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The Impact of Seasonality of Agricultural Production on Product Prices in Romania

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Abstract

This paper aims to determine the possible impact of the seasonality of agricultural production on the prices of these products. Three main products were analysed, the majority of which are wheat, maize and sunflower production. With the help of national databases, product prices were analysed quantitatively and qualitatively, as well as statistically, over the last 5 years by calendar month. A series of researches have been carried out on the data, such as: analysing the dynamics of both annual and monthly prices, as well as determining the correlations between the price level for these products and the calendar month to which these prices refer. Following this analysis, the third-degree polynomial regression equations were determined, showing that product prices follow a sinuous trend, with high prices in the first part of the year, when supply is running out, then, during the harvesting period, there is a drop in price, given the sudden increase in supply on the market, and in the last months of the calendar year, the highest prices are recorded, given the additional cost of storing production following the harvesting campaign.

Keywords: *agricultural products price; impact; seasonality; cereals; oilseeds.*

JEL Classification: *E31; E37; Q11.*

Introduction

Volatility represents how much and how fast a value, such as the price of a commodity, changes over time. While the concept may seem obvious, a precise definition of volatility is elusive and measurement tends to be subjective. In economic theory, volatility encompasses two main concepts: variability and uncertainty; the former describes general movement and the latter refers to unpredictable movement. (Goșa et al., n.d)

In this study, the first component of the concept of price volatility is to be analysed, i.e. its variation. As far as price variation of agricultural products is concerned, factors can be multiple

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and can be within the market or outside the market, thus, price changes can occur according to economic theory as a result of changes in market supply and demand, but in the agricultural sector exogenous factors are quite significant, the most important being the climatic environment, the level of direct expenditure and input prices, and seasonality (World Bank, 2008), (Tudir et al., 2022): The latter is the hypothesis on which this research was built, namely that seasonality of agricultural production implies changes in the market price of agricultural products due to the fact that harvesting is done only once and consumption is constant throughout the year. (Sørensen, 2002), (Bonuedi et al., 2022)

Seasonal changes in agricultural production lead to two sets of problems that interact together: imbalances in resource requirements and production processes. These problems exist in all types of agriculture—in fact, in all seasonal industries—but the exact nature and extent of them, and the severity of their consequences, depend greatly on the agricultural environment. (Gill & Gerard, 1991)

Little is known about how much subsistence farming actually contributes to household nutrition, and how that contribution varies seasonally. There will be some seasonal changes. Stored groceries account for more than half of all calories consumed off-season. But even in the main and post-harvest periods, grocery purchases accounted for more than a third of total calorie consumption. The market is more important for food quality. In all seasons, purchased food played a far greater role in dietary diversity than subsistence production. (Sibhatu and Qaim, 2017)

As far as developing countries are concerned, seasonality is considered by experts to be characteristic of rural subsistence areas, where poor, food-insecure and malnourished people live, mainly all over the world, dependent on traditional rain-fed agriculture. (Devereux et al., 2012; Khandker & Mahmud, 2012).

According to previous research: the main adverse effects of seasonality can also transfer and manifest themselves in urban areas, with limited food supply for isolated urban areas, leading to higher food prices and dietary and nutritional impairments. (Anderson et al., 2018; Gilbert et al., 2017).

In addition to all these effects on nutrition and food security, the aim is to determine whether the seasonality of agricultural production and therefore a very high level of supply at a given time of the year, in conjunction with the constant level of demand, leads to a price decrease in the harvest season and a possible price increase in the last months of the calendar year, or of the agricultural year depending on the products analysed, as a result of the increasingly limited supply on the market.

Material and Method

This paper seeks to identify whether the seasonality of production influences the level and volatility of prices of the main agricultural products. For this purpose, national databases, i.e. the National Institute of Statistics, were used to retrieve data on agricultural product prices by month and year. These agricultural products have been established according to the majority weight in the structure of agricultural crops according to the cultivated area, thus the important weights are found, according to the NIS, for wheat, maize and sunflower, which are the agricultural products included in the analysis.

These data taken from the national databases were analysed quantitatively and qualitatively, first determining the dynamics of product prices by calendar month and determining the minimum and maximum points. The price dynamics of these products were then analysed on an annual basis, determining the average annual rate of increase, the standard deviation and the coefficient of variation, in order to identify the years in which price volatility was higher, possibly also due to seasonality. In order to measure this, we used the correlation between the

price level and the calendar months to determine the third-degree polynomial regression equation between these two variables. Thus, it is possible to calculate the predicted price according to the regression equation for each calendar month for the three products analysed.

Results and Discussions

In order to achieve the aim of the paper, i.e. to identify the impact that the seasonality of agricultural production may have on the prices of these products, data on the prices of the main field crop products grown in Romania over the last five years, by calendar months, were analysed. These data will be subjected to quantitative and qualitative analyses in order to determine: the variation of prices in a calendar year, the existence or non-existence of significant differences between prices per quarter, and the determination of equations between price and calendar period of the year.

As can be seen from Figure 1, the price of wheat in Romania fluctuated, during the period 2017-2021, between 0.62 RON/kg (in 2017) and 1.15 RON/kg (in 2021). It can be seen that in the first years analysed, i.e. 2017-2019, prices do not fluctuate very much, or do not go so far out of the pattern, recording almost constant prices, during this period and the influence of external factors being very low (these years, being years with very good yields, with soil and weather conditions favourable to production and the agricultural sector, thus market disturbances were very small, hence this constant price trend. In recent years, however, there have been external influences on supply and demand, which have had an impact on prices.

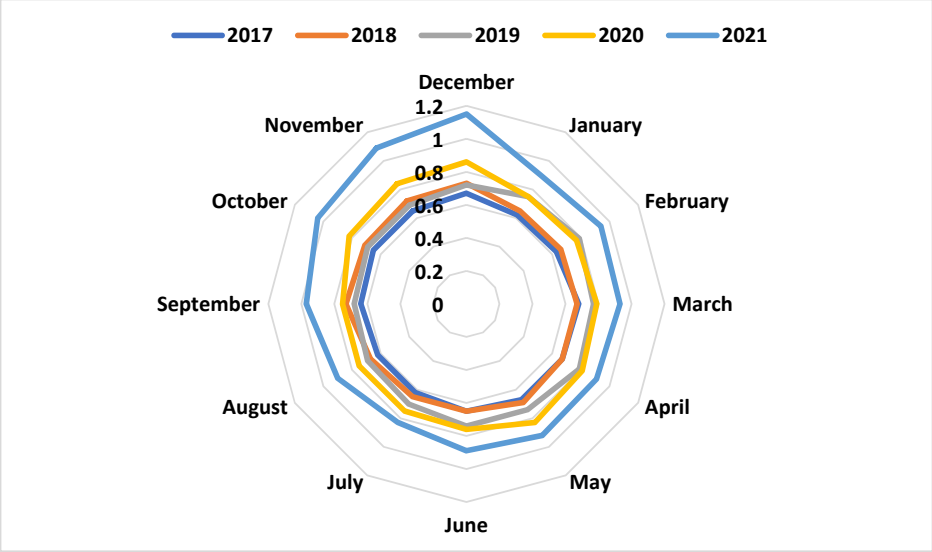

Fig. 1. Wheat price dynamics in Romania, 2017-2021, by calendar months (RON/kg)

Source: authors' processing based on NIS data.

Quite low supply in some years (year 2020) being a less productive year due to drought, thus low supply led to higher prices, on the other hand inflation in 2021, increasing, influenced the cost of agricultural production and thus farmers had to cover these costs through higher prices. Thus, a change in the trend is observed, in the last two years, prices have been higher, ranging between 0.75 - 1.15 RON/kg, but also from a calendar point of view, an increase in prices is observed in the last quarter, with the highest prices in December, when supply is low and demand is constant throughout the year.

As can be seen from Figure 2, the price of corn in Romania fluctuated, in the period 2017-2021, between 0.56 RON/kg (in 2017) and 1.02 RON/kg (in 2021). As in the case of the price for wheat, in the first years analyzed, namely 2017-2019, prices do not fluctuate much, almost

constant prices are recorded, during this period the influences of external factors are also very low, the disturbances on the market being very small. Instead, in recent years, there have been external influences on supply and demand, and these have left their mark on prices.

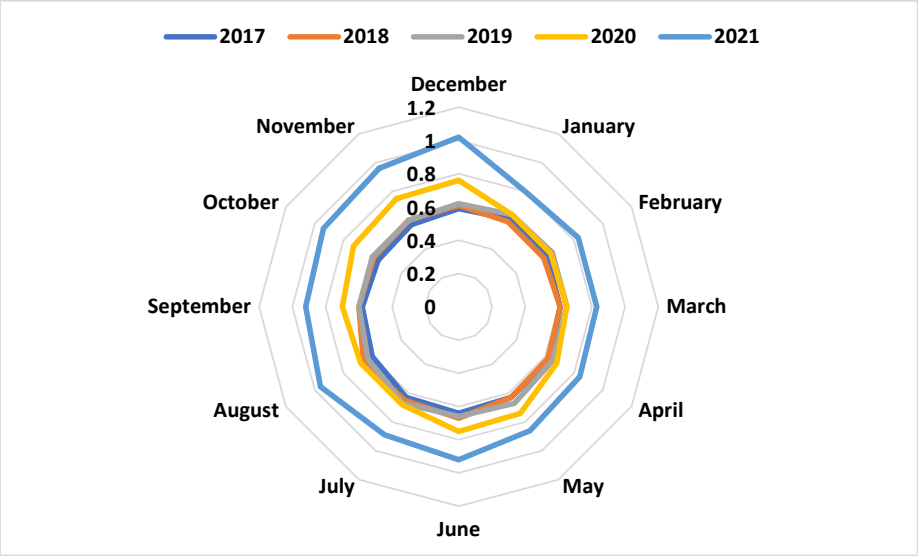

Fig. 2. Maize price dynamics in Romania, 2017-2021, by calendar months (RON/kg)

Source: authors' processing based on NIS data.

The fairly low supply in 2020 led to an increase in prices, on the other hand the inflation in 2021, on the rise, influenced the cost of agricultural production and implicitly farmers had to cover these costs through higher prices. Thus, a change in trend is observed, in the last two years, prices were higher, between 0.64 - 1.02 RON/kg, but also from a calendar point of view, an increase in prices is observed in the last quarter , with the highest prices being recorded in December, when supply is low and demand is constant throughout the year.

As can be seen from Figure 3, the price of sunflower in Romania fluctuated between 2017-2021, between 1.23 RON/kg (in 2019) and 2.28 RON/kg (in 2021).

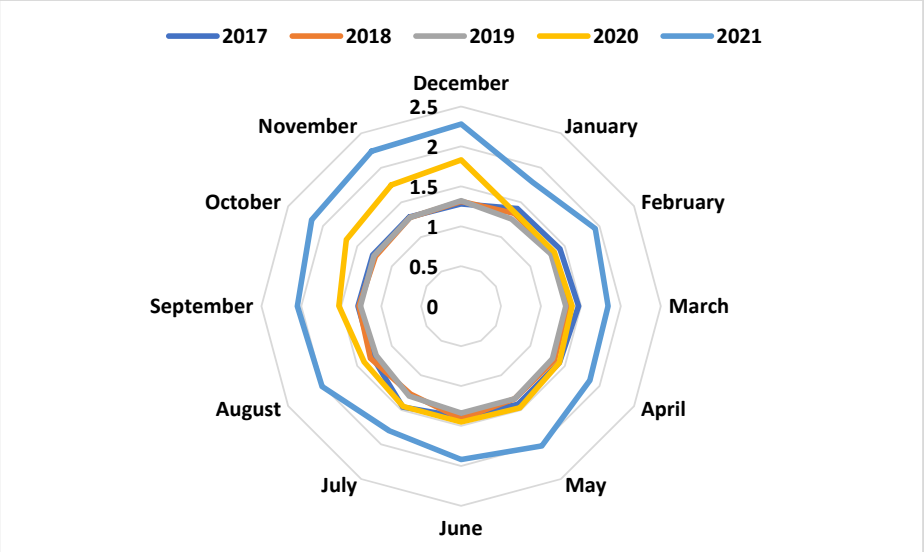

Fig. 3. Sunflower price dynamics in Romania, in the period 2017-2021, per calendar month (RON/kg)

Source: authors' processing based on NIS data.

As in the previous situations, in the first years analysed, i.e. 2017-2019, prices do not fluctuate very much, with almost constant prices, and during this period the influence of external factors is also very low, with very little market disturbance. In contrast, in recent years, there have still been external influences on supply and demand, which have had an impact on prices. The rather low supply in 2020 led to higher prices, on the other hand the rising inflation in 2021 influenced the cost of agricultural production and farmers had to cover these costs through higher prices. Thus, a change in the trend can be observed, in the last two years, prices have been higher, ranging between 1.35- 2.28 RON/kg, but also from a calendar point of view, an increase in prices can be observed in the last quarter, with the highest prices in December, when supply is low and demand is constant throughout the year.

A statistical analysis was then carried out to determine the standard deviation and coefficient of variation of prices by year and month (Table 1).

Table 1. Determination of standard deviation and variation for wheat price (RON/kg)

Wheat price	2017	2018	2019	2020	2021
January	0.62	0.65	0.75	0.75	0.9
February	0.63	0.66	0.79	0.77	0.94
March	0.68	0.67	0.77	0.79	0.93
April	0.67	0.67	0.79	0.81	0.91
May	0.67	0.69	0.74	0.83	0.92
June	0.65	0.65	0.74	0.76	0.89
July	0.62	0.65	0.7	0.75	0.83
August	0.62	0.67	0.69	0.75	0.9
September	0.64	0.73	0.68	0.75	0.97
October	0.65	0.71	0.69	0.82	1.04
November	0.65	0.72	0.69	0.84	1.09
December	0.67	0.73	0.72	0.86	1.15
St. Dev.	0.02	0.03	0.04	0.04	0.09
AVRG.	0.65	0.68	0.73	0.79	0.96
Var.	3.4%	4.6%	5.5%	5.1%	9.7%

Source: authors' calculations based on NIS data.

Regarding the price of wheat, it can be seen that the annual average has increased steadily over the last five years under review, from 0.65 RON/kg to 0.9 RON/kg, which represents an increase of 47.6% each year, with an average growth rate of 10.2%. In terms of the standard deviation for the price of wheat in each year, determined at the level of calendar months, it can be seen that it has increased from 0.02 RON/kg to 0.09 RON/kg, resulting in a price variation over one year between 3.4% (in 2017) and 9.7% (in 2021). As could also be seen from the analysis of price dynamics, the variation of wheat price in one year has been increasingly large, in the last year reaching almost ±10%.

Table 2 shows a similar analysis (by year and month) to determine the standard deviation and the coefficient of variability for the maize price.

Table 2. Determination of standard deviation and variation for maize price (RON/kg)

Corn price	2017	2018	2019	2020	2021
January	0.61	0.59	0.64	0.64	0.8
February	0.61	0.59	0.65	0.64	0.83
March	0.61	0.61	0.65	0.65	0.83
April	0.63	0.62	0.65	0.68	0.84
May	0.63	0.63	0.67	0.74	0.86
June	0.64	0.67	0.66	0.75	0.92

Table 2 (cont.)

July	0.63	0.65	0.67	0.68	0.89
August	0.6	0.66	0.63	0.68	0.96
September	0.58	0.6	0.6	0.7	0.92
October	0.56	0.59	0.6	0.73	0.94
November	0.57	0.6	0.6	0.75	0.96
December	0.59	0.61	0.62	0.76	1.02
St. Dev.	0.026	0.028	0.026	0.045	0.067
AVRG.	0.605	0.618	0.637	0.700	0.898
Var.	4.3%	4.6%	4.1%	6.4%	7.4%

Source: authors' calculations based on NIS data.

As regards the price of maize, it can be seen that the annual average has increased steadily over the last five years analysed, from 0.61 RON/kg to 0.9 RON/kg, which represents an increase of 48.4% each year, with an average growth rate of 10.4%. In terms of the standard deviation for the price of maize in each year, determined at the level of calendar months, it can be seen that it has increased from 0.026 RON/kg to 0.067 RON/kg, resulting in a price variation over one year between 4.1% (in 2019) and 7.4% (in 2021). As could also be seen from the analysis of price dynamics, the variation of maize prices in one year has been increasingly large, in the last year reaching almost ±7.5%.

Table 3 shows a similar analysis (by year and month) to determine the standard deviation and the coefficient of variability for the sunflower price.

Table 3. Determination of standard deviation and variation for sunflower price (RON/kg)

Sunflowers price	2017	2018	2019	2020	2021
January	1.41	1.34	1.26	1.35	1.79
February	1.43	1.33	1.3	1.35	1.94
March	1.47	1.33	1.31	1.39	1.84
April	1.42	1.35	1.32	1.42	1.86
May	1.42	1.34	1.34	1.47	2.02
June	1.39	1.41	1.34	1.45	1.92
July	1.46	1.27	1.3	1.45	1.8
August	1.28	1.31	1.23	1.4	2.01
September	1.29	1.28	1.26	1.53	2.05
October	1.28	1.24	1.26	1.66	2.16
November	1.29	1.28	1.28	1.75	2.24
December	1.28	1.31	1.32	1.83	2.28
St. Dev.	0.077	0.045	0.035	0.159	0.166
AVRG.	1.368	1.316	1.293	1.504	1.993
Var.	5.7%	3.4%	2.7%	10.6%	8.3%

Source: authors' calculations based on NIS data.

Regarding the price of sunflower, it can be seen that the annual average has increased in the last five years analysed, from 1.37 RON/kg to 1.99 RON/kg, which represents an increase of 45.6% each year, with an average growth rate of 9.85%. In terms of the standard deviation for the price of sunflower in each year, determined at the level of calendar months, it can be seen that it has increased from 0.077 RON/kg to 0.166 RON/kg, resulting in a price variation over one year of between 2.7% (in 2019) and 10.6% (in 2021). As could also be seen from the analysis of price dynamics, the price variation for sunflower in one year has been increasing, in the last year reaching 8.3%.

Next, the correlogram between the dependent variable: the price of agricultural products and the independent variable: the calendar month was developed in order to subsequently determine the regression equation between these variables.

As can be seen from the Figure 4, the correlogram between wheat prices in the period 2017-2021 was determined according to the twelve months of the calendar year, and the regression equation following the point cloud was the third degree polynomial, respectively:

$$y = 0{,}0005x3 - 0{,}0087x2 + 0{,}0393x + 0{,}7091 \quad (1)$$

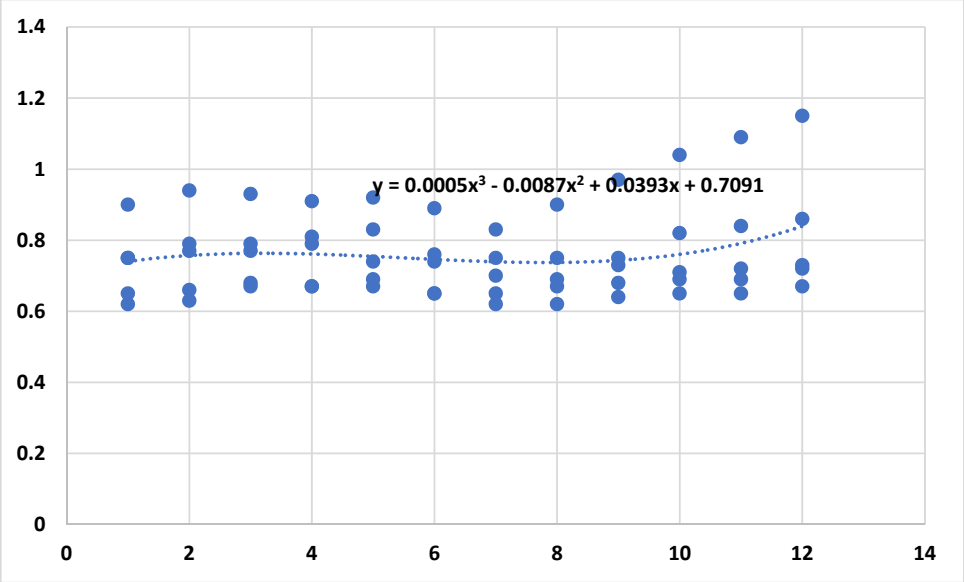

Fig. 4. Correlation between wheat price and months of the year

Source: authors' calculations.

If we were to interpret this equation as a simple first-degree equation, we can see that the value of the coefficient of x is about 0.04, so we could estimate that a one unit increase in the independent variable (every month) would increase the price by 0.04 units. However, this equation, being of degree 3, has a sinuous trend, and in order to accurately determine the influence of each calendar month, the predicted y was calculated as shown in Figure 5.

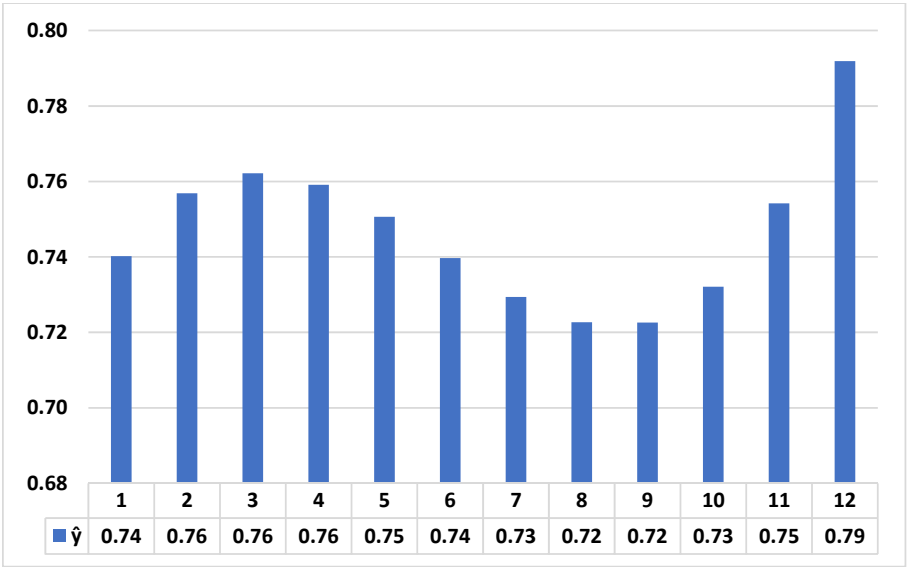

Fig. 5. Predicted wheat price (ŷ)

Source: authors' calculations.

As can be seen, and as determined in the analysis of wheat price dynamics, the price trend is an oscillating one throughout the year, with an increase in price in the first part of the year, when market supply is very tight, especially at the level of individual households, which account for the majority of all farms, then comes the harvest season in months 6-7, and the price drops during that period in view of the high supply, reaching a minimum in month 8 when each farm receives and stores its production, and in the winter months the highest prices are recorded in view of the need to store production.

As can be seen from the Figure 6, the correlogram between the price of corn in the period 2017-2021 was determined according to the twelve months of the calendar year, and the regression equation following the point cloud was the third degree polynomial, respectively:

$$y = 0{,}0003x3 - 0{,}0058x2 + 0{,}0413x + 0{,}6081 \quad (2)$$

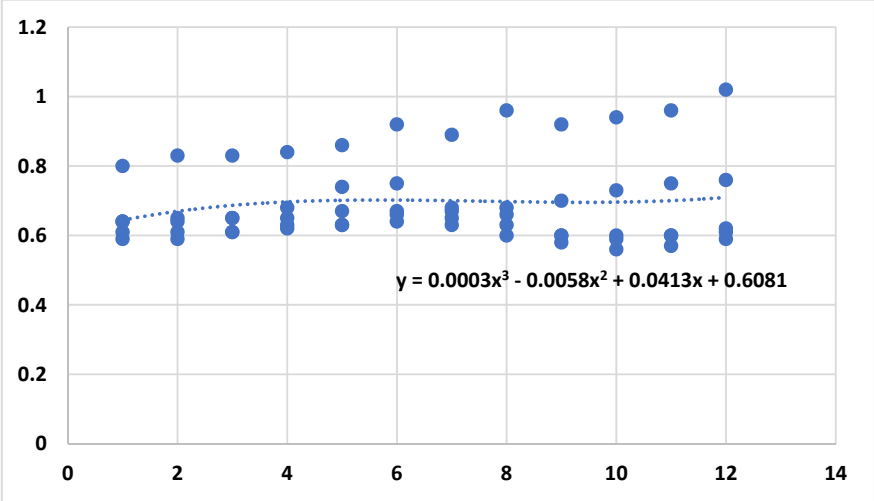

Fig. 6. Correlation between maize price and months of the year

Source: authors' calculations.

If we were to interpret this equation as a simple first-degree equation, we can see that the value of the coefficient of x is about 0.04, so we could estimate that a one unit increase in the independent variable (every month) would increase the price by 0.04 units. However, this equation, being of degree 3, has a sinuous trend, and in order to accurately determine the influence of each calendar month, the predicted y was calculated as shown in the Figure 7.

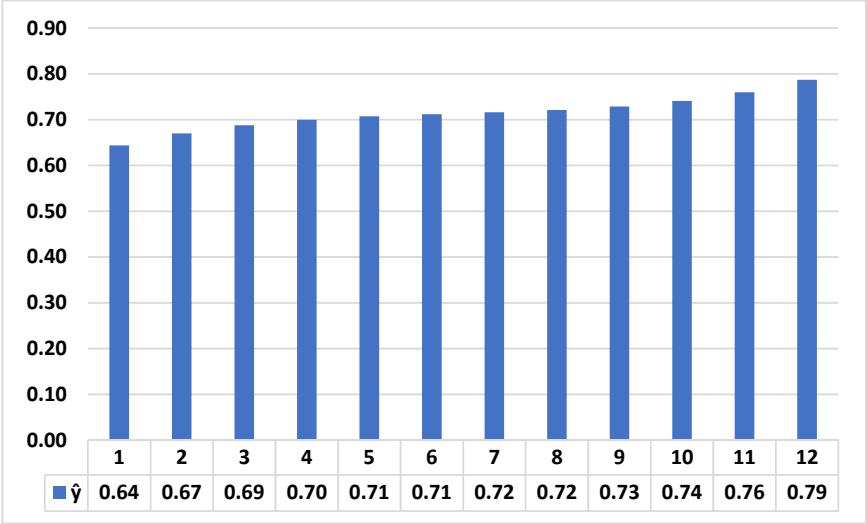

Fig.7. Predicted maize price (ŷ)

Source: authors' calculations.

As for the predicted price of maize according to the regression equation determined above, a difference is observed compared to wheat, even if the equation is still of degree 3, the oscillating trend is less, it can be observed, as in the case of wheat, an increase in the first part of the year, when resources become scarcer and scarcer, then during harvest, there is not a decrease, as we would have thought, due to the harvest season, rather the price stabilises during that period, and then there is a slight increase at the end of the year, given the need for storage during that period.

As can be seen from the Figure 8, the correlogram between the sunflower price in the period 2017-2021 was determined according to the twelve months of the calendar year, and the regression equation following the point cloud was the third degree polynomial equation, respectively:

$$y = 0{,}0008x3 - 0{,}0132x2 + 0{,}0704x + 1{,}3707 \quad (3)$$

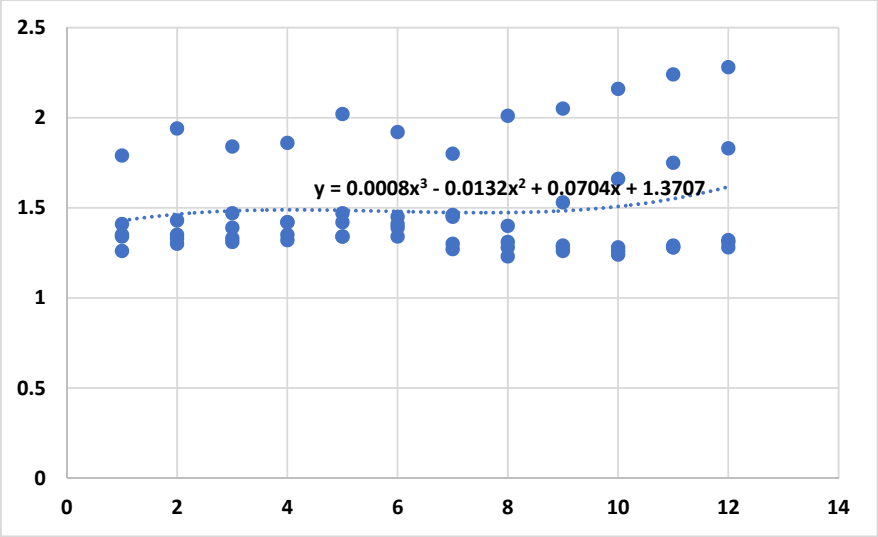

Fig. 8. Correlogram between sunflower price and months of the year

Source: authors' calculations.

If we were to interpret this equation as a simple first-degree equation, we can see that the value of the coefficient of x is about 0.07, so one could estimate that a one unit increase in the independent variable (every month) would increase the price by 0.07 units. However, this equation, being of degree 3, has a sinuous trend, and in order to accurately determine the influence of each calendar month, the predicted y was calculated as shown in the Figure 9.

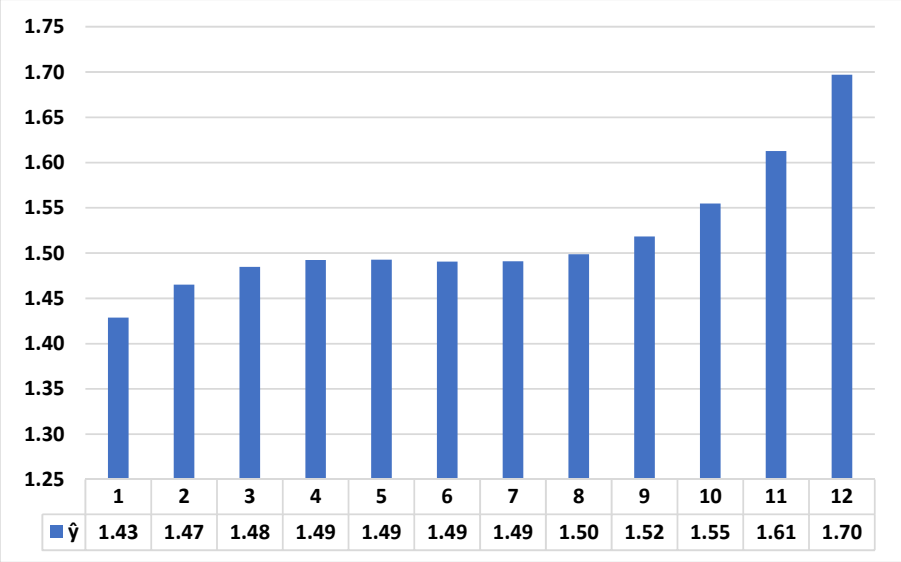

Fig.9. Predicted sunflower price (ŷ)

Source: authors' calculations.

As regards the predicted price for sunflower, a mixed situation is observed between the two previous ones, i.e. an increase in the first part of the year, then a slight downward trend, or rather stagnation during the harvest period, and in the last part of the year the price increases the most, with December being the month with the highest price.

Conclusions

The aim of this work was to determine the impact that the seasonality of agricultural production can have on the prices of these products. For this study, a number of major crops were considered for analysis, as they are very present in the structure of cultivated areas and yields, namely: wheat, maize and sunflower.

An analysis of the price dynamics of the crops analysed in the period 2017-2021, by calendar month, revealed the following. For all products the trend was similar, in the first three years of the analyzed period price dynamics were constant, recording similar prices from month to month over the years; this situation can be explained by the fact that the influences of internal and external factors of price volatility were somewhat constant: agricultural productions were among the highest, pedo-climatic conditions were favorable, thus market disturbances were low. On the other hand, in the last two years of the period under review, prices showed an upward trend, with some peaks, namely in the months of the 4th quarter of 2021, when the highest prices of these agricultural products were recorded. This situation may be due to the rather low supply during this period in view of the climatic drought recorded during that period, as well as the inflation recorded in recent years, which reached alarming values.

The analysis of the annual price dynamics shows a similar trend for all the products analysed, i.e. a price increase of about 50% in the last year compared to the first year analysed, with an

average growth rate of about 10% each year. As mentioned above, i.e. that in the last years of the period there is greater price volatility, this is confirmed by determining the coefficients of price variation over the years, in the first part of the period these are relatively small, with values between ±3% and ±6%, and in the last two years there is greater variation over the year, with variations between ±6 and ±10%.

In order to determine the potential price that can be recorded on the market during the calendar year, the regression equation between the dependent variable: the prices of the agricultural products analysed and the independent variable: the calendar month of the year was determined. By analysing the predicted value of prices, it was possible to establish a higher volatility of wheat prices depending on the time of the year, confirming the hypothesis that wheat prices are influenced by the seasonality of production. In the first part of the year, prices were quite high given the end-of-year supply on the market at harvest time, then in the harvest season the lowest prices were recorded, and in the last part of the year, given the cold weather and the need to store production, the highest wheat prices were recorded.

For maize and sunflower the situation is a little different and the hypothesis is partially validated, as these crops are spring crops, sown and grown in the same calendar year. The price of these products is not so volatile depending on the seasonality of production, there are increases in cold periods, but in the harvest season prices do not fall so much, to establish that the high supply on the market leads to a significant drop in prices.

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