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INFLUENCE OF CORN AND SOYBEAN PRICES ON BROILER PRICES
UTICAJ CENE KUKURUZA I SOJE NA CENU TOVNIH PILIĆA

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ABSTRACT

Given the crucial role of corn and soybeans in formulating poultry feed, this research delves into the interplay of prices between broilers chickens, corn, and soybeans. The primary objective of this study is to ascertain the influence of the previous year's corn and soybean prices on the current year's broiler chicken prices, employing a multiple linear regression model. The findings of the regression model reveal that an increase in the prices of corn and soybeans has a positive correlation with broilers prices. In simpler terms, as the prices of these two essential feed components rose in the previous year, a corresponding increase in broiler prices is anticipated in the current year. It's worth highlighting that the statistical analysis identifies only the influence of corn as statistically significant, while the impact of soybeans is deemed statistically non-significant. An increase in the price of corn in the previous year by 1 dinar will cause an increase in the price of broilers by 3,766 dinars/kilogram in the current year.

***Keywords**: price, corn, soybean, broilers, regression analysis.*

REZIME

S obzirom na značajnu ulogu kukuruza i soje u spravljanju hrane za tovne piliće, u okviru ovog istraživanja analiziran je uticaj cene kukuruza i soje na cenu tovnih pilića. Predmet ovog istraživanja su cenovne karakteristike kukuruza, soje i tovnih pilića na području Republike Srbije, u period od 2004-2022. godine. Primarni cilj ovog istraživanja je da se utvrdi uticaj cene kukuruza i cene soje iz prethodne godine na cenu tovnih pilića iz tekuće godine. Statistička obrada podataka izvedena je primenom deskriptivne statistike, a za utvrđivanje uticaja cene kukuruza i soje iz prethodne godine na cenu tovnih pilića iz tekuće godine primenjen je metod višestruke linerne regresije. Rezultatima deskriptivne statističke analize utvrđeno je da je prosečna cena tovnih pilića, u posmatranom periodu, iznosila 103.13 din/kg, dok je prosečna cena kukuruza iznosila 14.83 din/kg, a prosečna cena soje 36.35 din/kg. Rezultat ocenjenog regresionog modela ukazuje na to da se sa povećanjem cene kukuruza i soje iz prethodne godine može očekivati rast cene tovnih pilića u narednoj godini. Takođe, rezultati regresionog modela ukazuju na to da je samo uticaj cene kukuruza bio statistički značajan, tj. da se sa povećanjem cene kukuruza u prethodnoj godini za 1 dinar može očekivati povećanje cene brojlera za 3.766 din/kg u tekućoj godini.

***Ključne reči**: cena, kukuruz, soja, tovni pilići, regresiona analiza.*

INTRODUCTION

The significance of livestock production within a country's economy is multifaceted and underscored in various ways. It not only integrates with other economic sectors but also enhances the efficient utilization of natural resources. Furthermore, livestock production plays a pivotal role in bolstering plant production. While there are notable regional variations in livestock production systems and types that animal husbandry, owing to its shorter production cycle, contributes significantly to the overall growth of agricultural production *(Zekić et al., 2007).* It's worth noting that livestock production's value in the total agricultural production of the Republic of Serbia amounts to 32.5%. The most relevant branch of livestock farming on farms in the Republic of Serbia is poultry farming, with its two main production lines- broiler feeding and egg production (*Popović, 2014*).

Plant production stands as one of the primary sources of nutrition for livestock as a whole, with corn recognized as the foremost ingredient in feed mixtures *(Radosavljević, 2007).* Soybeans and other products from plant production also play a crucial role in this context. In broiler feed mixtures corn commonly constitutes up to 60%, while the soybean contributes up to 30%, depending on the type of fattening *(Milošević and Perić,2011)*. Given the critical importance of corn and soybeans in the formulation of feed mixtures, this research centers on investigating the interplay of prices among broilers, corn, and soybeans.

The primary objective of this research is to discern how the prices of corn and soybeans from the previous year impact the prices of broilers in the current year, utilizing a multiple linear regression model. This research is grounded in the assumption that the costs associated with broilers' nutrition during the fattening phase significantly influence the market selling prices. The initial hypothesis driving this research posits that the prices of corn and/or soybeans have a statistically significant influence on broiler prices. In other words, the hypothesis suggests that an increase in the prices of corn and/or soybeans, being the most critical components in the dietary composition of broilers chickens *(Bolu and Ibikanule, 2010),* would correspond to an increase in broilers prices.

MATERIAL AND METHOD

Data on the prices of corn, soybeans, and broilers were initially processed using basic descriptive statistical tools, which included:

- Mean value of the phenomenon $\overline{X}$
- Extreme values of the phenomenon (min, max)
- Coefficient of variation (CV)
- Annual rate of change in % (r).

In accordance with the defined research objective, a multiple linear regression method was applied to determine the influence of the previous year's prices of corn and soybeans on the price of broilers in the current year. Regression analysis is a method used to identify relationships between observed variables (Munćan

and Božić, 2018). Additional analysis is conducted to ascertain the direction and strength of these identified relationships. Regression analysis can also be defined as the estimation of the value of a dependent variable based on one or more independent variables. The general form of the regression model is as follows:

$$\hat{Y}_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_p X_{pi} + \varepsilon_i \qquad (1)$$

Where Yi represents the value of the dependent variable, X_{1i}, X_{2i}, … , X_{pi} represent the values of the independent variables, and β_1, β_2, ….. $\beta_p$represent the regression parameters. The parameter β_0 indicates the average initial level of the dependent variable (the influence of unexamined factors), while ε_i represents the random error. To assess the overall statistical significance of the defined model, a regression analysis of variance was performed.

A practical issue in the analysis of the influence of multiple variables is multicollinearity. This problem arises when variables are highly correlated with each other. Multicollinearity makes it difficult to calculate regression coefficients and can lead to incorrect conclusions. Specifically, a small change in data values can have a significant impact on the estimation of regression coefficients. One way to detect multicollinearity is through the tolerance level (Tolerance) and the Variance Inflation Factor (VIF), which are calculated for each independent variable. The critical tolerance value is 0.1, and the critical VIF value is 10, as these values unequivocally indicate multicollinearity.

Before interpreting the multiple regression model, it is necessary to test the model as a whole using the analysis of variance (ANOVA). The null hypothesis of this test assumes the equality of regression parameters: $H_0: \beta_1 = \beta_2 = \cdots = \beta_k = 0$, and the alternative hypothesis assumes that at least one of the parameters is not equal to zero, i.e., $H_1: \beta_1 \neq 0 \vee \beta_2 \neq 0 \ldots \vee \beta_k \neq 0$. The conclusion regarding the significance of the model is based on the acceptance or rejection of the null hypothesis. If the null hypothesis is rejected and the alternative hypothesis is accepted, the model is statistically significant.

The data used in the analysis were obtained from the website of the Republic Statistical Office (RZS) and pertain to the prices of corn, soybeans, and broiler chickens in the Republic of Serbia for the period from 2004 to 2022. For the statistical data analysis, the IBM STATISTICS 21 software package was employed.

RESULTS AND DISCUSSION

The basic parameters descriptive statistics for the observed parameters of corn, soybeans, and broilers are presented in Table 1.

Table 1. Descriptive statistics for the price of corn, soybean, and broilers (2005-2022)

Parameter	Mean	Min.	Max.	CV (%)	Rate of change (%)
Broilers (din/kg)	103.13	73.25	141.74	20.00	3.96
Corn (din/kg)	14.83	6.46	31.06	39.29	7.11
Soybean(din/kg)	36.53	12.3	74.92	45.71	10.55

In the observed period within the territory of the Republic of Serbia, the average price of corn amounts to 14.83 din/kg, with a minimum price of 6.46 din/kg and a maximum of 31.06 din/kg, demonstrating high variability of 39.29%. As for the price of soybeans, the average price is 36.53 din/kg, with a minimum of 12.03 din/kg and a maximum of 74.92 din/kg, while the annual variation stands at 45.71%. Regarding the price of broilers, the average price is 103.13 din/kg, fluctuating within the range of 73.25-141.74 din/kg. During the observed period, broiler prices exhibit moderate variability (CV=20%). Based on the results of the descriptive analysis, it is evident that there has been an annual increase of 3.96% in broiler prices, which is justified by the yearly rise in corn and soybean prices at rates of 7.11% and 10.55%, respectively.

In the subsequent part of the research, a regression model was formulated to determine the relationship between the price of broilers in the current year and the selling prices of corn and soybeans in the previous year.

The following table (Table 2) presents the results of correlation coefficients, as well as the results of multicollinearity testing.

Table 2. Correlation coefficients and multicollinearity testing

Model	Correlations			Collinearity Statistics	
	Zero-order	Partial	Part	Tolerance	VIF
(Constant)					
Price of corn	0.941	0.614	0.261	0.106	9.428
Price of soybean	0.905	0.142	0.048	0.106	9.428

Considering that the tolerance level in the model for both independent variables is greater than 0.1 and the variance inflation factor (VIF) is less than 10, we can assume the absence of multicollinearity. Some authors suggest that if the tolerance value is less than 0.2 or the VIF is greater than 8, there is a probability of multicollinearity. One solution to this issue is to exclude one of the independent variables; however, in the context of this research, such an action is not in line with the previously defined research objective. Table 3 displays the values of the multiple correlation coefficient and multiple determination coefficient.

Table 3. Multiple correlation and determination coefficient

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.942[a]	0.888	0.873	7.41910

The multiple correlation coefficient, indicating the linear correlation between the original values of the dependent variable and the predicted values of the dependent variable using the model, is R=0.942, signifying a very strong relationship. The determination coefficient reveals that 88.88% of the variability in broiler prices can be explained by the regression model. The value of the adjusted determination coefficient is R^2=0.873. Table 4 presents the results of the regression analysis of variance.

Table 4. Regression analysis of variance results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.518,865	2	3.259,432	59,216	0,000
	Residual	825,646	15	55,043		
	Total	7.344,511	17			

Based on the results of the regression analysis of variance, we conclude that the null hypothesis is rejected, and the formulated model is statistically significant ($p<0.05$). In the following table (Table 5) the results of regression analysis were presented.

Table 5. Regression analysis results.

Model		Unstandardized Coefficients		Stand. Coeff.	t	Sig	95,0% Confidence Interval for B	
		b	Std. Error	Beta			Lower Bound	Upper Bound
1	Constant	42,379	6,701		6,324	0,000	28,096	56,662
	Price of corn	3,766	1,249	0,802	3,016	0,009	1,104	6,427
	Price of soybean	0,214	0,387	0,147	0,554	0,588	-0,610	1,039

The estimated regression model has the following form:

$$\hat{Y} = 42{,}378 + 3{,}766X_1 + 0{,}214X_2 \quad (2)$$

Based on the results of the estimated multiple linear regression model, it is evident that the price of corn from the previous year emerged as a significant variable influencing the price of broilers in the current year. However, the price of soybeans from the previous year did not have a statistically significant impact on the price of broilers in the current year.

If we consider the sign of the first regression coefficient (β_1), it can be observed that the price of corn from the previous year had a positive influence on the price of broilers in the current year. In other words, with an increase of 1 dinar per kilogram in the price of corn, one can expect an increase of 3.766 dinars per kilogram in the price of broilers.

CONCLUSION

Due to the significant importance of corn and soybeans in broiler nutrition, this study analyzes how the price of corn and the price of soybeans impact the final price of broilers. During the analyzed period from 2004 to 2022, within the territory of the Republic of Serbia, the average price of broilers increases by 3.96%. The average purchasing price of the two most important feed ingredients for preparing animal feed, corn, and soybeans, stands at 14.83 din/kg and 36.53 din/kg, respectively, in the diet of broilers. It's noteworthy that the prices of both feed ingredients have been on the rise during the observed period. However, despite the substantial reliance of broiler prices on feed ingredients such as corn and soy, the poultry industry has managed to sustain its competitiveness. This achievement is attributed to technological innovations that contribute to lowering production overhead costs, consequently enhancing productivity. These findings align with the conclusions drawn by Elsedig et al. (2015) in their research.

In line with the research objective, which aims to determine the price trend of broilers in the current year concerning the price levels of corn and soybeans achieved in the previous year, a regression model has been established. The results of the regression model conclude that an increase in the prices of corn and soybeans has a positive impact on the price of broilers. In other words, with an increase in the prices of these two feed ingredients in the previous year, an increase in the price of broilers in the current year is expected.

Considering the orientation of agricultural producers toward either crop or livestock production, where the cost of purchased feed (corn and soybean) includes both production expenses and trade margins, it is recommended that, given the confirmed dependency, broiler producers redirect their production focus towards cultivating corn and soybean. This strategic shift can effectively reduce the overall cost of their products.

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