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PRICE INTEGRATION OF THE WHEAT AND MAIZE MARKETS OF FRANCE AND BULGARIA

The price integration of the French and Bulgarian wheat and maize markets are explored and the magnitude and speed of price transmission and the characteristics of price behavior are determined. The main methods applied are based on cointegration analysis. Data from the European Commission and the National Statistical Institute is used.

JEL: E39; O13; Q13

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Wheat and maize are the main cereals grown in Bulgaria: they account for more than 25% of the production in the agricultural sector. These two crops represent the most important part of our country's agricultural exports. This makes their production essential to the development of Bulgarian agriculture and determines the structure of agricultural exports.

The EU-27 ranks second in terms of wheat exports worldwide, with the largest quantity of wheat and maize being produced in France, which in 2013 occupied the 5th and 9th places in the world for wheat and maize production, respectively (FAO, 2016). Globally, the country is also among the main exporters of agricultural products and plays an important role in the grains trade. As concerns the exports of maize, France is once again among the leading EU Member States ranking fifth in the world. The French price of wheat, and to a large extent that of maize, can be considered as a determinant for their pricing in other regions of Europe.

Therefore, the link between the prices of cereals on the French market and in the Black Sea region, part of which is Bulgaria, is interesting. Bulgaria is among the top 20 exporters of wheat in the world and one of the main exporters of wheat in the EU. The country's proximity to the Black Sea region producers and to the major cereals markets plays an important role in pricing and trading. The cereals market in the country, and the export in particular, is dominated by large international companies, which play a leading role in determining the price paid to producers.

Soft wheat is one of the most traded commodities in the world. The main exporters are the USA, Canada, Argentina, France and Australia, which provide more than 80% of world wheat exports. The world imports of wheat are not so concentrated, with Egypt, Algeria, Japan, the EU and others being among the main importers (see FAO, 2013).

The world trade in maize is also developing dynamically. This is the second most commonly traded agricultural product due to its varied application and to the

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products obtained after its processing – as animal feed and human food, as well as in the processing industry, biotechnology, bioethanol production, etc. The worldwide leading exporters of maize in 2013 were Brazil, the USA, Argentina, Ukraine and France (see FAO, 2016), and the main importers were the EU, Japan, Korea, Egypt and China. However, world trade in maize is not as concentrated as the trade in wheat.

On both the wheat and maize markets, the European Union is among the most serious producers and in the same time among the largest importers and exporters. This raises the question to what extent the EU influences the world price and how this price is reflected on the markets of individual Member States. Although a number of empirical studies have been conducted to determine which of the main exporters and importers on the world wheat and maize market (the US, the EU, Argentina, Australia and Canada) has the strongest impact on pricing, they have not yet determined a prominent leader in this respect (see Listorti, 2009; Mohanty, Meyers, Smith, 1996). In most cases, the EU prices are influenced by those in Canada and the United States, but the price of the largest producer and exporter of agricultural products in Europe, France, can still be expected to have a strong impact on the price on the Bulgarian market.

In the international economy, the concept of price transmission[1] refers to the simultaneous movement of prices of the same commodity in different locations. It is related to the so-called Law of One Price, according to which the ratio between the prices of two commodities expressed in the currencies of two countries is equal to the exchange rate. Of course, this is possible in a free market and free trade situation. It is assumed that the prices of homogeneous and identical goods on two markets in the long run are aligned, taking into account transport and other transaction costs.

Bulgaria has always been a net exporter of agricultural products. However, given its share of exports and imports in the world trade, the country cannot be a leader in pricing. Considering that the EU is our biggest trading partner and one of our main competitors in terms of the export of wheat and maize, it could be assumed that prices in Bulgaria follow the development of prices in the Union.

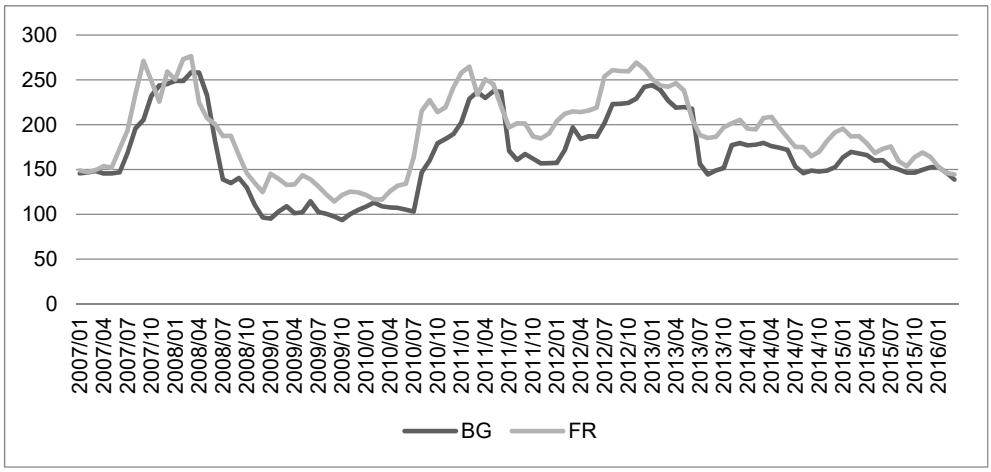
As mentioned, wheat and maize account for the major part of the agricultural exports of the country since its accession to the EU in 2007. The price dynamics of these products during the period under review is presented in Figures 1-4.

The data shown in Figures 1-4 proves that cereals prices are traditionally higher during the second part of the marketing year, when only a small part of the harvest in Bulgaria has remained in storage and has not yet been sold. In terms of prices on international markets, a high harvest and a high supply traditionally lead to lower prices. For maize, a lower price dynamics is observed due to the more diversified demand: in addition to food and feed, it is used in industrial applications.

[1] The 'price transmission' concept is used as a tool to explore the level of integration of markets and the efficiency of market mechanisms.

Figure 1

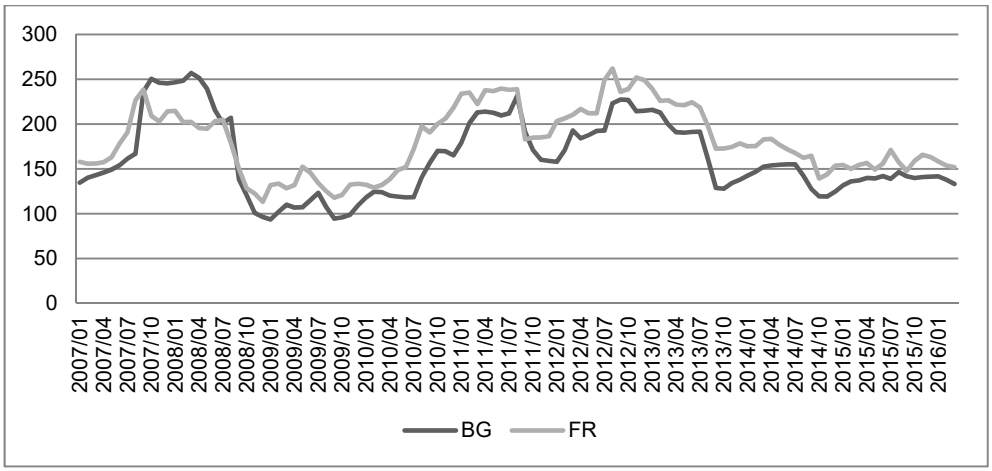
Dynamics of the monthly average prices of common wheat in Bulgaria and in France (EUR/metric ton), January 2007 - March 2016



Source. EC, http://ec.europa.eu/agriculture/markets-and-prices/price-monitoring/monthly-prices/ index_en.htm

Figure 2

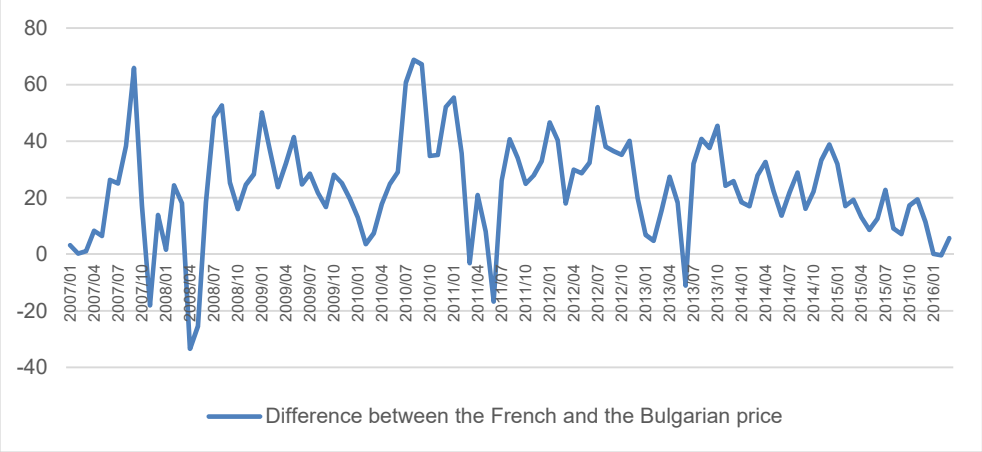
Dynamics of the monthly average prices of maize in Bulgaria and in France (EUR/metric ton), January 2007 - March 2016



Source. EC, http://ec.europa.eu/agriculture/markets-and-prices/price-monitoring/monthly-prices/index_en.htm

Figure 3

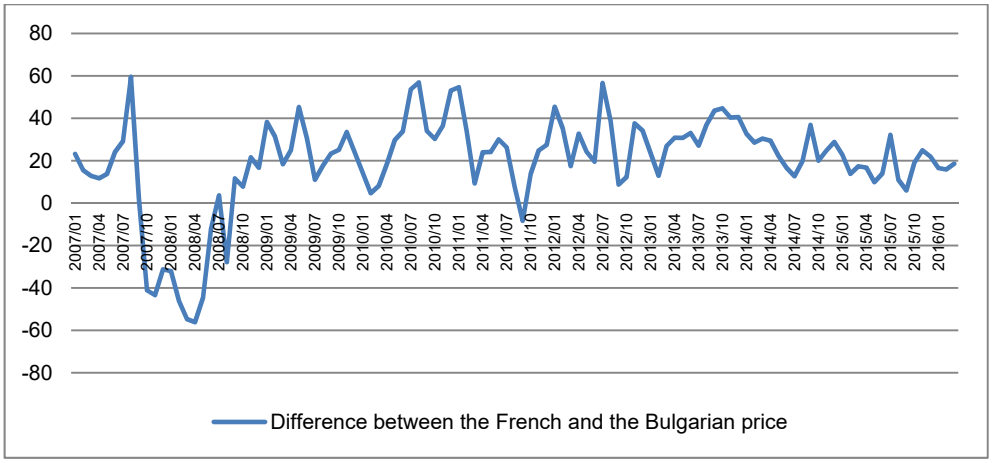
Dynamics of the difference between the monthly average prices of common wheat in Bulgaria and in France (EUR/metric ton), January 2007 - March 2016



Source. Own calculations, based on data from the EC, http://ec.europa.eu/agriculture/markets-and-prices/price-monitoring/monthly-prices/index_en.htm

Figure 4

Dynamics of the difference between the monthly average prices of maize in Bulgaria and in France (EUR/metric ton), January 2007 - March 2016



Source. Own calculations, based on data from the EC, http://ec.europa.eu/agriculture/markets-and-prices/price-monitoring/monthly-prices/index_en.htm

Table 1

Descriptive statistics and characteristics of the analyzed time series of wheat and maize (EUR/metric ton), January 2007 - March 2016

Country	Product	Min	Max	Mean	Standard deviation	Variation	Skewness	Kurtosis
Bulgaria	Common wheat	93.64	258.42	167.27	44.85	2011.61	0.276	-0.778
France	Common wheat	114.32	276.45	190.80	44.07	1942.66	0.120	-0.954
Difference between the French and the Bulgarian price of common wheat		-33.40	68.74	23.52	17.95	322.09	-0.178	1.034
Bulgaria	Maize	93.65	257.07	162.29	43.43	1886.38	0.492	-0,782
France	Maize	113.24	262.09	181.66	37.47	1404.34	0.189	-1.034
Difference between the French and the Bulgarian price of maize		-56.11	59.61	19.36	22.57	509.34	-1.477	2.872

Source. Own calculations, based on data from the EC, http://ec.europa.eu/agriculture/markets-and-prices/price-monitoring/monthly-prices/index_en.htm

The good and ever growing yield of grain and oilseed crops is becoming a solid reason to increase production. This growth is not only due to the larger areas, which have been increased by almost 38% between 2007 and 2014, but also due to the physical production, which has increased approximately 2.2 times. It should be noted that this data, especially in terms of quantities produced, is not sufficiently representative of the low harvest and low yields in 2007, but nevertheless illustrates the huge leap in the expansion of this production.

When examining the change in value and value added in the sector (2006 is taken as a baseline), it becomes clear that the gross value of the produce is increasing compared to 2006, reaching 1.7 in 2014. This means that the gross production in the cereal and oilseed sectors for the period under review has increased by 70%, which is in line with the increase in the amount occupied by this sub-sector in the structure of total gross vegetal and agricultural production.

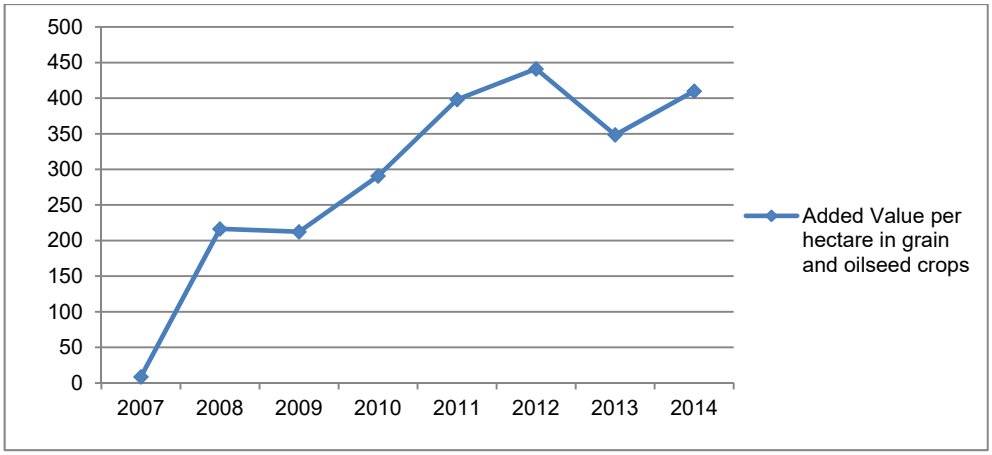
The increase in the production index for cereals and oilseeds is due to increased production, but also due to the better price situation. By comparison, the purchase prices of grain in 2014 are by about 21% higher than those in 2006, while for those of oilseeds the excess is about 36%. This price increase, which covers the period of the country's membership in the EU, largely contributed to the steady and sustainable increase in production in the cereal and oilseed sectors.

As regards the value added index, which is calculated as the sum of the production of cereals and oilseeds, an even sharper and more rapid increase is reported compared to 2006: it has reached 5.8 in 2014, whereas in 2006 it was equal to 1. A significant and progressive increase in the value added occurred after 2009, with the value added doubling each year in comparison to 2006 (see Figure 5).[2]

[2] The calculation of the value added is based on data provided by the NSI and the MAF and made using an own calculation algorithm, which has some conventions. However, it is clear that the accumulation of

Figure 5

Added Value per hectare in grains and oilseeds (BGN/ha)



Source. Own calculations, based on data from the National Statistical Institute and the Agricultural Reports department of the Ministry of Agriculture and Food.

The stable growth and upward trend in production and value added indices for the sector during the country's EU membership indicate the sustainable functioning of this production, which successfully adapts to the changed conditions and manages to expand its share in the arable land and out of the total utilized agricultural area in Bulgaria. The increase of this share, together with the steady increase in the production and added value indices within the sector, shows the stable, sustainable and viable development of production during the research period, which is a solid basis for the positive outlook.

The reason for the positive trends and steady growth in grain and oilseed crop production lies in both the good market situation, which offers a significant price increase over the whole period as compared to 2006, and the applied Single Area Payment Scheme (SAPS). Grain is a commodity, the demand for it is strong, the price is referenced by world markets, and the cost of production per area is lower than in other sectors. All of this, as well as the possibility to wait and store, provides more time for better decision making. The EU Common Agricultural Policy also contributes to risk mitigation, allocating significant public funds under Pillar 1 and Pillar 2. Direct payments also create better conditions for grain producers. The established subsidies cover about 20-30% of the production costs per area and minimize potential losses in case of adverse conditions or risks such as low average yields (production risk), low prices (price risk), and sales difficulties (market risk).

growth in physical production and purchase prices has led to a significant increase in the value added of the crops under consideration.

The upward trend in grain production in Bulgaria over the last decade is due to the fact that many of the listed risks are limited.

Cereals and oilseeds production is characterized as a sector where the value added per unit of product and area is among the lowest compared to other agricultural sectors and fields (see Figure 5). Global competition in this sector is huge and competitiveness is achieved through high efficiency and a lower rate of return, with farms being more interested in economic results at farm level rather than in unit yield per area. The development of this production requires a significant land resource that is limited by default and which, in theory, can bring higher alternative yields.

Next, the level of price correlation and the reaction of the Bulgarian grain market to changes in the prices in France are analyzed. The dependencies in the formation of the price base (the difference between the Bulgarian and the French price) are studied for trends and seasonality and an attempt is made to develop a relevant model for forecasting Bulgarian prices on the basis of the changes in French prices.

Cointegration model between the French and the Bulgarian prices of wheat and maize

The subject of the analysis is a dynamic series of the difference in the average monthly prices of wheat and maize in France and Bulgaria. The analyzed variable was calculated by subtracting the Bulgarian price (equation 1) from the French price of the respective crop for the two crops under consideration.

$$P_i = p_i^{FR} - p_i^{BG}, \quad (1)$$

where P_i is the difference between the French price (p_i^{FR}) and the Bulgarian price (p_i^{BG}) of the i-th crop. The variable P_i, considered in the selected period, represents the dynamics of the change in the relationship between the Bulgarian and the French prices.

The new variable, which is referred to as the “price basis”, is analyzed for a unit error in order to determine whether the dynamic series is non-stationary. If the dynamics of the price basis is constant, this means that, in the long run, the relationship between the Bulgarian and the French prices does not show a specific trend but instead fluctuates around a constant average level, i.e. both prices are interconnected and move in the same direction at a similar rate.

If the dynamic series is proven to be non-stationary, it means that there is unit error and a specific development is found. In case of a non-stationary dynamic series, the residual values in the regression equation (the error), which represents the difference and the change of the price base as a function of the price basis itself (auto-regression equation), changes in a random, undetermined order, indicating a slight autocorrelation and the presence of other factors, which influence the movement of the price basis. In that case for example, if there is a growing gap in the differences between the French and Bulgarian prices, this would mean that there is no symmetry between the two prices, i.e. they can move in different directions or move counter-cyclically.

The analysis of the presence of a unit error and the integrity of the examined dynamic series is accomplished by applying the Dickey-Fuller test (with a constant) and the Augmented Dickey-Fuller test (see Nestorov, 2015), as expressed in equations (2) and (3).

(2) $$P_i = a_0 + a_1 P_{t-1} + \varepsilon$$

(3) $$P_i = a_0 + a_1 P_{t-1} + a_2 \Delta P_{t-1} + \varepsilon,$$

where P_i is the price basis, P_{t-1} is the price basis during the period t-1, α_0 is the constant of the regression equation, α_1 and α_2 are the regression coefficients and ΔP_{t-1} is the difference between the price bases during the period t and t-1.

The Dickey-Fuller tests are used as a tool for exploring cointegration relationships, which are further developed and complemented by the VAR and VECM vector models and the error correction model (ECM). They allow for an econometric analysis of the power of the relationships and dependencies among certain factors, which is important for a better understanding of the market price model. In the study, the use of a dependent variable in order to analyze the change in the price base is not widely used, usually by a function of the differences in one price to the absolute value of the price of the independent variable. The choice to work with the price base is due to its importance and the interest in it, because it is precisely the movement and the change in the price basis between the French and Bulgarian prices of wheat and maize that indicates the degree of integration between the prices and the linkage between them. It may be that there is a high degree of integration, which means that the price movements are similar, but when the price difference is significant, in other words, when the price basis is large, then we can identify the cointegration of the price basis movements, but prices are split and there are indigenous factors determining their setting.

The Law of One Price is the strongest argument for the existence of a global grain market and for the perfect functioning of the price mechanism through demand and supply. The free movement of goods and the absence of restrictions and barriers to world grain trade should result in the achievement of a single grain price in a relatively short time span. The price differences between regions should be due to transport costs to the nearest point of delivery and the transaction costs of operating on a given market. This is explained by the perfect market conditions, which the grain market lays out – supply is composed of many net exporters, with no direct monopoly or global dominance; demand is diversified – many countries in different regions of the world import grain. The wheat and to a bigger extent the maize are commodities that have their substitutes, making demand relatively elastic and thus avoiding extreme slips and spikes in price movements, which may occur otherwise due to a lack of alternatives and substitutes.

As regards accepting or rejecting the hypothesis for the presence of a unit root error, the critical value of Student's coefficient from the t-statistics a_1 is taken into account. Whenever the critical value of a_1 obtained in the model is less than the

standard value from the t-statistics at the level of the covered observations, the null hypothesis (the existence of a unit root error) must be rejected and the alternative one must be avowed. It implies that the changes in the time series data series and the dynamics in the dependent variable are stationary (see Nestorov, 2015).

The initial stage in the analysis determines whether the dependent time series is stationary or non-stationary. The check of this state of the data series is done through the Dickey-Fuller test (with a constant) and the Augmented Dickey-Fuller (ADF test), which include lags in the equation application.

Table 2

The results from the analysis for the presence of a unit root error in the derived time series

		DF	ADF	Standard critical values for a time series of 100 observations at a significance level of 0.05 (Enders, 2010)
Difference between the French and the Bulgarian price of common wheat	P_w	-5.49	-6.27	-2.89
Difference between the French and the Bulgarian price of maize	P_c	-3.62	-3.77	-2.89

The results obtained for the t-statistics for both crops show that their values are lower than the standard critical value, which leads to the assumption that the data series of the price basis, representing the difference between the French and Bulgarian wheat and maize prices is stationary. This means that, in the long term, the basis between the Bulgarian and the French prices does not show a specific trend of development but instead fluctuates around a constant average level, i.e. the two prices are interconnected and move in the same direction at close rates. The price basis is seen as a sufficiently reliable variable that can be used to determine the change in the price basis in the immediate next period which, in the case of this study, is a monthly basis. Due to the fact that there is stagnation in the change of the price basis between the French and Bulgarian prices for maize and wheat, it can be implicitly concluded that the two prices are cointegrated, which means that they have the same direction of movement and a similar dynamics of change.

Analysis and check for the existence of a trend and seasonality between Bulgarian and French wheat and maize prices

The changes in the price basis determine the integration between Bulgarian and French grain prices. For the sake of a more throughout understanding and knowledge of the relationships between the two prices, an analysis is carried out of whether a trend or seasonality exists within the observed time series of the wheat and maize price basis. The presence of a trend is checked by going through the following steps:

1) the calculation of the average of all observations in the variable series (equation 4);

2) the calculation of the trend ratio from the averages of the two parts in the data series; the data series is divided into two even parts by the median;

3) dividing the average of the time series to the trend ratio and comparison to a threshold, which is assumed to indicate the existence or absence of the trend relevance. If the derived result is lower than the threshold, it is considered that there is no trend in the price basis.

The following equations are used in order to implement the calculations:

(4) $$\overline{\mathrm{P}} = \sum_{\mathrm{t=1}}^{\mathrm{N}} \frac{\mathrm{P_i}}{\mathrm{N}},$$

where $\overline{\mathrm{P_i}}$ is the average price basis for the commodity i, N is the number of the observations in the data series, and $P_i$is the average monthly price difference.

After estimating the median in the data series of the price basis variable, the data is divided into two subgroups with an even number of observations in each set, with the average being calculated in each of these groups.

The trend ratio is calculated through the use of the following equation:

(5) $$\mathrm{Tr} = \frac{\overline{\mathrm{P_i^1}}}{\mathrm{P_i^2}},$$

where Tr denotes the trend ratio and $\overline{P_i^1}$ represents the average of the group in the data series made by tracing the median throughout the entire data set. Through such an approach, by knowing the average of each of the two groups in the data series and deriving from it the trend step of the linear change, itis easy to determine the lowest and the highest point of the trend line.

Regarding the check for the existence of a trend in the variable values, the following formula is applied:

(6) $$(\mathrm{Tr} - 1)/\sqrt{\mathrm{N}} \geq 0.005.$$

If this ratio, divided by the square of the number of the time series is more than or equal to 0.005, it is assumed that the particular data series is subject to having a trend, which means the values in both parts of the data series are distinctly bound. The bound direction between the two parts of the data series depends on the relationship between $\mathrm{P_j}^1$ and $\mathrm{P_j}^2$, where the vector of this trend grows or decreases according to the two subgroup averages. In order to obtain the linear trend line, a trend step is used which is the difference between $\mathrm{P_j}^1$ and $\mathrm{P_j}^2$ divided by the number of data sequences included between the two subgroup averages subtracted by 1 (n-1). This approach models the trend line, exposing the data series in the linear way, which can then be used to study the cointegration between the two prices, taking into account the trend. The study of the presence of a trend between the price basis of the Bulgarian and French prices for wheat and maize shows not only how the price basis changes and evolves but also tidies up the analysis with the use of the autoregressive Dickey-Fuller test by taking into account the trend features of the data series.

The check and estimation for seasonality in the price basis movement is implemented, taking into consideration the length of the market year in wheat and

maize. Regarding the wheat, the marketing year begins on 01.07. (T-1) and ends on 30.06. (T), while in the case of the maize the period begins on 01.09. (T-1) and ends on 31.08. (T). In order to check and determine the seasonality in the price basis between French and Bulgarian grains, an approach is applied, wherein the differences between price basis in the first half of the market year and the second one are estimated. The check for the seasonality of the price basis is done through the following equation:

$$(7) \qquad Sr = \frac{\sum_{t=1}^{k} P_i^k}{\sum_{t=k+1}^{l} P_i^l},$$

where Sr is a coefficient to the proportion between the first and the second half of the market year; $\sum_{t=1}^{k} P_i^k$ is the sum of the price basis in the first half of all market years covered in the data series; and $\sum_{t=k+1}^{l} P_i^l$ is the sum of the price basis at the second half of the market years included in the data set. If the proportion of the sums of both halves of the market years is within the range 0.95 – 1.05, it can be assumed that there is a lack of seasonality in the movement of the price basis. In every other case, when the ratio between both sums of the price basis are beyond that range, it can be conceded that seasonality exists, as the price basis for each month depends on the time slot it occupies within the entirety of the market year.

After the analysis for the existence of a trend and seasonality in the price basis of French and Bulgarian grain prices, the econometric models for projecting the Bulgarian prices connected to the movement of the French prices are elaborated and explored. The models created for the making of the price projections include as independent variables the French grain spot prices and the grain yields during the studies period. The evaluation of the reliability and significance of the model is verified referring to the significance level of the F-criterion. Of the explored models, those in which the level of significance is less than the threshold Sig< 0.05 (Goev, 1996) are regarded as being reliable and relevant. The estimations and the analysis are implemented and run with MS Excel and SPSS 13.0 (Table 3).

Table 3

Results from the trend and seasonality analysis of price basis in the time series

		Trend	Seasonality	
		Step of change $Tr = (\frac{\overline{P_i^1}}{P_i^2}\text{-}1)/\sqrt{N}Tr = (\frac{\overline{P_i^1}}{P_i^2}\text{-}1)/\sqrt{N}$	Correlation between P and the sequent observation in the first or second half of the marketing year	Sr
Difference between the French and the Bulgarian price of soft wheat	P_w	0.003	R = 0.28	1.45
Difference between the French and the Bulgarian price of maize	P_c	0.07	R = 0.00	1.03

Based on the results obtained, it is clear that the prices of the two crops have developed differently over the years. In the case of wheat, there is no evidence of the existence of price trends over the years. The value of the trend ratio is 0.003, thus it is less than the threshold of 0.005, which leads to the assumption that there

are indications of a trend. Unlike the wheat, the trend ratio for the maize is 0.07, which is more than the threshold of 0.005, at which the price trend features are assumed or rejected. This means that, for maize, there is a trend in the price basis, which ascends and over time an increase in the price difference between the Bulgarian and the French price can be observed. The different results concerning the price basis trends of the wheat and maize are not in conflict with the allegation for the cointegration of the two prices, moreover the lack of a price basis trend in the case of wheat confirms the statements. On the other hand, regarding maize, the price basis trend is found and the price difference is subject to time dependence, which reveals the market complexity and the influence from various factors. The trend of the price basis for maize is on the rise, which means that the difference between the French and the Bulgarian price at the end of the period is greater than the one at the beginning of the data series observation in 2007. This can be explained by the fact that the price of maize in the global market jumped up significantly in the second half of the observed period and the bigger average maize price led to a higher price basis between Bulgarian and French maize.

As regards the wheat seasonality, despite the relatively low correlation, it can be argued that there is a seasonal determination, and in the first six months of the marketing year the sum of prices is higher than the one in the second half of the year. Contrarily, concerning maize, the ratio between the sums of the price bases in the two halves is 1.03. This falls within the tolerance range of 0.95 – 1.05, which is assumed to indicate the absence of seasonality. The failure to identify seasonality in this crop testifies that the price basis, which stands for the difference between the French and Bulgarian prices, is steady within the close range during the different periods of the marketing year. This difference remains relatively constant, while the maize prices vary during the different months and periods, but does so in a symmetric way for both the French and the Bulgarian prices. Usually (but not always), in the second half of the year the price of maize is rising compared to the first half, but the difference between the two prices does not change.

The model for projecting the price evolution of wheat and maize on the Bulgarian market

Following up on the results obtained, two groups of models were approbated for the development of the Bulgarian price in relation to the French price.

The first group consists of single factor linear regression models of the dependency between Bulgarian and French prices, which have the following functional form:

$$p_i^{BG} = a_0 + a_1 p_i^{FR} + \varepsilon,$$

where $a_1 = \Delta_1 * \left(p_i^{BG} \middle| p_i^{FR}\right); \Delta_1 = 1$; Δ_1 is the elasticity between the Bulgarian and the French prices.

Since it has been proven that prices are integrated and therefore it can be assumed that the Law of One Price is in force, the result is that the elasticity between the two prices equals 1. The model was applied to soft wheat and to maize.

The second group of models is based on the inclusion of additional variables which make it possible to present more efficiently some of the characteristics of the Bulgarian production of common wheat and maize. For this purpose, the variable "average yield" is included, and in the case of wheat, the consecutive number of the month of the marketing year is included as well.

For wheat, the purchase price model is represented by the following system of equations:

$$p_w^{BG} = a_0 + a_1 p_w^{FR} + a_2 P_{t-1}^{w} + \varepsilon$$
$$P_{t-1}^{w} = f\{(m^{*}yld)\}$$
$$a_1 = \Delta_1{}^{*}(p_w^{BG} | p_w^{FR}), \text{ a } \Delta_1 = 1$$
$$a_2 = \Delta_2{}^{*}\left(p_w^{BG} \middle| P_{t-1}^{w}\right), \text{ a } \Delta_2 = 0.1,$$

where m is the consecutive number of the month of the market year for the production of wheat, and yld is the average yield for the corresponding year.

Deriving from the computation, the purchase price model for maize is represented by the following system of equations:

$$p_c^{BG} = a_0 + a_1 p_c^{FR} + a_2 P_{t-1}^{c} + \varepsilon$$
$$P_{t-1}^{w} = f\{Ln(yld)\}$$
$$a_1 = \Delta_1{}^{*}(p_c^{BG} | p_c^{FR}), \text{ a } \Delta_1 = 1$$
$$a_2 = \Delta_2{}^{*}\left(p_c^{BG} \middle| P_{t-1}^{c}\right), \text{a } \Delta_2 = 0.07,$$

where $\Delta_1$is the elasticity of the Bulgarian and the French prices.

And in this group of models, the elasticity between the two prices is assumed to equal 1.

For wheat Δ_2, (the elasticity of the Bulgarian price and the difference between it and the French price for the previous period) is accepted as being equal to 0.1 and that of the maize is equal to 0.7.

All considered models are statistically significant and with a high degree of adequacy, determined by the determinant coefficient (Table 4). However, expanded models have lower average levels of error, which makes them the more suitable choice for the modelling of the purchase price of wheat and maize in Bulgaria.

Table 4

Results of the tested models of the purchase price of wheat and maize in Bulgaria

Product	Model	Average level of error, %	Correlation coefficient	Determination coefficient	P-value
Wheat	$p_w^{BG} = a_0 + a_1 p_w^{FR} + \varepsilon$	8.0	0.92	0.84	0.00**
	$p_w^{BG} = a_0 + a_1 p_w^{FR} + a_2 P_{t-1}^{w} + \varepsilon$	**7.7**	0.92	0.85	0.00**
Maize	$p_c^{BG} = a_0 + a_1 p_c^{FR} + \varepsilon$	9.4	0.85	0.73	0.00**
	$p_c^{BG} = a_0 + a_1 p_c^{FR} + a_2 P_{t-1}^{c} + \varepsilon$	**8.3**	0.92	0.85	0.00**

**The model is significant at an error level of 0.05.

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The production of cereals in Bulgaria is one of the few well developing and ascending production sectors in Bulgarian agriculture. That is confirmed by both the growth in the cultivated area and its share in country's added value. Through the observed period of EU membership and implementation of CAP, the sector has improved its indicators and value. This gives reason to conclude that production is relatively stable, sustainable and with increasing competitiveness on domestic and international markets.

The contemporary sustainability of cereals is also supported by the good potential for the increase of production (where there are reserves). This is especially true for maize – when irrigation practices and technologies are introduced, for example, the average yields may increase by at least 50%. The fact gives optimistic perspectives for the overall development of the sector in the future because it shows there is a potential for sustainable development and strong performance.

The reasons for the good performance and the stable positions should be sought not only in the way CAP has been implemented (through single area payment policy) but also in the nature of the produced output that is highly liquid and with a high commodity price, a well-developed market and with relatively weak risks regarding potential loses. Nowadays, risk taking and its allocation are the most important factor determining how a particular production will develop. When the risk is under control and managed properly, the consequences of its undertaking are minimized, and prerequisites for its development and expansion are created. The good conditions and the appropriate environment with regard to the management and control of risks in the cereal sector are responsible for unlocking its upward development and for the positive expectations about its future.

The results of the conducted analysis show that the wheat and maize markets in Bulgaria and France should be considered as part of the regional price markets for those crops whose prices gravitates around a common world price. It cannot be affirmed that there is a single world price which would occur in a long-term horizon because such a perfect outcome from the work of the global market mechanism is unheard of.

As a part of the Black Sea regional market for cereals, Bulgaria is strongly determined by it. Its price is unified for this specific market but depends on and reflects changes on the European continental regional market where France is the leading force. That means the prices on the Bulgarian and French markets are highly integrated and move in the same direction at approximately the same pace. Individual grain markets are closely linked and transmit their signals of supply and demand to one another, thus forming a single global virtual price for the grain, which is later transmitted and transferred to regional markets around the world.

At the same time, the trend in the price base is mixed in the case of wheat and maize. Regarding wheat, there isn't a statistical reason to claim that there is a distinct trend of difference in Bulgarian and French prices. There is difference between the two prices, but there is no noticeable direction of alteration over time.

Contrarily, in the case of maize there is a price base trend as the average price base during the months of the second half of the time series are much higher than the ones in the first half. This is due to a couple of reasons which deserve future research, but also serve to demonstrate that maize has certain specific features. This crop is with much less importance not only for Bulgaria, but also for the Black Sea region and for the EU as a whole – Europe has a much weaker influence on the formation of the world price of maize, as compared to that of wheat. For maize, there is a significantly higher yield and production volatility than there is for wheat. Its production is significantly more dependent on climate fluctuations than that of wheat and therefore its price moves in wider ranges compared to that of wheat. It should be noted that during the period under review, the use of maize for biofuels also intensified, thus creating additional uncertainty in demand which has had an impact on prices. This may also be the reason for the emergence of a trend in the change of the price base for maize, which however, does not disrupt the integration between the two prices.

Seasonality in prices is explained by the additional cost of storing the agricultural produce with the time away from its harvest, as well as by the alternative cost accumulated due to the retention. In the case of wheat, there is an expressed seasonality of the base – through the first half of the marketing year it is 45% higher than in the second half. Maize has no seasonality. The lack of seasonality in the price of maize is an uncharacteristic feature – this can be attributed to the specificity of the crop. The instability of demand, as well as the greater supply variability due to higher production cycles lead to the disappearance of the factor "seasonality" from the maize price.

The results of the performed testing of the possible models for the Bulgarian price show that models which take into account the average yields in the country during the period under review and the consecutive number of months in the marketing year (for wheat) are better suited to predict the Bulgarian price.

From the study it can be concluded that the prices of wheat and maize in France are a projection and transmission mechanism between the world markets, Europe and the Black Sea region, which includes Bulgaria.

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