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Research Article

# Evaluation of the Effect of Exchange Rate and Energy Prices on Livestock Products and Feed Prices in Türkiye with Path Analysis

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**Abstract**

The aim of this study was to reveal the effects of exchange rate ($) and energy (oil) prices on livestock product (red meat, milk, eggs) and input (feed) prices in Türkiye through Path Analysis. The material of this study consisted of monthly average exchange rate and energy prices vs. fattening feed, milk feed, and egg feed prices, and producer prices of red meat, milk, and eggs for the years 2010-2023. According to the findings of this study, one unit increase in the exchange rate resulted in a total increase of 0.98, 0.99 and 0.98 units in the prices of fattening, milk and egg feed, respectively; a total increase of 0.93, 0.98 and 0.97 units in red meat, milk and egg prices, respectively ($P<0.05$). It was determined that a one unit increase in energy prices caused a total increase of 0.09, 0.09 and 0.11 units in fattening, milk and egg feed prices, respectively ($P<0.05$). However, energy prices did not affect livestock product prices ($P>0.05$). As a result, it has been observed that the exchange rate affects, particularly, input and livestock product prices, whereas energy prices affect only input costs in Türkiye. Therefore, it is thought that reducing external dependence on energy and upward fluctuations in exchange rates will make significant contributions to the reduction of input costs and product prices in animal husbandry, increase consumption rates and profitability of producers.

**Keywords:** Livestock products, Energy, Exchange rate, Path analysis, Price

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## Introduction

According to data of the United Nations (UN), it is estimated that the world population will reach 8.5 billion in 2030 and approximately 10 billion in 2050 [1,2]. The demand for many basic needs, such as food, clothing, housing, and heating, has increased every day with the increasing population [3]. In addition to increasing the amount of food, it is also necessary to consume food items in an adequate and balanced manner for health purposes. From this perspective, it can be speculated that foods of animal origin are of key importance for adequate and balanced nutrition, especially in underdeveloped and developing countries such as Türkiye. Because animal foods contain substances with high nutritional value such as essential amino acids, valuable oils, vitamins and trace elements, they are vital for a healthy/balanced diet at every stage of life [4].

Food prices are one of the most important criteria for access to animal food [5]. The more affordable and accessible food prices are, the easier it will be for all segments of the society to access food. High production costs, decrease in meadow-pasture areas, global warming/drought, imbalances in the precipitation regime, withdrawals from production (migration), war and natural disasters are among the factors that cause the increase in animal food prices [6]. Increases in production costs depend on the increases mainly in feed, labor, veterinary-health, maintenance-repair, depreciation and other expense items. In addition, the factors that cause the increase in these cost elements include volatility in exchange rates and energy prices in recent years, especially in developing countries such as Türkiye. Continuous and upward changes in energy prices and exchange rates instantly affect the market, and are reflected in an increase in

product prices [7,8]. It is known that these increases cause food inflation and increase general inflation [9].

The Path Analysis method, which was used to determine the effect of exchange rates and energy prices on livestock product and input (fattening feed, milk feed and egg feed) prices in this study, was first introduced by Sewall Wright in the 1930s, and it has been used to determine the statistical relationship between variables in structural equation models. Structural equation models (SEM) are the methods that can be applied in all areas where cause-effect relationships need to be determined. The Path Analysis method, a structural equation model (SEM), is used to determine how much of the effects of independent variables on dependent variables are direct and how much indirect by estimating the structural relationship between numerical variables [10]. In recent years, Path Analyses have been used in many areas [11- 15]. These are marketing and logistics, transportation services, business etc [16-18].

The effect of increasing exchange rates and energy prices on livestock products is a research topic. In this study, it was aimed to reveal the effect of exchange rate and Brent oil prices as energy source on input (fattening feed, milk feed and egg feed) and prices of livestock products (red meat, milk and egg prices) in Türkiye through Path Analysis.

***Table 1.*** *Exchange rate, energy prices, feed prices, red meat, milk and egg producer prices by years (2010-2023)**

| Dates | Egg Feed TRY/ kg | Milk Feed TRY/ kg | Fatt, Feed TRY/ kg | Energy (Oil) $/Barrel | Exc Rate $/TRY | Meat Price TRY/ kg | Milk Price TRY/L | Egg Price TRY/ Piece | Dates | Egg Feed TRY/ kg | Milk Feed TRY/ kg | Fatt, Feed TRY/ kg | Energy (Oil) $/Barrel | Exc Rate $/TRY | Meat Price TRY/ kg | Milk Price TRY/L | Egg Price TRY/ Piece |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2010-Jan** | 0.6 | 0.4 | 0.4 | 76.8 | 1.5 | 16.8 | 0.9 | 0.2 | **2017-Jan** | 1.2 | 1.0 | 0.9 | 54.6 | 3.7 | 25 | 1.2 | 0.3 |
| **2010-Apr** | 0.7 | 0.5 | 0.5 | 84.8 | 1.5 | 19.2 | 0.9 | 0.1 | **2017-Apr** | 1.2 | 1.0 | 0.9 | 52.3 | 3.7 | 26.7 | 1.2 | 0.2 |
| **2010-Aug** | 0.7 | 0.5 | 0.5 | 77.0 | 1.5 | 18.3 | 0.9 | 0.1 | **2017-Aug** | 1.2 | 1.0 | 0.9 | 51.7 | 3.5 | 27.9 | 1.3 | 0.2 |
| **2010-Dec** | 0.7 | 0.6 | 0.6 | 91.5 | 1.5 | 19.1 | 0.9 | 0.1 | **2017-Dec** | 1.3 | 1.1 | 1.0 | 64.4 | 3.8 | 26.1 | 1.4 | 0.3 |
| **2011-Jan** | 0.7 | 0.6 | 0.6 | 96.5 | 1.6 | 19.1 | 0.8 | 0.1 | **2018-Jan** | 1.3 | 1.1 | 1.0 | 69.0 | 3.8 | 26.6 | 1.4 | 0.3 |
| **2011-Apr** | 0.8 | 0.6 | 0.6 | 123.3 | 1.5 | 18.2 | 0.8 | 0.1 | **2018-Apr** | 1.5 | 1.2 | 1.1 | 72.1 | 4.1 | 28.6 | 1.5 | 0.3 |
| **2011-Aug** | 0.9 | 0.7 | 0.6 | 110.2 | 1.7 | 18.4 | 0.8 | 0.2 | **2018-Aug** | 1.7 | 1.4 | 1.3 | 72.5 | 5.7 | 28.9 | 1.7 | 0.4 |
| **2011-Dec** | 0.8 | 0.6 | 0.6 | 107.9 | 1.9 | 18.8 | 0.9 | 0.2 | **2018-Dec** | 1.6 | 1.4 | 1.3 | 57.4 | 5.3 | 27.1 | 1.7 | 0.4 |
| **2012-Jan** | 0.8 | 0.6 | 0.6 | 110.7 | 1.8 | 18.3 | 0.9 | 0.2 | **2019-Jan** | 1.7 | 1.4 | 1.3 | 59.4 | 5.4 | 27.8 | 1.7 | 0.4 |
| **2012-Apr** | 0.9 | 0.7 | 0.6 | 119.8 | 1.8 | 17.7 | 0.9 | 0.2 | **2019-Apr** | 1.8 | 1.5 | 1.4 | 71.2 | 5.7 | 31.0 | 1.7 | 0.4 |
| **2012-Aug** | 0.9 | 0.7 | 0.7 | 113.4 | 1.8 | 17.4 | 0.9 | 0.2 | **2019-Aug** | 1.8 | 1.5 | 1.4 | 59.0 | 5.6 | 31.4 | 2 | 0.3 |
| **2012-Dec** | 0.9 | 0.8 | 0.7 | 109.5 | 1.8 | 16.7 | 1 | 0.2 | **2019-Dec** | 1.8 | 1.5 | 1.4 | 67.3 | 5.8 | 31.4 | 2.3 | 0.4 |
| **2013-Jan** | 0.9 | 0.8 | 0.8 | 113.0 | 1.8 | 16 | 0.9 | 0.2 | **2020-Jan** | 1.9 | 1.5 | 1.4 | 63.7 | 5.9 | 32.8 | 2.3 | 0.4 |
| **2013-Apr** | 0.9 | 0.7 | 0.7 | 102.3 | 1.8 | 15.9 | 0.9 | 0.2 | **2020-Apr** | 2.2 | 1.7 | 1.6 | 18.4 | 6.8 | 36.6 | 2.3 | 0.4 |
| **2013-Aug** | 0.9 | 0.7 | 0.7 | 111.3 | 2.0 | 15.8 | 0.9 | 0.2 | **2020-Aug** | 2.2 | 1.7 | 1.6 | 44.7 | 7.3 | 36.7 | 2.3 | 0.4 |
| **2013-Dec** | 0.9 | 0.7 | 0.7 | 110.8 | 2.1 | 15.9 | 1 | 0.2 | **2020-Dec** | 2.5 | 2.2 | 2.0 | 50.0 | 7.7 | 36.2 | 2.3 | 0.7 |
| **2014-Jan** | 1.0 | 0.7 | 0.7 | 108.1 | 2.2 | 15.9 | 1 | 0.3 | **2021-Jan** | 2.6 | 2.2 | 2.1 | 54.8 | 7.4 | 37.4 | 2.8 | 0.6 |
| **2014-Apr** | 1.0 | 0.8 | 0.7 | 107.8 | 2.1 | 16.2 | 1 | 0.2 | **2021-Apr** | 2.9 | 2.5 | 2.3 | 64.8 | 8.2 | 40.0 | 2.8 | 0.6 |
| **2014-Aug** | 1.1 | 0.8 | 0.8 | 101.6 | 2.2 | 17.5 | 1.1 | 0.2 | **2021-Aug** | 3.2 | 2.7 | 2.5 | 70.8 | 8.5 | 44.5 | 3.2 | 0.7 |
| **2014-Dec** | 1.0 | 0.7 | 0.7 | 62.3 | 2.3 | 18.4 | 1.1 | 0.2 | **2021-Dec** | 5.5 | 4.1 | 3.9 | 74.2 | 13.5 | 61.9 | 4.7 | 1 |
| **2015-Jan** | 1.0 | 0.8 | 0.7 | 47.8 | 2.3 | 18.9 | 1.1 | 0.2 | **2022-Jan** | 5.4 | 3.9 | 3.7 | 86.5 | 13.5 | 65.2 | 4.7 | 1V1 |
| **2015-Apr** | 1.1 | 0.8 | 0.8 | 59.5 | 2.6 | 20.1 | 1.2 | 0.2 | **2022-Apr** | 7.3 | 5.6 | 5.1 | 104.6 | 14.7 | 87.8 | 5.7 | 1.3 |
| **2015-Aug** | 1.1 | 0.8 | 0.7 | 46.5 | 2.8 | 22.2 | 1.2 | 0.2 | **2022-Aug** | 7.8 | 6.0 | 5.6 | 100.6 | 18.0 | 97.4 | 7.5 | 1.6 |
| **2015-Dec** | 1.0 | 0.8 | 0.7 | 38.0 | 2.9 | 22.6 | 1.2 | 0.3 | **2022-Dec** | 8.0 | 6.3 | 5.9 | 81.0 | 18.6 | 114.2 | 8.5 | 1.8 |
| **2016-Jan** | 1.0 | 0.8 | 0.7 | 30.7 | 3.0 | 24.2 | 1.2 | 0.3 | **2023-Jan** | 8.4 | 6.7 | 6.2 | 82.5 | 18.8 | 133.3 | 10 | 1.8 |
| **2016-Apr** | 1.0 | 0.8 | 0.8 | 41.6 | 2.8 | 24.6 | 1.1 | 0.2 | **2023-Apr** | 8.4 | 6.8 | 6.4 | 84.6 | 19.3 | 218.5 | 10 | 2.2 |
| **2016-Aug** | 1.1 | 0.9 | 0.8 | 45.8 | 3.0 | 25.5 | 1.2 | 0.2 | **2023-Aug** | 9.2 | 7.6 | 6.8 | 86.2 | 27.0 | 232.1 | 11.5 | 2.3 |
| **2016-Dec** | 1.2 | 0.9 | 0.9 | 53.3 | 3.5 | 25.7 | 1.2 | 0.4 | **2023-Sep** | 9.2 | 7.5 | 6.7 | 93.72 | 26.9 | 236.5 | 11.5 | 2.6 |

* Dates are spaced

## Material and Methods

The study material consisted of monthly average exchange rate ($) and energy (Brent oil) prices, and fattening, milk and egg feed prices as well as red meat, milk and egg producer prices for the years January 2010 - November 2023. The data for exchange rate ($/TRY), energy ($/Barrel), fattening (TRY/kg), milk (TRY/kg) and egg feed (TRY/kg) prices and red meat (TRY/kg), milk (TRY/L) and egg (TRY/piece) producer prices were obtained from the records of official and sectorial institutions such as Central Bank of the Republic of Türkiye [19], U.S. International Energy Agency [20], Turkish Feed Manufacturers Association [21], National Red Meat Council [22], National Milk Council [23] and Egg Producers Central Union [24], respectively (*Table 1*). In this study, the direct effects of exchange rate and energy prices on feed prices (fattening, milk and egg feed) which are considered important inputs [25,26] and red meat, milk and egg prices were examined. In addition, the indirect effects of exchange rates and energy prices on red meat, milk and egg prices through feed prices were also examined. Path Analysis method was used to evaluate the obtained data. The data used in the study were analyzed monthly and are given intermittently in *Table 1*. Model fit values were examined and it was seen that the model fit well for all data [27]. AMOS 24 statistical package program was used in the calculations.

In the Path Analysis method, the direct effect between variables is expressed with standardized regression coefficients (β = Path coefficients). Path coefficient (Pyxk) is found by calculating the effect of the independent variable on the dependent variable [28].

$$Pyx_k = b\frac{Sx_k}{S_y} \quad [1.1]$$

Pxy in the equation expresses the direct effect of the independent variable on the dependent variable.

b: partial regression coefficient;

Sx: Standard deviation of feature x;

Sy: Shows the standard deviation of the y feature.

$$Sx_k = \sqrt{\left[\sum\left(X_{kj} - \bar{X}_k\right)^2\right].\frac{1}{n}} \quad [2.1]$$

$$= \left(\sqrt{\sum X_{kj^2} - \frac{\left(\sum x_{kj}\right)^2}{n}}\right).\frac{1}{n} = \sqrt{S_{xx_k}} \quad [2.2]$$

$$S_y = \sqrt{\sum\left(Y - \bar{Y}\right)^2}.\frac{1}{n} \quad [3.1]$$

$$= \sqrt{\left(\sum Y^2 - \frac{\left(\sum Y\right)^2}{n}\right).\frac{1}{n}} \quad [3.2]$$

$$= \sqrt{S_{yy}} \quad [3.3]$$

## Results

In the present study, a Path diagram was initially created, and the obtained model was found to have a good fit. Variance inflation factor (VIF) values were examined for each independent variable, and since the values were less than 10 no multicollinearity problem between the variables was determined. Model fit values for all data were $X^2$/df: 0.001; normed fit index (NFI): 1.000; comparative fit index (CFI): 1.000; root mean square error of approximation (RMSEA): 0.0001; incremental fit index (IFI): 1.001 and Relative Fit Index (RFI): 1.000. Subsequently, the results were obtained by calculating the Path coefficients *(Fig. 1)*.

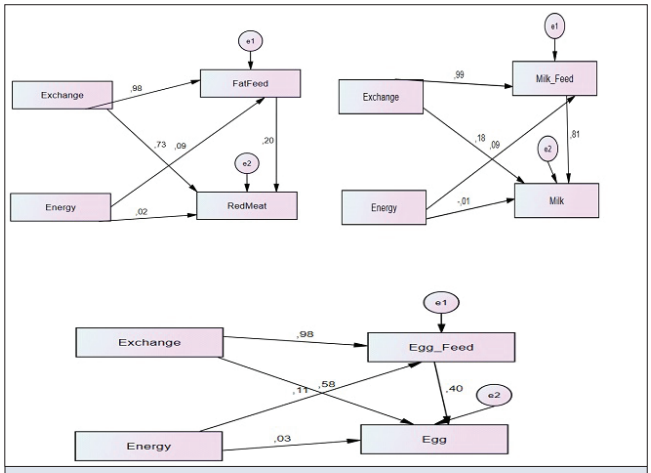


**Fig 1.** LPath diagram for the dependent variables red meat, milk, egg, fattening feed, milk feed, egg feed prices and independent variables energy prices (oil) and exchange rate

In the present study, Path coefficients and results of analyses showing the relationship between independent variables (exchange rate and Brent oil prices) and dependent variables (fattening feed prices, red meat prices) were presented in *Table 2* and *Table 3*.

***Table 2.*** *Results of Path coefficients of independent variables and red meat and fattening feed prices*

| Structural Relationships | | | β | $S_x$ | C.R. | $R^2$ | P |
|---|---|---|---|---|---|---|---|
| Fatt. Feed Price | ← | Exchange Rate | 0.984 | 0.004 | 81.97 | 0.98 | 0.001 |
| Fatt. Feed Price | ← | Energy Price | 0.093 | 0.001 | 7.767 | | 0.001 |
| Red Meat Price | ← | Energy Price | 0.023 | 0.058 | 0.708 | 0.87 | 0.479* |
| Red Meat Price | ← | Exchange Rate | 0.734 | 1.444 | 4.024 | | 0.001 |

β: Standardised Regression Coefficients; Sx: Standard Error; C.R: Critical Ratio; * P>0.05

In this study, in which the direct effects were evaluated, according to the results of the structural equation model, there was a positive relationship between exchange rate (β=0.984) and energy prices (β=0.093) and fattening feed prices. The 98% of the total change in fattening feed

***Table 3.*** *Results of direct, indirect and total effects of independent variables on red meat and fattening feed prices*

| Standardised Direct Effects | | | Standardised Indirect Effects | | Standardised Total Effects | |
|---|---|---|---|---|---|---|
| **Prices** | **Exc. Rate** | **Energy (Oil)** | **Exc. Rate** | **Energy (Oil)** | **Exc. Rate** | **Energy (Oil)** |
| Fatt. Feed | 0.984 | 0.093 | 0.000 | 0.000 | 0.984 | 0.093 |
| Red Meat | 0.734 | 0.023 | 0.197* | 0.019* | 0.931 | 0.042 |

* P>0.05

price was explained with the exchange rate and energy prices ($R^2$=0.98). In the second structural model, it was determined that the 87% of the total change in red meat was explained by the exchange rate ($R^2$=0.87) and the relationship between the two variables was positive (P=0.001; *Table 2*).

When the exchange rate used in this study, the standardized values of the direct effects of Brent oil prices on fattening feed prices and red meat prices and the indirect effects of exchange rate and energy prices on red meat prices through fattening feed prices were examined, it was observed that the exchange rate had a direct effect on fattening feed prices (β=0.984). It was determined that the direct and indirect effect of the exchange rate on red meat prices was 0.734 and 0.197 units, respectively. It was observed that energy prices did not have a significant effect on red meat prices (P>0.05), whereas it had a direct effect of 0.093 units on fattening feed prices. One unit increase in the exchange rate led to a total (direct + indirect effect) increase of 0.98 unit in fattening feed and a total (direct + indirect effect) increase of 0.93 unit in red meat. It was determined that one unit increase in energy prices caused a total (direct + indirect effect) increase of 0.09 unit in fattening feed *(Table 3)*.

Path coefficients and analysis results showing the relationship between independent variables (exchange rate, energy prices) and dependent variables (milk feed prices, milk prices) were presented in *Table 4* and *Table 5*.

***Table 4.*** *Results of Path coefficients of independent variables and milk and milk feed prices*

| Structural Relationships | | | β | $S_x$ | C.R. | $R^2$ | p |
|---|---|---|---|---|---|---|---|
| Milk Feed Price | ← | Exchange Rate | 0.985 | 0.004 | 87.872 | 0.98 | 0.001 |
| Milk Feed Price | ← | Energy Price | 0.091 | 0.001 | 8.151 | | 0.001 |
| Milk Price | ← | Exchange Rate | 0.182 | 0.039 | 2.07 | 0.97 | 0.038 |
| Milk Price | ← | Energy Price | -0.006 | 0.001 | -0.42 | | 0.675* |

β: Standardised Regression Coefficients; Sx: Standard Error; C.R: Critical Ratio; * P>0.05

A positive relationship was determined between the exchange rate (β=0.985) and energy prices (β=0.091) and milk feed prices. The exchange rate and energy prices explained 98% of the total change in milk feed prices ($R^2$=0.98). The 97% of the change in milk prices was explained by the exchange rate, and a positive relationship was found between milk prices and exchange rate (β=0.182; $R^2$=0.97; P<0.05; *Table 4*).

***Table 5.*** *Results of direct, indirect and total effects between independent variables, milk and milk feed prices*

| Standardised Direct Effects | | | Standardised Indirect Effects | | Standardised Total Effects | |
|---|---|---|---|---|---|---|
| **Prices** | **Exc. Rate** | **Energy (Oil)** | **Exc. Rate** | **Energy (Oil)** | **Exc. Rate** | **Energy (Oil)** |
| Milk Feed | 0.985 | 0.091 | 0.000 | 0.000 | 0.985 | 0.091 |
| Milk | 0.182 | -0.006 | 0.796* | 0.074* | 0.978 | 0.068 |

* P<0.05

When the standardized values of the direct effects of exchange rate and energy prices on milk feed prices and milk prices, and the indirect effects of exchange rate and energy prices on milk prices through milk feed prices were examined; it was seen that the exchange rate's direct impact (prediction) power on milk feed and milk prices was 0.985 and 0.182 units, respectively. It was determined that the indirect impact (prediction) power of the exchange rate on milk prices was 0.796 units. The direct impact (prediction) power of energy prices on milk feed prices was 0.091 units, and it did not directly affect milk prices (P>0.05). However, it was determined that it indirectly affected milk prices through milk feed prices (β=0.074; P<0.05). It was observed that one unit increase in the exchange rate caused a total (direct + indirect effect) increase of 0.99 and 0.98 units in milk feed prices and milk prices, respectively. One unit increase in energy prices caused a total (direct + indirect effect) increase of 0.09 unit in milk feed prices *(Table 5)*.

The relationship of the variables (exchange rate, energy, egg feed, egg prices) with each other, Path coefficients and analysis results were given in *Table 6* and *Table 7*.

According to the findings obtained from the structural equation model, a positive relationship was determined between exchange rate (β=0.978) and energy (β=0.108)

***Table 6.*** *Results of Path coefficients of independent variables and egg and egg feed prices*

| Structural Relationships | | | β | $S_x$ | C.R. | $R^2$ | p |
|---|---|---|---|---|---|---|---|
| Egg Feed Price | ← | Exchange Rate | 0.978 | 0.006 | 71.173 | 0.97 | 0.001 |
| Egg Feed Price | ← | Energy Price | 0.108 | 0.001 | 7.856 | | 0.001 |
| Egg Price | ← | Exchange Rate | 0.582 | 0.008 | 6.513 | 0.96 | 0.001 |
| Egg Price | ← | Energy Price | 0.033 | 0.000 | 1.781 | | 0.075* |

β: Standardised Regression Coefficients; Sx: Standard Error; C.R: Critical Ratio; * P>0.05

prices and egg feed prices. It was observed that the 97% of the total change in egg feed price was caused by exchange rate and energy prices ($R^2$=0.97).

There was a positive relationship between egg prices and exchange rate (β=0.582). The 96% of the total change in egg prices was explained by the exchange rate ($R^2$=0.96; P=0.001; *Table 6*).

***Table 7.*** *Results of direct, indirect and total effects of independent variables on egg and egg feed prices*

| | Standardised Direct Effects | | Standardised Indirect Effects | | Standardised Total Effects | |
|---|---|---|---|---|---|---|
| **Prices** | **Exc. Rate** | **Energy (Oil)** | **Exc. Rate** | **Energy (Oil)** | **Exc. Rate** | **Energy (Oil)** |
| Egg Feed | 0.978 | 0.108 | 0.000 | 0.000 | 0.978 | 0.108 |
| Egg | 0.582 | 0.033 | 0.391* | 0.043* | 0.974 | 0.076 |

* P<0.05

When the standardized values of the direct effects of the independent variables (exchange rate, energy prices) on the dependent variable (egg feed prices and egg prices) and the indirect effects of these independent variables on egg prices through egg feed prices were examined, the direct impact (prediction) power of exchange rate on egg feed and egg prices was determined as 0.978 and 0.582 units, respectively. It was found that the exchange rate's indirect influence (prediction) power on egg prices was 0.391 units. The direct impact (prediction) power of energy prices on egg feed prices was determined to be 0.108 units, whereas energy prices did not directly affect egg prices (P>0.05). However, it was determined that energy prices indirectly affected egg prices through egg feed prices (P<0.05). It was determined that one unit increase in the exchange rate led to a total (direct + indirect effect) increase of 0.98 unit in egg feed prices and a total (direct + indirect effect) increase of 0.97 unit in egg prices. One unit increase in energy prices caused a total (direct + indirect effect) increase of 0.11 unit in egg feed prices *(Table 7)*.

## Discussion

Access to food has become even more difficult as there have been serious problems in the production and supply chain owing to the crises experienced in recent years (pandemics, earthquakes, droughts, global wars, etc.). Problems in the production and supply chains have caused an increase in food prices, which has made it difficult for people to access food. In addition to these problems, increases in exchange rates and energy prices, especially in developing countries such as Türkiye, have caused an increase in the costs of food production and supply and an increase in food prices. This situation has made it even more difficult for people, in Türkiye as in almost all countries around the world, to access food [29].

In the present study, it was observed that the exchange rate had an effect on red meat prices, whereas energy prices did not have a significant effect on red meat prices. The main reasons why the increases in the exchange rate affect the prices of red meat are that live animal and red meat imports are carried out with the exchange rate, and the cost elements in beef cattle breeding are affected by changes in the exchange rate and the depreciation of the TRY against the US dollar every day. It is thought that the lack of the effect of changes in energy prices on red meat prices due to a small share of energy in production costs in beef cattle enterprises where red meat is produced. Both the fact that the biggest cost element in beef cattle breeding is not feed but fattening material [30-32] and the energy cost of enterprises in the feed plant production phase are proportionally limited compared to fertilizer and drug costs. This may have prevented the increases in energy prices from being reflected in red meat prices. On the other hand, it suggests that the unstable environment in the supply of red meat due to imports, problems in dairy cattle farming (milk market is not regulated, diseases etc.), production costs and subsidies may be one of the factors affecting the market prices of red meat, in addition to exchange rates and energy prices [33,34]. In this study, it was determined that the exchange rate had a direct effect on milk and egg prices. It was seen that energy prices indirectly affect milk and egg prices through feed prices. It is known that the biggest expense item in dairy cattle and egg poultry farming is feed cost [35-37]. Therefore, it is seen that the increases in feed prices in dairy cattle breeding and egg poultry farming are reflected in the prices of products obtained from these sectors. In addition, it is thought that changes in feed prices affect milk prices because of lesser pasture use in dairy cattle farming compared to beef cattle farming. The majority of inputs in dairy cattle and egg poultry farming have been affected by the exchange rate, which has increased production costs, and product prices have increased as a result of this cost increase. Changes in energy prices may have affected livestock product (milk, egg) prices by affecting transportation costs (feed supply and production stages) [38]. In addition, countries dependent on foreign oil for Brent oil suffer from both changes in energy prices and negative effects on the exchange rate since they import oil in foreign currencies. Supporting the findings of the present study, several studies have indicated that increases in oil prices indirectly increase food prices [39-42].

This study will help both producers and policy makers to estimate how much input costs and livestock product prices in livestock production may be in the future by looking at the data of institutions Central Bank, etc.) that makes future exchange rate predictions.

In conclusion, Türkiye is a developing country with foreign dependence on energy and high exchange rate

fluctuations. Therefore, it was observed that changes in exchange rates and energy prices affected input and livestock product prices. Fluctuations in exchange rates, foreign dependency and depreciation of TRY can be reduced with the right policies, consumption can be increased by preventing the increase in food prices, and the profitability of producers can be ensured by reducing costs.

## Declarations

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**Author Contributions:** MK: Designed the research, Analyzing, Supervision, Writing and editing, MAA: Collected the data, Analyzing, Review, Writing, CİZ: Investigation, Collected the data; EA: Supervision, Writing and editing; SS: Supervision, Writing and editing.

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