Identification of factors affecting purchasing power in dairy cattle farms

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ABSTRACT

The aim of this study is to analyze the economic welfare and purchasing power changes of dairy cattle farms by using internal terms of trade index. In the study, for the period of January 2011 to December 2023, NITOT (Net Internal Terms of Trade Index) was calculated as the "Economic Welfare Indicator," and INTOT (Income Internal Terms of Trade Index) was calculated as the "Purchasing Power Indicator," using data from the Turkish Statistical Institute (TURKSTAT) and the National Milk Council (USK). In the regression model, it was determined that a 1-unit increase in the independent variables—milk feed parity, milk premium support, monthly real raw milk prices, real feed prices, and the monthly milk production quantity index—resulted in increases of 36, 5.4, 0.28, 0.38, and 1.1 units, respectively, in the purchasing power of dairy cattle farms. In addition, in the regression model, the effects of COVID-19 and sectoral crises in 2014, 2018, and 2020 on the purchasing power index were analysed. As a result, it has been observed that Türkiye, which is located at the transition point of regional and global crises, needs to ensure self-sufficiency policies and price stability in order to minimise the impact of these crises on the agriculture and livestock sector. In this context, it is of great importance to provide adequate and timely support for the livestock sector in solving the structural problems in the sector.

Introduction

The issue of sustainability, which became popular after the 1980s, took its place in the literature with the subheadings of economic, environmental, and social sustainability after the 1990s (19). The concept of sustainability in animal husbandry is the continuation of animal production activities in a way that can meet the needs of both present and future generations with the optimum combination of environmental, economic, and social dimensions. This includes elements such as the efficient use of natural resources, ensuring animal welfare, economic profitability, and improving the quality of life of rural communities (5).

Nowadays, especially the supply of agricultural and animal products in a healthier and more sustainable way constitutes an important topic of country policies. When the sustainability potential of livestock enterprises is evaluated economically, it is seen that parameters such as profitability, productivity, competitiveness, food loss and waste, changes in economic welfare, and purchasing power indicators are taken as the basis (1). Among these parameters, changes in economic welfare and purchasing power indicators stand out as the two most striking elements (30).

Purchasing power refers to the ability of an individual or a business to acquire goods and services at a given income level. In the context of businesses, purchasing power generally reflects the relationship between a company's revenue and its costs. If revenue remains constant while prices (costs) increase, purchasing power declines; conversely, if costs decrease or revenue rises, purchasing power improves. Purchasing power is particularly crucial in the agriculture and livestock sectors, as it helps analyze the balance between producers' income and expenses (7). For instance, the extent to which dairy farmers can cover their basic input costs (such as feed

prices) with their earnings is a key determinant of their purchasing power and, by extension, their economic welfare.

Changes in economic welfare reflect the profitability and growth potential of businesses, providing valuable data for investment decisions and strategic planning. Meanwhile, purchasing power indicators measure the ability of businesses to meet input costs, ensuring production sustainability and efficiency (1). Therefore, it can be argued that changes in economic welfare and purchasing power indicators are fundamental elements in determining the long-term sustainability and competitiveness of livestock enterprises.

A review of the literature reveals that purchasing power and economic welfare changes have been examined using various methods. Since the 1920s, personal and disposable income have been used as key indicators to measure purchasing power at the household level (27). However, since the 1950s, alternative parameters have been incorporated, leading to more comprehensive studies on purchasing power at both household and business levels (14, 26). Similarly, while income-based methods were used as economic welfare indicators for many years, it became evident over time that these approaches were insufficient. This realization necessitated the adoption of new parameters for assessing economic welfare levels. Since the 1960s, the impact of price fluctuations across different sectors within countries has been analyzed in greater detail, and in this context, terms of trade have become widely recognized as a key indicator of purchasing power (7). Terms of trade, which focus on the relationship between the prices businesses receive for their sales and the costs incurred during production, have proven to be a practical tool for researchers examining purchasing power and economic welfare indicators (8). Some studies in the literature have calculated terms of trade across a broad range of products (e.g., all agricultural products), while others have focused on single-product analyses.

A review of studies conducted in Türkiye indicates that terms of trade research at the single-product level is quite common. Specifically, when examining research on terms of trade in the agriculture and livestock sectors, it has been found that Uzunöz et al. (34) conducted a study on milk, Uzunöz (33) analyzed legumes, Mencet Yelboğa et al. (23) focused on tomatoes, Mencet Yelboğa et al. (22) examined citrus fruits, Kızılaslan et al. (20) investigated sunflowers, and Tuncel & Cevger (30) conducted a single-product level study on cattle fattening enterprises. However, existing studies have generally been limited to calculating the purchasing power index using terms of trade and have not sufficiently focused on a detailed examination of the factors affecting this index through regression analysis. For instance, Uzunöz et al. (34) calculated terms of trade in their study but did not conduct an in-depth statistical analysis of the variables influencing these terms. Similarly, Tuncel and Cevger (30) evaluated the terms of trade in cattle fattening enterprises but did not examine the factors affecting these terms using regression analysis. This study aims to fill this gap in the literature. Specifically, it analyzes the factors affecting the Income Terms of Trade Index (INTOT) for dairy cattle enterprises between 2011 and 2023. In the study, terms of trade have been calculated as a practical and effective tool for measuring economic welfare and purchasing power in cattle fattening enterprises, as previously utilized in the literature. Subsequently, potential parameters affecting purchasing power—including the milk/feed parity, raw milk prices, milk production volume, milk support premiums, the effects of the COVID-19 pandemic, seasonal periods, and sectoral fluctuations—were examined to determine their impact on INTOT through regression analysis. Through this approach, the study aims to provide strategic guidance to policymakers and public authorities by identifying the key variables underlying the purchasing power index, thereby contributing to the development of policies that support dairy producers.

Materials and Methods

The material of this study consisted of cattle milk production quantities in liters, raw milk prices, feed prices, the consumer price index (CPI), milk/feed parity, and milk support premium payments in a monthly frequency. In the study, raw milk prices and feed price data were obtained from the National Milk Council (32), and other data were obtained from the Turkish Statistical Institute (30). Since raw milk prices in Türkiye were determined by the USK as a “reference price” instead of the free market after 2011, the study period was conducted at a monthly frequency between January 2011 and December 2023.

In the research, the Net Internal Terms of Trade Index (NITOT) was calculated by dividing the income index (P1) obtained from the sale of 1 liter of raw milk by the index (P2) of the cost incurred to realize this production. By multiplying the NITOT index by the production level, the Income Internal Terms of Trade Index (INTOT), the purchasing power of dairy cattle farms, was determined (21).

NITOT(milk) = P1 / P2 *100

INTOT(milk) = NITOT x Qmilk/100

In the research, raw milk prices determined by the NRA on a monthly basis were used in the calculation of the income from the milk sales index (P1), and the cost of raw milk determined by the NRA on a monthly basis was used in the calculation of the expenses incurred by the breeder index (P2). In the research, these data were

converted into index values at a monthly frequency. 'Raw milk costs' used in the scope of the research were obtained by adding the operating costs of concentrate feed, straw, corn silage, and alfalfa materials, as well as other expense items (labor, water, electricity, health, insurance, interest, etc.) on a monthly frequency by the NRA, and the calf and fertilizer income were deducted from the income obtained and calculated as final.

Statistical Analysis: Regression analysis is a statistical analysis used to quantify the relationship between a dependent variable and one or more independent variables and is used to measure the direction and effect of the relationship between variables.

In the study, the SPSS 22 statistical package program was used to solve the multiple linear regression model. The stepwise selection technique was used, which adds the independent variables to the model one by one, tests the model validity stepwise with the least number of variables by taking into account the partial correlations between both independent variables and the dependent variable, and selects the most compatible model (17).

In the multiple linear regression model, a total of 14 independent variables (Monthly period (M), seasonal period (SP), milk/feed parity (MFP), monthly real raw milk prices (MP), monthly real feed prices (MRFP), monthly milk production quantity index (MQ), milk support premium (MSP), labor cost, consumer price index (CPI), producer price index (PPI), beef price, raw milk cost, dummy variable (Covid-19), and dummy variable (sectoral fluctuation)) were used to analyze their effects on the INTOT index. In the study, monthly period (January: 1...December: 12), seasons (1: winter; 2: spring; 3: summer; 4: autumn), Covid-19 (1: present, 0: absent), and sectoral fluctuation (1: 2014, 2018, 2020; 0: absent) were included in the analyses as categorical (qualitative) variables, while the other variables were analyzed as continuous (quantitative) data.

The stepwise regression technique was applied in the study. As a result of the analysis, labor cost, consumer price index (CPI), producer price index (PPI), beef price, and raw milk cost were removed from the model, leaving a total of 9 independent variables. The degree of correlation, linear relationship, multicollinearity, and multivariate issues among the selected 9 independent variables were tested.

Multiple linear regression model of the factors affecting the purchasing power index (INTOT) of dairy cattle farms:

INTOT = f (M, SP, MFP, MP, MRFP, MQ, MSP, Cov, SF).

The independent variables affecting the INTOT are given in Table 1.

Table 1. Factors affecting the purchasing power index (INTOT) of dairy cattle farms.

Variables	Definitions
INTOT	Purchasing power index
M	Monthly period (1...12)
SP	Seasonal period (1...4)
MFP	Milk/feed parity
MP	Monthly real raw milk prices (USK)
MRFP	Monthly real feed prices (USK)
MQ	Monthly milk production quantity index
MSP	Milk Support Premium
COV	Dummy variable (covid 19)
SF	Dummy variable (sectoral fluctuation in 2014, 2018, 2020)

*The Turkish lira has been used as the currency in this study

Results

In the study, the income index (P1) received by producers from the sale of 1 liter of raw milk, the cost index (P2) they incurred, and the Consumer Price Index (CPI) values on a monthly basis for the years 2011-2023 are presented in Figure 1.

When Graph 1 is analyzed, it is observed that although P1 and P2 price indices behave close to each other, the P2 index exhibits a more dominant behavior. However, both P1 and P2 index values are above the CPI. Accordingly, it can be said that there are more aggressive increases in both the prices paid and the prices received by the growers than the general inflation level.

The NITOT index, which shows the economic welfare of producers from the terms of trade, and the INTOT index, which is an indicator of purchasing power, are given in Figure 2. When Figure 2 is analyzed, it is seen that the INTOT and NITOT indexes decreased significantly in 2014 due to the sectoral fluctuation experienced in 2014, increased from 2015 to 2018, but started to decrease again from 2019 and reached their lowest level in 2021. The low NITOT index is interpreted as the fact that the grower receives relatively little money and that his economic welfare has changed negatively.

The change in the value of the INTOT index is closely related to the volume of milk production, although it follows a parallel course with the NITOT index. In Figure 2, it can be said that the rapid change in milk production volume after 2011 has caused the INTOT index to exhibit a more significant change compared to the NITOT index.

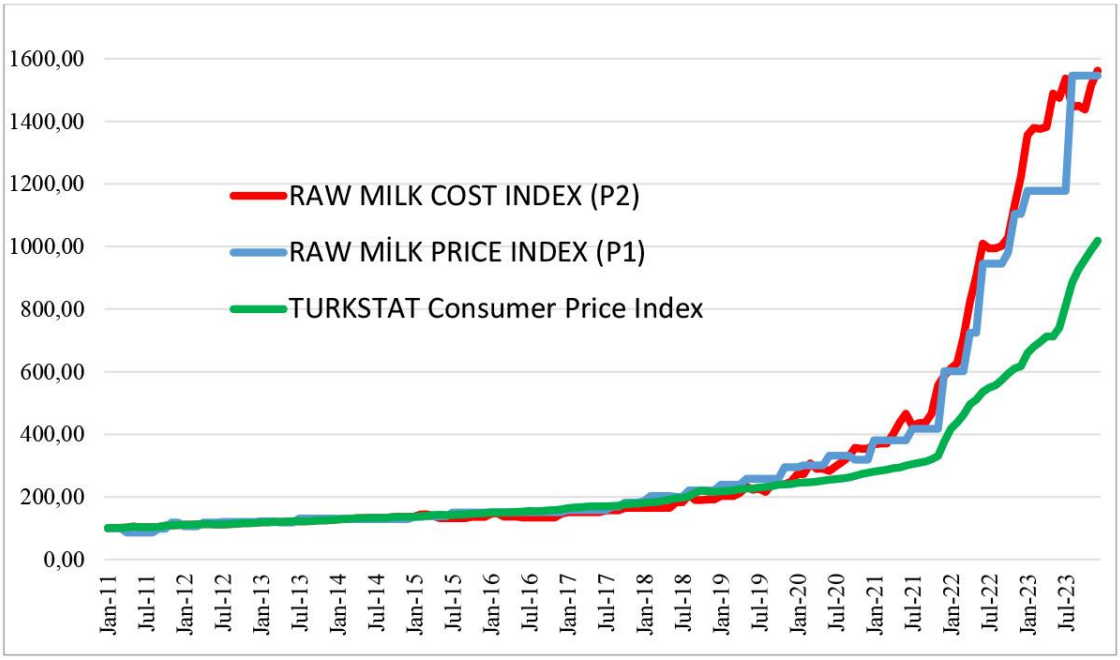

Figure 1: P2, P1, TURKSTAT, consumer price index (CPI).

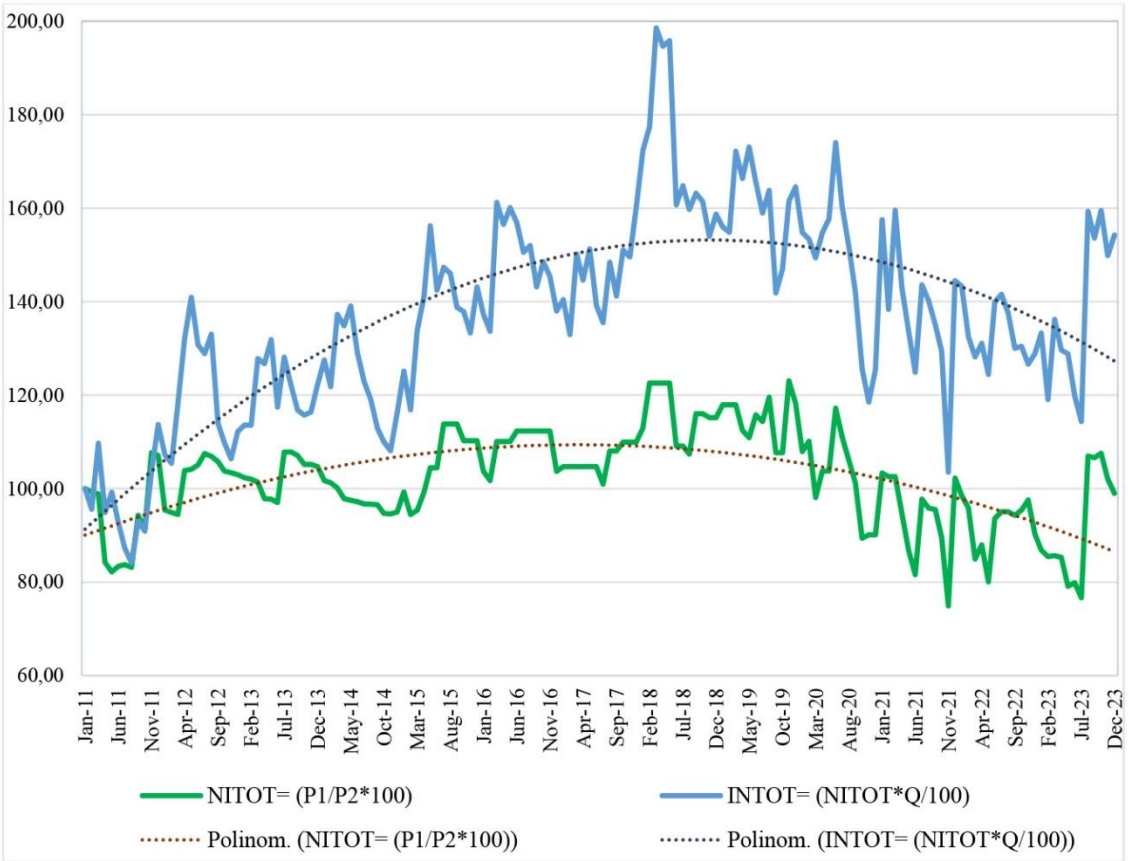

Figure 2. Monthly frequencies of NITOT and INTOT indices in dairy cattle enterprises.

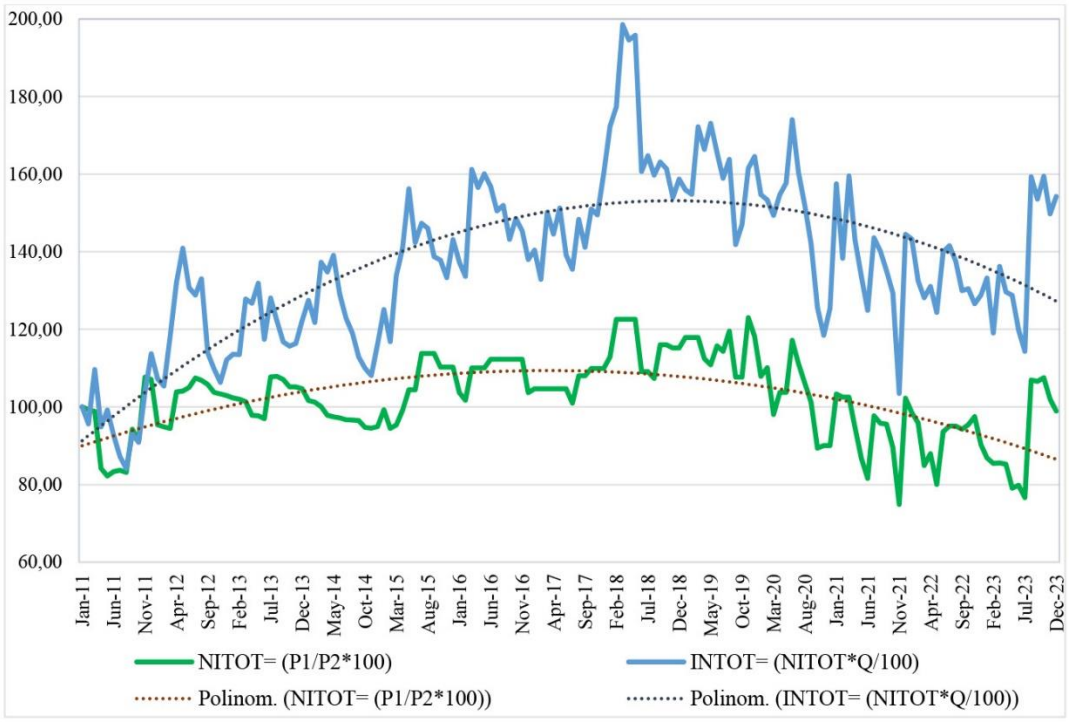

Figure 3. Inflation-adjusted real raw milk prices and real feed prices at monthly frequency

Table 2. Regression analysis results of the factors affecting the INTOT.

	Unstandardized coefficients				Correlations		Collinearity statistics	
	B	Std. Error	t	Sig.	Partial	Part	Tolerance	VIF
(Constant)	-4495.549	1176.589	-3.821	.001				
M	2.192	.590	3.715	.001	.294	.119	.098	10.160
SP	3.943	1.133	3.482	.001	.277	.112	.737	1.356
MFP	36.015	7.393	4.872	.001	.374	.156	.668	1.496
MP	0.284	.100	2.833	.005	.228	.091	.083	2.006
MRFP	-0.038	.007	-5.150	.001	-.392	-.165	.064	5.552
MQ	1.102	.090	12.299	.001	.613	.395	.253	3.956
MSP	5.466	5.425	1.008	.031	.083	.032	.214	4.673
Cov	-18.456	4.413	-4.182	.001	-.327	-.134	.117	8.545
SF	-2.897	2.480	-1.168	.024	-.096	-.037	.458	2.185

n: 156 R=0.922 R2: 0.850 Adj R2: 0.840 F stat: 91.694 DW: 1.779.

Within the scope of the research, the change in the purchasing power index on an annual basis between 2011 and 2023 was determined as 0.89% on average. Accordingly, it has been determined that there is an annual growth of approximately 1% in purchasing power in dairy cattle farms. Data on inflation-adjusted real feed prices, real raw milk prices, and milk-feed parity between 2011 and 2023 are given in Figure 3.

Figure 3 shows that there were significant fluctuations in milk-feed parity between January 2011 and December 2023. While the milk/feed parity exhibited a small but positive increase until 2017, except for the years 2011-2014, it is observed that it entered a downward trend in 2018. In the second half of 2019, the milk/feed parity index, which started to rise again, reached its maximum level in December 2019 before declining once more. In November 2021, milk-feed parity fell to its lowest level in the last 12 years. Another notable aspect in Figure 3 is that the change in feed prices after 2018 has been faster and more significant than the change in raw milk prices. In particular, feed prices, which have increased sharply since November 2021, reached their highest level in June 2022.

The results of the multiple linear regression model used to determine the factors affecting the purchasing power index of dairy cattle farms are presented in Table 2.

R^2, which expresses the ratio of independent variables explaining the dependent variable of the model, is 0.92. Accordingly, it was determined that the purchasing power of milk-producing enterprises, which is the dependent variable, is explained by 92% of the independent variables, and the model is valid (P<0.01). When the table is examined, it is seen that the probability values of the independent variables used in the model are less than 0.05, the F-statistic value expressing the significance of the model is 91.964 (P=0.000; P<0.01), and the model as a whole is significant.

In order to determine whether there is multicollinearity in the model, a coefficient diagnostic measurement was performed, and since the variance inflation factor (VIF) values obtained as a result of this measurement were below 10, no multicollinearity problem was found between the variables. The assumption of a normal distribution of the error terms and thus the dependent variable was evaluated by looking at the Kolmogorov-Smirnov test (P=0.200; P>0.05), and it was observed that this assumption was valid. Durbin-Watson test results were analyzed for the autocorrelation problem, and it was concluded that there was no such problem (DW=1.799). The multicollinearity problem was further investigated by examining the correlation matrix between the variables, and 'part and partial correlation' measurements were made to assess the correlations between the independent variables. It was determined that there was no high correlation between any variables. To examine the validity of the homoscedasticity assumption in the model, the relationship between the dependent variable and the standardized errors was examined, and as a result of these evaluations, it was concluded that all assumptions were fulfilled in the estimated regression model.

The fact that the R^2 value is 0.92 indicates that the model has a high explanatory power for the dependent variable (INTOT – the purchasing power index of dairy cattle farms). However, this situation may also bring the risk of overfitting. Nevertheless, the small difference between R^2 and adjusted R^2 (Adj. R^2) (0.08), the F-statistic value of 91.694 (P<0.01), which demonstrates the overall significance of the model, and the fact that all independent variables in the model are statistically significant (P< 0.05) indicate that the risk of overfitting is negligible and that the model is statistically reliable.

In the model, month (M), seasonal period (SP), milk feed parity (MFP), real milk price index (MP), milk production quantity index (MQ), and milk premium support are statistically significant at the 5% significance level. (SP) variables have positive signs and positively affect the purchasing power of dairy cattle farms, while the coefficients of the real feed price index (MRFP), COVID-19 pandemic (Cov), and sectoral fluctuation (SF) variables have negative signs and negatively affect the purchasing power of dairy farms.

Discussion and Conclusion

The focus of this study is on dairy cattle enterprises, specifically examining their purchasing power and economic welfare levels to assess their economic sustainability potential. In this context, the relationship between the costs incurred during the production process and the revenues obtained from sales is considered a key indicator of the economic sustainability of dairy cattle enterprises.

In particular, the transition to a market economy after April 24, 1980, the privatization of state institutions (such as the Meat and Fish Institution (EBK) and the Dairy Industry Institution (SEK)), and the reduction of livestock subsidies have led to price instabilities in the dairy sector, posing significant threats to its economic sustainability. These structural changes have negatively impacted the long-term financial resilience of the dairy sector, potentially reducing the profitability and competitiveness of dairy enterprises (11, 25).

In this study, despite the increase in livestock subsidies since 2010, the economic sustainability of dairy cattle enterprises operating under free market conditions has been analyzed through calculated terms of trade in an effort to assess their financial viability. Within the scope of the research, the change in the purchasing power index on an annual basis between 2011 and 2023 was determined as 0.89%. Accordingly, it is determined that there is an annual growth of approximately 1% in purchasing power in dairy cattle farms. Similar to this study, Uzunöz et al. (32) reported that the purchasing power index for dairy cattle farms was 1.09% on average on an annual basis between 1984 and 2001.

In this study, a regression model was constructed in which the purchasing power index, included in the terms of trade indices, is the dependent variable. In this model, it was determined that a 1-unit increase in milk premium support increases the purchasing power of producers by 5.466 units. In studies conducted parallel to this finding, it has been reported that the milk incentive premium positively affects cattle milk production and thus the income of producers (2, 10). Bayramoğlu et al. (4) stated in their study that the milk incentive premium has the highest effect among livestock subsidies. However, the fact that increases in the milk incentive premium are not sufficient causes the effects on quality milk production and producers' income to remain limited (33).

Within the scope of the research, the milk/feed parity index, which is the most influential variable among the independent variables, plays a crucial role in the economic sustainability of enterprises. In the analyses conducted, it was determined that a 1-unit increase in milk-feed parity

results in an average increase of 36.015 units in the purchasing power of dairy cattle farms (INTOT). However, both in this study and in the literature review, it is evident that the commonly accepted value of 1.5 for milk-feed parity has not been achieved since 2000 and has remained around an average of 1.1 (12, 16, 19). The sharp decline in milk-feed parity, especially in 2021, prevented milk production costs from being met and negatively affected the economic sustainability of enterprises. This situation weakened the competitiveness of small and medium-sized dairy enterprises in the market and exacerbated the economic crisis in the sector. The decrease in milk-feed parity due to rising feed costs reduces profitability in milk production and leads to an increase in bankruptcies in the sector in the long term (11). Additionally, a drop in milk-feed parity below 1 not only negatively affects producers but also has a multiplier effect on all stakeholders. The slaughtering of female animals with reproductive potential during these periods led to a rapid decline in fattening calf production, which resulted in a contraction in meat supply, causing a sharp rise in meat prices and ultimately making meat imports inevitable.

The most significant cost item in milk production is feed expenses, which account for 60-70% of total costs. The trend of dairy feed prices is crucial both for producers' production planning and the sustainability of production. For this purpose, inflation-adjusted milk and feed prices are considered in this study.

In the regression analysis, it was determined that while an increase in real raw milk prices raised the purchasing power of dairy cattle farms by 0.284 units, a 1-unit increase in feed prices led to a decrease of 0.038 units. Since rising feed prices directly increase milk production costs, they significantly reduce the profitability of enterprises. Similarly, if raw milk prices remain constant or do not increase sufficiently in comparison to feed prices, the income-expenditure balance of producers is disrupted, leading to a decline in their purchasing power. In their study, Kaplan and Çiçek (18) reported that dairy feed prices increased in response to rising raw milk prices, but milk prices did not respond significantly to increases in feed prices, with an average reflection time of two months.

In the literature review, the most critical problems identified in dairy cattle farms are high feed costs and difficulties in feed supply (12, 15, 28). Persistently high feed costs, despite continuously low real raw milk prices, lead to consolidation in the sector, allowing large producers to expand their market share while forcing small producers to exit the market. Additionally, increases in feed prices compel producers to use lower-quality feed, which negatively affects both animal health and milk yield and quality. This situation results in increased production costs, decreased productivity, and weakened competitiveness in the sector. It also poses a serious threat to the sectoral sustainability of small and medium-sized enterprises.

In February 2001, the financial economic crisis arising from the banking sector and the global financial crisis in 2008 had negative impacts on the Turkish economy and livestock sector (24). Red meat imports began in Türkiye in 2010. In 2014, the decline in milk prices worldwide put pressure on milk prices in Türkiye, while the significant increase in feed prices during the same period negatively affected the NITOT and INTOT indices. In 2018 and 2020, the severe depreciation of the Turkish lira against foreign currencies caused general economic instability, and inflation rates rose rapidly. In parallel with this, despite rising production costs in the livestock sector, milk prices remained flat, and livestock support remained insufficient, which negatively affected the purchasing power of producers and, consequently, their economic sustainability.

The research also determined that the Covid-19 pandemic reduced the purchasing power of dairy cattle farms by -18.4456 units. The results of the study indicate that the Covid-19 outbreak had a more profound impact than sectoral crises. In addition to the ongoing crisis in 2018, significant production losses occurred due to the disruption of supply chains and restricted market access (6). Furthermore, factors such as fluctuations in feed price increases and reduced consumer purchasing power contributed to instability in the sector (3). These economic pressures negatively affected the profitability of animal husbandry, leading to the withdrawal of small-scale enterprises from the market (29).

Indeed, in the study conducted, it was determined that during the peak period of the Covid-19 pandemic (January-November 2020), inflation-adjusted real feed prices increased by 34.7%, while real milk prices decreased by 3%. Despite the rise in feed prices during the pandemic, the lack of an increase in milk prices negatively affected dairy farms. In parallel with this study, Doğar et al. (13) reported that while milk and dairy product production in Türkiye largely maintained its continuity during the pandemic period, a delayed decline in production was observed in 2021. According to TURKSTAT (31) data, milk and dairy product production decreased by 2.3%, falling from 23 million 504 thousand tons in 2020 to 22 million 960 thousand tons in 2021.

The research findings indicate that policymakers in Türkiye should primarily focus on stabilizing the milk/feed parity to address the structural issues within the dairy sector. However, during the study period, it was observed that the decline in the purchasing power of dairy cattle enterprises in Türkiye was not effectively mitigated by policymakers. This situation has led to imbalances and

instabilities in the dairy sector, negatively impacting not only dairy producers but also the red meat sector, creating a vicious cycle where meat imports are used to balance the market. Therefore, policymakers should recognize the strong correlation between the dairy and red meat markets and focus on adjusting the existing price imbalances in the dairy sector in favor of dairy cattle enterprises, as this plays a critical role in enhancing producer welfare. In particular, the following measures should be implemented to prevent price fluctuations in the dairy market: ensuring a minimum price guarantee in milk production, establishing floor price policies that allow producers to cover their costs, increasing direct incentives for milk producers, controlling input costs (especially feed prices) for dairy farmers, implementing feed subsidies, encouraging domestic feed production, and reducing dependence on feed imports.

In conclusion, this study, which analyzes the economic sustainability of dairy cattle enterprises in Türkiye, has determined that the purchasing power of producers was positive between 2011 and 2018 but showed a negative trend from July 2018 to 2023. However, in the last two quarters of 2023, a positive change was observed again. Among the most significant factors affecting the purchasing power of dairy cattle enterprises, milk/feed parity and milk support premiums were identified as the key parameters. On the other hand, as Türkiye is located at a critical transition point for regional and global crises, prioritizing price stability and implementing policies aimed at enhancing the purchasing power and economic welfare of milk producers are crucial for ensuring the sustainability of the dairy and meat sectors.

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Ethical Statement

This study does not present any ethical concerns.

Conflict of Interest

The authors declared that there is no conflict of interest.

Author Contributions

ST and PAD conceived the presented idea and designed the study. ST was involved in data collection. PAD performed the data analysis. All authors discussed the findings and contributed to the preparation of the final manuscript.

Data Availability Statement

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

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