4.952	190.105	52.460	736.074	-0.2	-5.5	-7.0	-7.7	-2.6
2005	491.560	4.629	190.539	50.492	737.220	0.6	-6.5	0.2	-3.8	0.2
2006	514.042	4.442	187.236	48.906	754.625	4.6	-4.0	-1.7	-3.1	2.4
2007	549.513	4.347	191.428	50.712	796.000	6.9	-2.1	2.2	3.7	5.5
2008	581.497	4.128	192.647	50.254	828.527	5.8	-5.0	0.6	-0.9	4.1
2009	608.183	4.019	188.496	46.240	846.939	4.6	-2.7	-2.2	-8.0	2.2
2010	647.067	3.785	186.121	42.846	879.819	6.4	-5.8	-1.3	-7.3	3.9
2011	710.652	3.780	210.171	44.840	969.443	9.8	-0.1	12.9	4.7	10.2
2012	790.034	4.027	220.359	53.133	1.067.553	11.2	6.5	4.8	18.5	10.1
2013	798.784	4.580	236.186	59.532	1.099.081	1.1	13.7	7.2	12.0	3.0
2014	815.674	5.004	238.670	63.711	1.123.059	2.1	9.3	1.1	7.0	2.2
2015	862.098	5.300	249.863	69.757	1.187.018	5.7	5.9	4.7	9.5	5.7
2016	956.180	5.470	266.675	75.322	1.303.648	10.9	3.2	6.7	8.0	9.8
2017	1.093.841	5.868	262.825	77.794	1.440.327	14.4	7.3	-1.4	3.3	10.5
2018	1.281.234	6.515	291.179	82.839	1.661.767	17.1	11.0	10.8	6.5	15.4
2019	1.330.169	7.150	316.170	87.126	1.740.616	3.8	9.8	8.6	5.2	4.7
2020	1.341.446	8.424	345.639	90.443	1.785.952	0.8	17.8	9.3	3.8	2.6
2021	1.460.719	10.831	385.933	94.555	1.952.038	8.9	28.6	11.7	4.5	9.3
2022	1.572.747	13.586	489.354	115.938	2.191.625	7.7	25.4	26.8	22.6	12.3
2023	1.670.606	15.386	569.066	128.989	2.384.047	6.2	13.3	16.3	11.3	8.8
2024	1.483.042	13.781	509.539	99.532	2.105.895	-11.2	-10.4	-10.5	-22.8	-11.7

Source: TURKSTAT, (2025a,b).

The 2013-2016 period was marked by continued growth in red meat production, although the pace of increase gradually slowed. Total production rose by 3% in 2013, 2.2% in 2014, 5.7% in 2015, and 9.8% in 2016. The increases in 2015 and 2016 were largely driven by enhanced support for small ruminant livestock and relatively stable producer prices. Moreover, the notably higher growth rates in sheep and goat meat compared to the pre-2010 period strengthened the trend toward greater diversification in red meat supply. The 2017-2019 period stood out as a phase of rapid expansion. Total production grew by 10.5% in 2017, 15.4% in 2018, and 4.7% in 2019. In particular, beef production rose by 17.1% and sheep meat by 10.8% in 2018. These high growth rates reflect one of the strongest historical performances in Turkey's red meat production. However, despite this increase, the expected stabilization in prices did not occur, as red meat prices continued to rise. This suggests that demand-side dynamics and rising costs exerted a stronger influence than production increases. The 2020-2022 period saw continued expansion in red meat production, although cost pressures intensified toward the end of the period. Production increased by 2.6% in 2020, 9.3% in 2021, and 12.3% in 2022. The year 2022 was particularly notable for high growth in sheep meat (26.8%) and goat meat (22.6%), indicating a strengthened focus on small ruminant livestock and increased species diversification in red meat production. However, rising feed, energy, and transportation costs negatively affected producer profitability during this period. In 2023, total production continued to grow, rising by 8.8%, though the rate of increase slowed slightly. Beef production grew by 6.2%, buffalo meat by 13.3%, sheep meat by 16.3%, and goat meat by 11.3%. This year highlights continued strong growth in small ruminant production, while the growth in beef production showed a relative slowdown. By 2024, red meat production experienced a significant decline for the first time in many years. Total output fell by 11.7% compared to the previous year, with reductions observed across all species: beef (-11.2%), buffalo (-10.4%), sheep (-10.5%), and goat (-22.8%). This decline can be attributed to rising production costs and weakening consumer demand. Additionally, fluctuations in feed prices, drought conditions, and higher slaughtering costs adversely affected production.

Overall, the analysis of the 2004-2024 period indicates that Turkey's red meat production has followed a long-term upward trend, although this growth has been marked by instability. Periodic fluctuations in production growth rates have exerted pressure on red meat prices, creating vulnerabilities in the supply demand balance. In this context, it is possible to identify a structural tendency toward an inverse relationship between production volumes and price levels. This pattern suggests that the red meat market is sensitive both to supply-side production dynamics and to demand-side price elasticity. As a result, while the increases in red meat production have strengthened Turkey's long-term supply capacity, these gains have not consistently translated into price stability. Consequently, restructuring red meat production policies to mitigate price volatility, alongside supporting efficiency-based sustainable production models, is critical for ensuring the sector's stable growth.

3. LITERATURE REVIEW

Different modeling approaches have been developed to examine the interaction between the production volume of a good and its price level, with various methodologies proposed depending on whether lagged effects are considered finite or infinite. Among the models most frequently used in the literature, the Almon and Koyck models are particularly prominent (Koutsoyiannis, 1989: 296-320). In this study, the focus is placed exclusively on research applying the Almon model, enabling a more detailed examination of how lagged effects influence the production price relationship.

There are several studies in Turkey that examine the relationship between agricultural products and prices using the Almon model. For instance, Doğan, Gürler, and Ayyıldız (2014) analyzed the interaction between rice production and prices in Samsun province through the Almon polynomial technique. Utilizing data from the period 1993-2013, the study applied the Almon model, which considers not only the current period but also the effects of past periods on the explanatory variable in time series econometrics. The results indicate that rice production in Samsun is influenced by prices in periods t, t-1, and t-2. While current period (t) prices have a negative effect on production, prices from one and two periods earlier (t-1 and t-2) exert a positive impact. The study further notes that these findings are consistent with the Cobweb theorem in economic theory and suggests that producer associations, cooperatives, and government support should be effectively utilized in production planning. This approach is emphasized as a way to facilitate production forecasting and prevent imbalances between supply and demand. Çelik and Özbay (2015) analyzed the relationship between tomato production and prices over the period 1994-2013 using the Almon approach, one of the distributed lag models. According to the Almon model results, tomato production was influenced by prices up to five years back. The findings indicate that a 1 TL increase in the current year's tomato price raises production by 0.21 tons, while a 1 TL increase in the previous year raises it by 0.49 tons, two years prior by 0.52 tons, and three years prior by 0.30 tons. Conversely, a 1 TL increase in prices four years ago reduces production by 0.16 tons, and a similar increase five years ago decreases production by 0.86 tons. In summary, changes in tomato prices during the first, second, and third lagged periods had a positive effect on production, whereas changes in the fourth and fifth lagged periods exerted a negative impact. Köleoğlu and Çelik (2025) examined the relationship between maize production and maize prices in Turkey using data from 2000 to 2023. In their study, the dependent variable was the national maize production, while the independent variable was the maize price, and the relationship was analyzed using distributed lag models, specifically the Koyck and Almon approaches. The results indicate that maize production is most strongly influenced by prices over the previous three years. In the absence of any price changes, maize production was estimated at 6,194 tons. A 1 TL increase in the current year's price (t) raised production by 302,283.6 tons, while a 1 TL increase in the previous year's price (t-1) increased production by 260,266.2 tons, and a 1 TL increase two years prior (t-2) led to an increase of 224,089.2 tons. Price increases in the third to sixth lagged periods (t-3, t-4, t-5, t-6) corresponded to production increases of 192,940.8; 166,122; 143,031.1; and 123,149.7 tons, respectively. These findings suggest that increases in lagged maize prices positively affect production, although the magnitude of this effect diminishes over time.

A review of the literature indicates that considerable research has been conducted on the relationship between production and prices in agricultural products. However, studies empirically analyzing the relationship between the production of animal-based products and their prices remain relatively limited. For instance, Çelik (2015a) examined the relationship between buffalo milk production and prices over the period 1994-2013 using distributed lag models, specifically the Koyck and Almon approaches. According to the Koyck model results, buffalo milk production is influenced by prices up to eight years in the past. It was estimated that it takes approximately 5.37 years for changes in buffalo milk prices to have a significant and noticeable effect on production. A 1 TL increase in current-year prices (t) raises production by 4,203 tons, while a 1 TL increase in the previous year's price (t-1) increases production by 3,543 tons, and a price increase two years prior (t-2) raises production by 2,987 tons. Price increases in earlier periods (t-3 to t-8) also lead to production increases of 2,518; 2,123; 1,789; 1,508; 1,272; and 1,072 tons, respectively. These findings suggest that changes in lagged buffalo milk prices have a diminishing positive impact on production over time. According to the Almon model, buffalo milk production is affected by prices in the current period (t) as well as the eight preceding periods (t-1 to t-8). While current-period prices positively influence production, prices in all lagged periods have a negative effect. Overall, the analysis indicates that the Koyck model provides a better fit than the Almon model in explaining the buffalo milk production price relationship. In a study conducted by Çelik (2015b), the relationship between sheep milk production and prices over the period 1994–2014 was analyzed using distributed lag models, specifically the Koyck and Almon approaches. According to the Koyck model results, sheep milk production is influenced by prices up to nine years in the past. It was found that it takes approximately 8.71 years for changes in sheep milk prices to have a significant and noticeable impact on production. A 1 TL increase in the current year's price (t) raises production by 72,053.98 tons, while a 1 TL increase in the previous year's price (t-1) increases production by 64,632.41 tons, and a price increase two years prior (t-2) raises production by 57,975.28 tons. Price increases in the third to ninth lagged periods (t-3 to t-9) were found to increase production by 52,004; 46,647; 41,842; 37,533; 33,667; 30,199; and 27,089 tons, respectively. These findings indicate that changes in lagged sheep milk prices have a diminishing positive effect on production over time. According to the Almon model, sheep milk production is affected by prices in the current period (t) as well as the nine preceding periods (t-1 to t-9). While prices in the current period and the first four lagged periods (t-1 to t-4) negatively influence production, prices in the fifth through ninth periods (t-5 to t-9) have a positive effect. Overall, the study demonstrates that past prices play a significant role in shaping sheep milk production decisions and that the impact of lagged prices diminishes over time.

Studies examining the relationship between red meat production and prices using the Almon distributed lag model are relatively limited in the literature. For instance, Akgül and Yıldız (2016) analyzed this relationship in Çorum province over the period 1994-2014. In their study, red meat production in Çorum was treated as the dependent variable, while the national red meat price in Turkey served as the independent variable, and the analysis was conducted using the Almon distributed lag approach. The model was found to be statistically significant at the 10% level, indicating that red meat production is influenced by prices over the previous six years. The results revealed a positive relationship between production and prices from the current year (t) up to six years prior (t-6). In the absence of any price changes, red meat production was estimated at 8,713.03 tons. Furthermore, a one-unit increase in the current year's price (t) raised production by 26,832 tons, while price increases in the previous years led to progressively higher production: 113,476 tons (t-1), 200,120 tons (t-2), 260,880 tons (t-3), 321,640 tons (t-4), 373,772 tons (t-5), and 417,276 tons (t-6). These findings suggest that increases in lagged red meat prices positively affect production, with the impact becoming stronger over time. Overall, the study highlights the significant role of red meat prices in shaping production decisions under market-driven conditions.

Overall, a review of the literature indicates that the Almon model has been effectively employed to examine agricultural products, demonstrating that lagged price effects play a decisive role in shaping production decisions. However, empirical studies focusing specifically on animal products, and red meat production in particular, remain limited. This gap underscores the need for a more comprehensive, nationally focused analysis of the relationship between production and prices in Turkey's red meat sector. Accordingly, the present study contributes to the literature by analyzing the link between red meat production and prices over the 1994-2024 period within the framework of the Almon model, thereby addressing this empirical gap.

4. MATERIALS AND METHODS

4.1. Materials

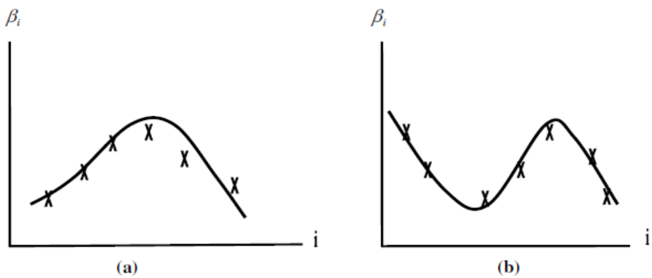
The Distributed Lag Almon Model was used to analyze the dynamic relationship between red meat production and prices in Turkey. In this context, red meat production volume was included in the model as the dependent variable, and red meat price as the independent variable. Red meat production calculations in Turkey cover the total production of cattle, buffalo, sheep, and goat meat. The analysis period covers the years 1994-2024, and red meat production and price data were obtained from the databases of the Turkish Statistical Institute (TURKSTAT, 2025b,c). In this framework, the model aims to empirically examine the lagged effects of price movements in the red meat market on production decisions.

4.2. Methods

In the economics literature, various econometric models have been developed to examine the relationship between the production quantity of a good and its price. Among these, lag-distributed models such as the Koyck and Almon models are the most commonly used (Koutsoyiannis, 1989: 296-320). Lag-distributed models are designed to incorporate not only the current value of the independent variable but also its past values (İşyar, 1999). If a finite number of lags is assigned to the independent variable, the model is referred to as a *"finite lag model";* if no such restriction is imposed, it is called an "infinite lag model" (Kutlar, 2005: 205-207). The Almon model is a finite distributed lag model developed as an alternative to the Koyck model. One of the key assumptions of the Koyck model is that the coefficients (*βs*) continuously decrease as the lag length increases. However, this assumption limits the model's flexibility, particularly when lag effects occur in a nonlinear manner.

The Almon model overcomes this limitation by allowing the β coefficients to first increase and then decrease or vice versa offering a more flexible structure (Cezayirli, 2007: 32).

Figure 1: Almon Polynomial Delay Diagram



Source: Adapted from Gujarati (2001: 613) and drawn by the authors.

Shirley Almon (1965: 178-196) developed her model by considering that lagged effects can take various forms, drawing on a fundamental concept in mathematics known as the Weierstrass Theorem. Her approach allows lag coefficients *(β values)* to be expressed as polynomial functions of a certain degree (Gujarati, 1999: 613). This representation makes it possible to model the effects as changing smoothly and continuously over time. In general, a finite distributed lag model assumes that the dependent variable is influenced not only by the current value of the independent variable but also by a set number of its past values. Such a framework provides a more realistic way to examine dynamic interactions among economic variables. The general form of the finite distributed lag model is illustrated in Equation (1) (Almon, 1965).

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots + \beta_k X_{t-k} + \varepsilon_t \quad (1)$$

In the finite distributed lag model, the dependent variable Y_t can be expressed as a combination of the current and past values of the independent variable. This relationship is formulated as shown in Equation (2) (Amemiya, 1985: 178):

$$Y_t = \alpha + \sum_{\mathrm{i}=0}^{k} \beta_{\mathrm{i}} X_{t-\mathrm{i}} + \varepsilon_t \quad (2)$$

In Equation (2), the coefficients β_{i} are represented as a polynomial function of the lag i (Amemiya, 1985: 178). Here, k denotes the lag length, and

ε_t represents the error term. This formulation enables the model to account for the influence of past values on the dependent variable in a structured and flexible way. Accordingly, the β_{i} coefficients can be estimated across the lag sequence, as illustrated in Figure 1(a) and formally presented in Equation (3).

$$\beta_{\mathrm{i}} = c_0 + c_1^{\mathrm{i}} + c_2^{\mathrm{i}^2} \tag{3}$$

At this point, a second-degree polynomial emerges in the estimation of the β_{i} coefficients. If the lag sequence is as depicted in Figure 1(b), the polynomial form allows the coefficients to exhibit increasing or decreasing trends across the lags, as formally expressed in Equation (4).

$$\beta_{\mathrm{i}} = c_0 + c_1^{\mathrm{i}} + c_2^{\mathrm{i}^2} + c_3^{\mathrm{i}^3} \tag{4}$$

This expression represents a third-degree polynomial. In general, if the β_{i} coefficients are expressed using higher-degree polynomials, they can be represented as shown in Equation (5).

$$\beta_{\mathrm{i}} = c_0 + c_1^{\mathrm{i}} + c_2^{\mathrm{i}^2} + c_3^{\mathrm{i}^3} + \cdots + c_m^{\mathrm{i}^{\mathrm{m}}} \tag{5}$$

Thus, β_{i} can be expressed as an m-th degree polynomial of i, where mmm is assumed to be smaller than the maximum lag length k. Consequently, given the ccc coefficients and the polynomial degree mmm in Equation (5), an approximate value of the β_{i} coefficient can be calculated.

To illustrate the functioning of the Almon model, let us assume that the β_{i} coefficients follow the pattern shown in Figure 1(a), forming a second-degree polynomial. In this case, by substituting the β_{i} expression from Equation (3) into the model in Equation (6), we obtain a structure in which the lagged coefficients are represented through a polynomial form.

$$Y_t = \alpha + \sum_{\mathrm{i}=0}^{k} \left(c_0 + c_1^{\mathrm{i}} + c_2^{\mathrm{i}^2}\right) X_{t-\mathrm{i}} + \varepsilon_t \tag{6}$$

If the equation in Equation (6) is expressed in a more explicit form, it can be written as in Equation (7).

$$Y_t = \alpha + c_0 \sum_{\mathrm{i}=0}^{k} X_{t-\mathrm{i}} + c_1 \sum_{\mathrm{i}=0}^{k} \mathrm{i} X_{t-\mathrm{i}} + c_2 \sum_{\mathrm{i}=0}^{k} i^2 X_{t-\mathrm{i}} + \varepsilon_t \tag{7}$$

To simplify the expressions in Equation (7), the abbreviations presented in Equation (8) can be employed.

$$Z_{0t} = \sum_{i=0}^{k} X_{t-i}, \quad Z_{1t} = \sum_{i=0}^{k} \dot{I} X_{t-i} \quad ve \quad Z_{2t} = \sum_{i=0}^{k} i^2 X_{t-i} \tag{8}$$

By applying the abbreviations in Equation (8) to reorganize the model in Equation (7), it can be expressed as shown in Equation (9).

$$Y_t = \alpha + c_0 Z_{0t} + c_1 Z_{1t} + c_2 Z_{2t} + \varepsilon_t \tag{9}$$

This framework allows the effects of lagged independent variables to be incorporated into the model in a systematic and flexible manner through polynomial functions.

Gujarati (2001: 615-616) outlines the procedural steps to be followed prior to applying the Almon technique. According to his guidance, the first step involves specifying the maximum lag length (k) in advance. In the process of model selection and evaluating its adequacy, criteria such as the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC) are frequently employed (Kutlar, 2000: 44-46). The AIC, which accounts for both the explanatory power of the model and the number of parameters, is computed as expressed in Equation (10) (Cooray, 2008: 194).

$$\text{AIC} = \text{T} \ln \hat{\sigma}^2 + 2n \tag{10}$$

In contrast, the SBC applies a stronger penalty for the number of parameters when evaluating the model's fit, and it is represented as shown in Equation (11).

$$\text{SBC} = \text{T} \ln \hat{\sigma}^2 + n\, ln(T) \tag{11}$$

In Equations (10) and (11), T denotes the number of usable observations, n represents the number of estimated parameters, and $\hat{\sigma}^2 = \frac{KKT}{T-n}$ corresponds to the variance of the error term, or equivalently, the maximum likelihood estimate of σ\sigmaσ. Here, SSE refers to the sum of squared residuals. When selecting a model and determining the appropriate lag length, the ideal values for both the AIC and SBC are those that are as small as possible. AIC and SBC values are computed for different model specifications, and the model exhibiting the smallest value is considered the most suitable for the given dataset (Kutlar, 2000: 44-46). As additional explanatory variables are incorporated into the model and the explanatory power increases, both AIC and SBC values tend to decrease accordingly (Kutlar, 2000: 46). Beyond these criteria, there exist alternative methods for determining the optimal lag length. These include estimating the lag length when the maximum lag is known (Judge et al., 1988: 1024; Genceli, 2001: 772) and using the cross-correlation function to infer the lag structure (Lardaro, 1993: 550-551). Distributed lag models are typically estimated using the ordinary least squares (OLS) method, adapted specifically for the structure of each model (Alt, 1942: 113-128; Tinbergen, 1949: 174-185; Tarı, 2014: 261-265).

Once the lag length k has been determined, the degree of the polynomial, m, must be specified. The polynomial degree is generally chosen to be one more than the number of inflection points (maxima or minima) in the lag structure, or at least one higher. For instance, if there is only a single turning point, as illustrated in Figure 1(a), a second-degree polynomial is typically considered an appropriate approximation. However, since the number and location of turning points are usually unknown in advance, the choice of k and m remains largely subjective (Gujarati, 2001: 619; Akın, 2002: 742). Consequently, researchers often determine the appropriate lag length and polynomial degree based on their judgment. For example, if there is uncertainty about whether a second- or third-degree polynomial should be used, one can examine the regression results of Z_{3t}. If the coefficient c_2 is statistically significant while c_3 is not, it may be concluded that a second-degree polynomial provides a sufficiently accurate representation (Akın, 2002: 670-671).

Once the lag length k and the polynomial degree m have been established, the Z values in Equation (8) can be calculated. For example, if the polynomial degree is set to m=2 and the number of lags is k=6, the corresponding Z values are derived as presented in Equations (12), (13), and (14).

$$Z_{0t} = \sum_{\mathrm{i}=0}^{6} X_{t-\mathrm{i}} = (X_t + X_{t-1} + X_{t-2} + X_{t-3} + X_{t-4} + X_{t-5} + X_{t-6}) \tag{12}$$

$$Z_{1t} = \sum_{\mathrm{i}=0}^{6} \dot{\mathrm{I}} X_{t-\mathrm{i}} = (X_{t-1} + 2X_{t-2} + 3X_{t-3} + 4X_{t-4} + 5X_{t-5} + 6X_{t-6}) \tag{13}$$

$$Z_{2t} = \sum_{i=0}^{6} i^2 X_{t-i} = (X_{t-1} + 4X_{t-2} + 9X_{t-3} + 16X_{t-4} + 25X_{t-5} + 36X_{t-6}) \quad (14)$$

When the sub-models are incorporated into the main model, the core equation presented in Equation (9) is obtained. Following this integration, within a second-degree polynomial lag framework, an integer is assigned to each lag, and the model is estimated using the ordinary least squares method. This procedure produces the coefficients $c_0, c_1, and\ c_2$. Substituting these ccc coefficients back into the model allows the lagged coefficients β_i to be derived (Tarı, 2014: 261-265). In this way, the impact of past values of the independent variable on the dependent variable is systematically modeled through polynomial functions. The β_i coefficients, expressed in terms of c, are calculated using the equations presented in Equations (15) through (21) (Gujarati, 2001: 614-615).

$$i = 0,\ \hat{\beta}_0 = c_0 \quad (15)$$
$$i = 1,\ \hat{\beta}_1 = c_0 + c_1 + c_2 \quad (16)$$
$$i = 2,\ \hat{\beta}_2 = c_0 + 2c_1 + 4c_2 \quad (17)$$
$$i = 3,\ \hat{\beta}_3 = c_0 + 3c_1 + 9c_2 \quad (18)$$
$$i = 4,\ \hat{\beta}_4 = c_0 + 4c_1 + 16c_2 \quad (19)$$
$$i = 5,\ \hat{\beta}_5 = c_0 + 5c_1 + 25c_2 \quad (20)$$
$$i = 6,\ \hat{\beta}_6 = c_0 + 6c_1 + 36c_2 \quad (21)$$

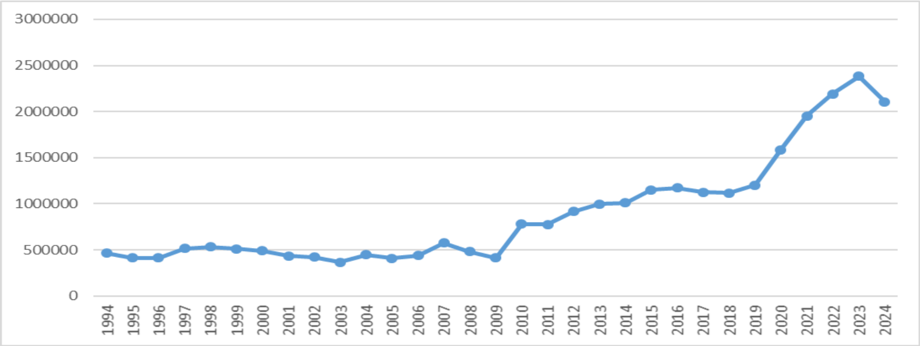
In summary, this framework provides a clear demonstration of the Almon model's capacity to systematically capture lagged effects through polynomial functions.

5. RESEARCH FINDINGS

Considering the time lags between production and marketing in animal products, it is evident that these delays tend to be longer than those observed in crop production. Accordingly, this study examines the relationship between production and prices of red meat an animal product within a framework that accounts for lagged effects, employing the Almon model for empirical analysis.

As shown in Figure 2, an examination of red meat production in Turkey over the 1994-2024 period reveals that production does not follow a continuous upward or downward trajectory; rather, it displays a fluctuating pattern across different periods. This volatility suggests that the relationship between production and prices does not emerge instantaneously but instead occurs with certain time lags, thereby emphasizing both the relevance and importance of employing lagged regression models such as the Almon model to analyze this dynamic relationship.

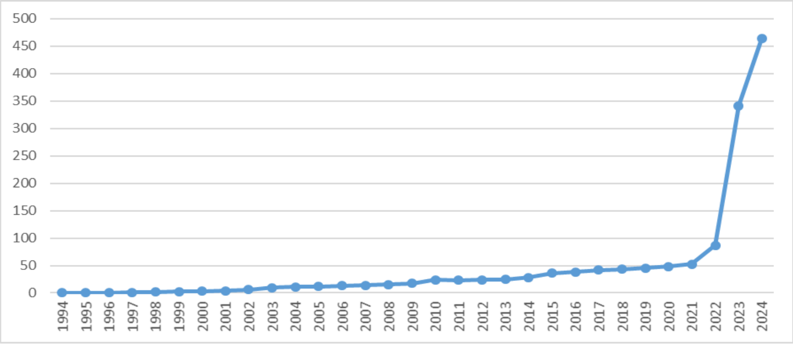
Figure 2: Red Meat Production Amount (Tons)



As shown in Figure 3, red meat prices in Turkey generally remained low and stable throughout the 1994-2024 period, but exhibited a marked increase beginning in 2020. This post-2020 rise in prices is most likely associated with the impacts of the pandemic, rising production costs, and shifts in global demand. Such a trend clearly highlights the importance of employing lagged models, such as the Almon model, in analyzing the dynamic relationship between red meat production and prices.

In general, the fluctuating pattern in production highlights the significance of lagged effects in the relationship between red meat production and prices, indicating that both short-term variations and long-term trends should be taken into account in production planning and price forecasting.

Figure 3: Red Meat Prices (TL/Kg)



To examine whether the relationship between red meat production and prices involves lagged effects, the correlation coefficient between the two variables was calculated as 0.730816. Implementing the Almon distributed lag model requires accounting for the lagged values of red meat prices. To determine the appropriate lag length, both the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC) were utilized. This approach allows the model to maintain an unrestricted distributed lag structure when a higher lag length (k) is chosen, while also enabling the assessment of whether shortening the lag materially alters model performance (Davidson & MacKinnon, 1993). In this study, to evaluate the influence of past prices on historical red meat production, the AIC and SBC values corresponding to different lag lengths are presented in Table 1. These findings suggest that lagged effects may play a meaningful role in shaping production outcomes.

Table 4: AIC and SBC Values at Different Lag Lengths

Delay length	AIC	SBC
k=0	39.87642	39.95481
k=1	39.75421	39.83265
k=2	39.63248	39.71235
k=3	39.52137	39.60524
k=4	39.43218	39.51067
k=5	39.34571	39.42683
k=6	**37.98462***	**38.05674***
k=7	38.10237	38.17843
k=8	38.24516	38.31675

An examination of the findings presented in Table 4 indicates that, for the implementation of the Almon distributed lag model, lagged values of the red meat price series were first constructed. The appropriate lag length to be included in the model was determined by considering the AIC and SBC values. When both criteria consistently indicated the lowest value, a lag length of six periods (k = 6) was selected. This result suggests that the model not only possesses the statistically most suitable lag structure but also reflects that the effects of price changes on production extend over approximately six periods.

Table 5: Red Meat Production-Price Relationship Lag Distributed Model Results

	Constant	t	t-1	t-2	t-3	t-4	t-5	t-6
Coefficient (β)	694.163**	-1,542**	0,158*	0,392*	0,629**	0,671*	0,715	0,759**
t-Statistic	23,859	-3,018	2,011	2,045	2,754	3,215	0,098	3,526
R^2= 0.86 F=10.87 p= 0.004 DW=2.019								

Note: * indicates significance at the p<0.05 level, and ** indicates significance at the p<0.01 level.

The results of the estimated distributed lag model, showing both the magnitude and direction of the lagged relationship between red meat production and prices, are presented in Equation (22).

$$Q_t = 694.163 - 1{,}542\beta_t + 0{,}158\beta_{t-1} + 0{,}392\beta_{t-2} + 0{,}629\beta_{t-3} + 0{,}671\beta_{t-4} + 0{,}715\beta_{t-5} + 0{,}759\beta_{t-6} \quad (22)$$

An examination of the model results presented in Table 5 indicates that price changes in the current period negatively affect red meat production, whereas price levels in periods t-1, t-2, t-3, t-4, t-5, and t-6 exert a positive influence on production. This finding suggests that producers shape their production decisions by taking past price movements into account, with price levels from one to six periods prior playing an especially incentivizing role in promoting production increases. A detailed evaluation of the model parameters shows that the coefficients $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, and\ \beta_6$ are statistically significant (P<0.004 and P<0.01). Consequently, the significance of the parameter estimates for periods t, t-1, t-2, t-3, t-4, and t-6 indicates that lagged price effects play a substantial role in influencing production. The model's correlation coefficient, R^2=0.86, demonstrates a strong relationship between production and prices. Although the β_5 coefficient is not statistically significant, the model's explanatory power remains high, with R^2 =0.86. Moreover, the F-statistic of 10.87 confirms the overall significance of the model (P=0.004<0.01). The Durbin-Watson statistic, calculated as 2.019, further indicates that there is no autocorrelation problem in the model.

The Z values have been calculated in the model, and the degree of the model has been set to m=2 for estimating these values. This expression, shown in Equation 9, has been rearranged in Equation 23 based on the model results in Table 6. Thus, the structure of the model's lagged effects has been revealed more clearly through the obtained Z values.

Table 6: Estimation of Red Meat Production and Price Relationship with the Almon Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
C	694.163	2.513	276.12	0.000**
Z_0	162.657	1.317	123.55	0.000**
Z_1	223.419	1.468	152.13	0.000**
Z_2	-6.271	1.592	-3.94	0.142

Note: * indicates significance at the p<0.05 level, and ** indicates significance at the p<0.01 level.

$$Q_t = 694.163 + 162.657Z_{0t} + 223.419Z_{1t} - 6.271Z_{2t} + \varepsilon_t \quad (23)$$

After obtaining the Z values calculated in Table 6, the mathematical derivations presented in Equations (15) through (21) were carried out, yielding the lagged coefficients β_{i}, as shown below.

$$\hat{\beta}_0 = 162.657$$
$$\hat{\beta}_1 = c_0 + c_1 + c_2 = 162.657 + 223.419 - 6.271 = 379.805$$
$$\hat{\beta}_2 = c_0 + 2c_1 + 4c_2 = 162.657 + 2(223.419) - 4(6.271) = 584.411$$
$$\hat{\beta}_3 = c_0 + 3c_1 + 9c_2 = 162.657 + 3(223.419) - 9(6.271) = 776.475$$
$$\hat{\beta}_4 = c_0 + 4c_1 + 16c_2 = 162.657 + 4(223.419) - 16(6.271) = 955.997$$
$$\hat{\beta}_5 = c_0 + 5c_1 + 25c_2 = 162.657 + 5(223.419) - 25(6.271) = 1122.977$$
$$\hat{\beta}_6 = c_0 + 6c_1 + 36c_2 = 162.657 + 6(223.419) - 36(6.271) = 1277.415$$

Based on the estimated coefficient values, the Almon distributed lag model can be expressed in its final form, as presented in Equation (24). This formulation, obtained by substituting the estimated polynomial coefficients, analytically captures the empirical structure of the model as well as the temporal distribution of the lagged effects.

$$Q_t = 694.163 + 162.657P_t + 379.805P_{t-1} + 584.411P_{t-2} + 776.475P_{t-3} + 955.997P_{t-4} + 1122.977P_{t-5} + 1277.415P_{t-6} \quad (24)$$

According to the results of the Almon distributed lag model presented in Equation (24), red meat production is estimated at approximately 694,163 tons when there is no change in price levels. An examination of the model coefficients reveals that the impact of price changes on production increases gradually over time. Specifically, a 1 TL increase in red meat prices in the current period raises production by 162,657 tons, while the effect grows to 379,805 tons with a one-period lag and 584,411 tons with a two-period lag. In the third and fourth periods, the impact reaches 776,475 tons and 955,997 tons, respectively, and further rises to 1,122,977 tons and 1,277,415 tons in the fifth and sixth periods.

These findings indicate that the impact of price increases on red meat production intensifies over time in a lagged and cumulative manner, suggesting that producers respond only modestly to price signals in the short term but more substantially over longer horizons. This pattern reflects that production decisions are spread out over time and that the adjustment to market conditions occurs with a certain delay. Overall, it can be concluded that red meat production is sensitive to past price movements and that this relationship operates in a positive direction.

6. CONCLUSION AND EVALUATION

In this study, the interaction between red meat production and prices was examined using the Almon distributed lag model. The analysis utilized annual data spanning the period from 1994 to 2024, with red meat production treated as the dependent variable and red meat prices as the independent variable. Correlation analysis revealed a strong and positive relationship between production and prices, with a coefficient of 0.73. This finding indicates that red meat production is significantly influenced by price changes and suggests that the Almon model provides an appropriate framework for capturing this relationship. The model's lag length was determined by considering both the AIC and the SBC. When both criteria reached their minimum values, the maximum lag length was identified as six years (k=6), implying that red meat production is affected by price movements over the preceding six years.

According to the results of the Almon distributed lag model, both the model and its coefficients were found to be statistically significant at the 1% and 5% levels. The findings indicate that red meat production is meaningfully influenced by price movements over the past six years, and that a positive relationship exists between production and prices in the t-1 through t-6 periods. While current-period price changes were observed to have a negative effect on production, past price levels contributed positively to production. In the absence of any price changes, red meat production is estimated at approximately 694,163 tons. An examination of the model coefficients reveals that the effect of price changes on production increases gradually over time. Specifically, a 1 TL increase in red meat prices in the current period raises production by 162,657 tons, while the same increase one period earlier (t-1) raises it by 379,805 tons, and two periods earlier (t-2) by 584,411 tons. In the third and fourth periods (t-3 and t-4), the effect reaches 776,475 tons and 955,997 tons, respectively, and in the fifth and sixth periods (t-5 and t-6), it rises to 1,122,977 tons and 1,277,415 tons. These results suggest that red meat production is sensitive to past price movements, and that this relationship is positive in direction. Furthermore, the model demonstrates a high degree of explanatory power, with an R^2 of 0.86, an F-value of 10.87, and a p-value of 0.004, indicating a strong relationship between prices and production and confirming the overall significance of the model.

Overall, the analysis reveals a strong and positive relationship between red meat production and price levels. The model suggests that price changes affect production not only in the current period but also progressively across subsequent lagged periods. This pattern reflects the biological and investment-related delays inherent in the red meat sector. Producers cannot respond immediately to price signals; due to the time-consuming nature of processes such as animal rearing, feeding, and slaughtering, supply adjustments occur with a lag. As a result, the production-boosting effect of rising prices is limited in the short term but becomes increasingly pronounced over time. Furthermore, the fact that this effect peaks in the sixth period highlights that production decisions are strongly influenced by past price movements and that producers require time to adapt to market conditions. This finding aligns with the fundamental assumption of the Almon model, namely that lagged effects unfold in a smooth and continuous manner, either gradually decreasing or increasing over time.

In conclusion, the model's findings indicate that supply in the red meat market responds to price changes with a lag, implying that the impact of pricing policies on production primarily manifests over the medium and long term. This suggests that production decisions driven by short-term price fluctuations are likely to have limited effectiveness, whereas consistent and stable pricing policies can play a crucial role in enhancing the sustainability of supply within agricultural planning.

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