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Forecasting the directions of the EU sugar market development after limiting government intervention

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Abstract

Motivation: The EU sugar industry is one of the most regulated industry which is subject to import duties, subsidies and quotas. Government intervention in sugar markets significantly affects sugar production, consumption and trade. The GATT/WTO negotiations led to the commencement of the liberalization process in the EU sugar market, and initiated a number of reforms aimed at abolishing government support. Consequently, the sugar market in the EU has undergone considerable changes. Proper recognition of the directions of changes will contribute to reducing the difficulties of entities operating on the global sugar market.
Aim: The purpose of this publication is to present the forecasts made in 2017 regarding the main categories characterizing the EU sugar market and to verify their validity following the analysis of the actual data. The work uses the forecasts made for 2017–2020 based on empirical data collected from 1993–2016, and then verifies their validity when set against the real data.

Results: The results of the research showed that statistical models are not able to predict correctly not only the forecasted values, but also the directions of their changes. The range of indicators of forecast errors was almost 40 percentage points, which reduced their credibility. The Pearson correlation index of over 0.7 indicated a significant correlation between the real data and the forecast values for the consumption or sugar beet harvest, while interpreting the discrepancy coefficient index, which did not exceed 1 for the forecast of the sugar production volume. This allows to conclude that this forecast shows the smallest differentiation in comparison to the actual data obtained.

Keywords: sugar market; government intervention; sugar quotas; forecasting
JEL: E31; E37; Q17

1. Introduction

The sugar market in the world consists of both producers from almost 100 countries and consumers, thus, including every inhabitant of the globe. Sugar is consumed not only in households as a final product, but it is also an important intermediate for many industries. Soare & Chiurciu (2016, pp. 327–332) emphasized that for these reasons sugar was classified as a strategic product in domestic economies. Therefore, it was covered by numerous mechanisms supporting the profitability of its production as well as the production of raw materials necessary in the production process.

According to Smutka et al. (2014, pp. 70–77), the sugar market represents one of the markets that are most distorted by protectionist government policies in the world. State interventions have been used to control domestic prices, demand and supply. In the opinion of Borrel & Duncan (1992, pp. 171–194), these activities have created an ineffective pattern of world production, consumption and trade. In turn, Pechrova & Simpach (2017, pp. 527–531) concluded that the EU sugar production and sugar beet cultivation sector have been so far the most regulated plant production branch in the world. The common organization of the sugar market was introduced in 1968 as part of the Common Agricultural Policy. For nearly 40 years, on the internal market of the European Union, regulatory instruments have been applied with regard to guaranteed prices for sugar and sugar beet, production quotas and intervention purchases of sugar surpluses. At the same time, in trade with entities from outside the Community, the following were still in force: export subsidies and refunds for sugar used for industrial purposes, high import duties with quotas for sugar import at reduced tariffs, production limits for sugar substitutes — is glucose and inulin syrup (Regulation No 1009/67, 1967). Due to the high costs of such interventions and significant market distortion, the European Union took into consideration liberalisation of its sugar policy (Budzyńska & Chojnacki, 2018, pp. 2778–2788). Furthermore, during the WTO negotiations there were made arrangements that imposed on the EU an obligation to reduce government support in order to enable the poorest countries and more efficient world sugar producers to compete with large EU international concerns (van Berkum et al., 2005). While reviewing the reform of the EU sugar market initiated in 2006, Chudasama (2016, p. 537) noticed its positives, namely increased rationalization in the production sphere, as some producers completely gave up production, while others carried out processes aimed to increase productivity and competitiveness. The above mentioned author, noted an improvement in collaboration between processors, researchers and growers and considered it crucial for the future success of the EU sugar sector. Yet, the subject literature provides a number of opposite views which claim that the main objectives of the reform have not been met as the expected improvements in competitiveness have not been made; in many cases production has been restricted in regions that were not the least competitive. Market stabilization and reduction of sugar price fluctuations were not achieved, either. On the other hand, the Single European Market has been turned from a net exporter into a net importer of sugar, covering almost 20% of internal demand with sugar imports from the third countries (European Court of Auditors, 2010).

The first step towards the complete liberalization of the sugar market in the European Union was the abolition of sugar quotas in 2017. In the coming years, producers of sugar from the Member States will face the withdrawal of government support and increased competition from cane sugar producers. Forecasts of the likely directions of changes, among the EU entities making up the sugar market, rise a significant issue not only for science, but also for their application. They may become an important tool supporting the process of limiting the mechanisms of state intervention on the global sugar market, which we can witness nowadays, and which is supported by the research of Kuzmenko et al. (2020, pp. 23–38). The authors argue that despite the difference in raw materials, prices and supporting tools used in different countries, there is one sugar market in the world with related entities.

A significant number of entities on the demand and supply side, represented by a developed sugar industry (located in half of the existing countries), and consumers (i.e., virtually every inhabitant of the globe), is just one of the arguments confirming the importance of the sugar market in the economy. Another is the fact that many negotiating rounds were devoted to liberalizing the conditions for the operations of the above-mentioned entities. At the same time, it should be noted how many changes have been made in the last two decades, which are only an introduction to the complete abolition of the support mechanisms used so far for almost all entities. This will radically change the functioning of entities on the global market. That is the reason why so many scientists and practitioners make attempts to predict the directions in which sugar producers will operate under the new conditions.

The purpose of this publication is to present the forecasts made in 2017 regarding the main categories characterizing the EU sugar market and to verify their validity on analysing the actual data. The trend model and harmonic analysis were used to predict the development trends of the sugar market. To verify the correctness of the performed tests, the error rates PE (percentage error) and MAPE (mean absolute percentage error) were applied, defining the percentage in which the forecast was erroneous in Pearson's correlation, linear determination and the divergence coefficient for differences. The resulting discrepancies between the forecast and actual values were used to identify and assess the operating conditions of sugar market entities. What is innovative about the studies carried out is that the forecasts prepared indicate both the direction of the expected changes and their exact value. The most important added value is the long time horizon of the research, which enabled the verification of the accuracy of the forecasts to be carried out. This made it possible to evaluate the forecasting methods used. This is an important application value for government policy makers who make decisions on the design of their policies and public spending based on predicted phenomena.

The article reviews the literature and provides a description of already existing forecasts for changes in the sugar market as a result of the liberalization of the interventionist tools used in the European Union member states. A special focus is on the end of sugar production limits lifted in 2017. The next part of the work presents the methodology of the research conducted both in 2017 when forecasts were prepared and currently to check their accuracy. After presenting the results of the analyses, an attempt was made to specify the reasons for their lack of accuracy due to the factors that characterize the EU sugar market. The last part of the article contains a recommendation and conclusions that might be used in further work on forecasting changes affected by the liberalization of the CAP rules.

2. Literature review

The introduction of the EU sugar market reform of 2006 indicated a new direction of changes in the functioning of the sugar sector and was aimed to prepare EU sugar producers to function without government support. The first stage, which brought to the end the high level of state intervention and which was used for almost 40 years, was marked by the liquidation of sugar quotas in 2017. Both before their abolition and while the new operating conditions were in force, various forecasts were made regarding the directions of changes that were expected on the sugar market, as well as their extent and intensity.

Pechrova & Simpach (2017, pp. 527–531) based their study on ARIMA(1,0,0) model with constant on the data from 01/2001 to 08/2016 on the sugar production sector. The authors pointed out that so far it has been the most regulated branch of plant production, which makes further directions of its development difficult to predict. However, they believe that only knowledge of future variables may help producers make decisions on production volumes. The most extensive forecasting model for the EU sugar market, predicting not only the direction but also the scope of changes in individual indicators in national and regional terms, was provided by the CAPRI (Agricultural Policy Regionalized Impact) model developed by a consortium coordinated by Adenäuer (2008) after two years of the reform, i.e. in 2008. This research based on statistical methods and sensitivity analysis of the balance of partial supply and market modules, the authors predicted the likely behaviour of producers and consumers in individual agricultural markets. With regard to the abolition of production limits on the sugar market, the prediction showed an increase in the yield of sugar beet crops throughout the European Union, with a simultaneous reduction in the volume of crops bringing about a reduction in the production of raw material for sugar factories. Consequently, sugar production in 2020 fell by almost 13%. The largest decrease in the volume of sugar produced was expected from the leading EU producers of the "old" EU–15. For France, the estimated reduction was more than 25%, while for Germany it accounted for almost 17% and 21% for Sweden. However, both France and Germany remained their lead in sugar production in the European Union.

In the case of the main producers from the countries admitted to the Community after 2004, a slight increase in production was expected, in Poland reaching nearly 2%, in the Czech Republic and Slovakia — about 4%. On the other hand, in the countries which ceased production as a result of the reform of 2006, it was not planned to be resumed. The results of the above simulations were confirmed in theoretical studies commissioned by the European Commission DG Agriculture and Rural Development (2011, p. 162), which research based on the combination of theoretical analysis, quantitative empirical assessment, and qualitative analysis of information. The general conclusion of the analyses recommended the reduction of the amount of sugar produced in countries with higher production costs due to the reduction of the beet plantation acreage, and the maintenance of a constant volume of sugar produced in regions with lower production costs. Similar simulations, based on using the augmented Dickey–Fuller (ADF) and the Kwiatkowski–Phillips–Schmidt–Shin (KPPSS) tests for stationarity, were presented five years earlier by Gohin & Bureau (2006, p. 239), according to which they forecasted a 10% global decline in EU sugar production within a few years after the end of the quota system. The convergence of the above predictions in subsequent years was confirmed by the research conducted by Nolte et al. (2012, p. 86), who apply a spatial price equilibrium model (SPQ). The research findings assumed an increase in sugar production in the regions of Eastern Europe, mainly in Poland, after the abolition of production limitations.

Contrary to this is the prediction given by the European Commission (2013) based on partial stochastic analysis and sensitivity analysis, which forecasted a drop in sugar prices in the Member States below the reference threshold, i.e. below the average sugar production costs. This would not only reduce the profitability of production, but also reduce the competitiveness of EU sugar exports to the global market.

In 2015, the Congress of the International Confederation of European Beet Growers (p. 2), was informed about the drastic changes in the EU sugar industry from October 2017, which provided for an increase in competition between beet crops and alternative crops, due to the forecasted significant reduction in the prices of sugar and raw materials used in its production. Hence, the proposed activities should focus on two areas. First, the prices paid to beet growers should cover not only the costs of their production, but also ensure long-term profits. It was also important to increase the automation of raw material quality assessment, which would have a direct impact on a reliable assessment of the value of the delivered beetroots, and thus ensure adequate payment. The second important aspect were the proposals for actions aimed at reducing the level of the tools of state intervention used by the world major sugar producers and exporters. While the European Union runs an active policy of deregulation on the sugar market, its main competitors on the global market apply a number of regulations and mechanisms to support domestic sugar industries. This, in turn, combined with a large number of granted preferential import concessions for sugar from the third world countries, significantly reduces competitiveness of EU exports.

Representatives of the European Union authorities present much more optimistic forecasts. Hogan (2017), Commissioner for Agriculture and Rural Development, on the eve of the complete elimination of sugar quotas, stated that their abolition was a turning point for the marketization of the EU sugar sector, as the sales of sugar produced in the Member States takes place without any restrictions, and, thanks to the support of the European Commission, it should be intensified on the global market. In order to provide additional assistance from the EU administration, the Sugar Market Monitoring Centre was established, the purpose of which is to collect and provide interested entities with up-to-date information on the sugar market.

3. Methods

The research was based on the forecasts prepared in 2016 concerning the main categories characterizing the EU sugar market. The forecasts were based on data for the years 1993–2016 from the following databases: the Institute of Agricultural and Food Economics — National Research Institute, Eurostat and FAOstat.

The economic processes for which forecasts are made are usually stochastic. Therefore, the possibility of actual values of the forecast variable, which will be realized in the prediction period, from the forecasts is assumed in advance. The possibility of a forecast error, also known as a prediction error, is considered real. That is why, it becomes necessary to determine the accuracy of the forecast with the use of appropriate measures that allow the determination and comparison of the order of accuracy of the forecasts. These measures are referred to as the measures of accuracy or accuracy of the prepared predictions. The work uses measures of the accuracy of ex post forecasts for expired forecasts. Two measures were used:

1. Root mean square error:

$$RMSE = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(y_i - y_i^*\right)^2}, \tag{1}$$

where:

y_i — predicted values of a variable in the term i (i=(1, ..., m));

y_i^* — observations in the term i;

m — the number of observations available for analysis.

RMSE measures of how far the actual values of the predicted variables deviate on average from the calculated predictions. The smaller the error, the more accurate the prediction.

2. Normalized root-mean-square deviation or error (VRMSD) ex post:

$$V_{RMSE} = \frac{RMSE}{\left|\overline{y}\right|}, \tag{2}$$

where:

$\left|\overline{y}\right|$ — the average of observation value in the term m, i=1,..., m:

$$\overline{y} = \frac{1}{m}\sum_{i=1}^{m} y_i . \tag{3}$$

VRMSE indicates the percentage of the average actual execution of the studied variables the average ex-post forecast error corresponds to.

A forecast is admissible when it is endowed by its recipient with a degree of trust sufficient to enable it to be used for the purpose for which it was established. The acceptability of the forecast is determined at the same time as the forecast is made. It was assumed that the forecasts will be acceptable if the VRMSE errors are lower than 10%.

The following models were used for prediction:

1. Model of a trend (development tendency), which belongs to a special class of econometric models in which the variability of the dependent variable is described by a specific explanatory variable, which is time. In general, these models do not explain the mechanism of the analysed dependent variable, but illustrate the evolution of this variable over time. In general, the trend model can be written:

$$Y = \alpha_0 + \alpha_1 t + e_t, \tag{4}$$

where:

α_0, α_1 — models parameters;

ε — random variable characterizing the effects of the impact of random fluctuations on the trend, the expected value of which is equal to zero and t=1,..., n.

The parameters of this model can be estimated by the least squares method, when its assumptions are met:

- E(ε)=0;
- D2(εTε)=σ2 I;
- rzX=k+1≤n;

X — matrix of observations of explanatory variables (here — a time variable).

Model parameters are estimated using an estimator:

$$a = \left(X^T X\right)^{-1} X^T y. \tag{5}$$

The assessment of the model fit to empirical data was made by calculating the coefficient of determination:

$$R^2 = 1 - \frac{\sum_{t=1}^{n} e_t^2}{\sum_{t=1}^{n} (y_t - \bar{y})^2}. \tag{6}$$

The coefficient of determination informs what part of the total variability of the explained variable is explained by the development trend model.

Forecasts are calculated from the following formula:

$$y_T^* = a_0 + a_1 T, \tag{7}$$

where:

y_T^* — forecast of the phenomenon for the period T;
a_0, a_1 — estimated parameters of the regression model;
T — period for which the forecast is made.

2. Harmonic analysis — when there are seasonal fluctuations along with a development trend or a constant average level, the model is built in the form of the sum of the so-called harmonics — sinusoidal or cosine functions of a given period. The first harmonic has a period equal to the period of the period under study — n, the second $n/2$, the third $n/3$, etc. The number of all harmonics is $n/2$. The general form of the harmonic model can be represented as follows:

$$Y = \alpha_0 + \sum_{t=1}^{\frac{n}{2}} \left[\alpha_i \, sin\left(\frac{2\pi}{n} it\right) + \beta_i \, cos\left(\frac{2\pi}{n} it\right) \right]. \tag{8}$$

The values of the parameters α_0, α_i, β_i are estimated using the least squares method.

$$a_0 = \frac{1}{n} \sum_{t=1}^{n} y_t, \tag{9}$$

$$a_i = \frac{2}{n}\sum_{t=1}^{n} y_t \, sin\left(\frac{2\pi}{n}it\right), \tag{10}$$

for: $\left(i = 1, \ldots, \frac{n}{2} - 1\right)$,

$$b_i = \frac{2}{n}\sum_{t=1}^{n} y_t \, cos\left(\frac{2\pi}{n}it\right), \tag{11}$$

$$a_{\frac{n}{2}} = 0, \tag{12}$$

$$b_{\frac{n}{2}} = \frac{1}{n}\sum_{t=1}^{n} y_t \, cos(\pi t), \tag{13}$$

where:

i — harmonic number;

t — time (t=1,..., n);

n — number of observations;

y_t — the level of the analysed phenomenon in the period t.

A_i amplitude is the greatest (in absolute value) difference between the value of the i-th harmonics and the average level. The values of individual amplitudes for individual harmonics are calculated according to the formula:

$$A_1 = \sqrt{a_i^2 + b_i^2}. \tag{14}$$

The part of the total variance of the variable Y (analyzed), which is included by the first n–1 harmonics in the total variance, is presented in the form of the quotient:

$$\omega_i = \frac{c_i^2}{2S^2}, \tag{15}$$

for: $i = 1, \ldots, \frac{n}{2} - 1$, and through the last harmony:

$$\omega_i = \frac{c_i^2}{S^2}, \tag{16}$$

for: $i = \frac{n}{2}$, where:

$$c_i^2 = a_i^2 + b_i^2, \tag{17}$$

for: i=1,..., n;

S^2 — evaluation of the variance of the variable y.

The forecast is made on the basis of the model for harmonics that explain more than 90% of the total variability of the variable y:

$$y_T^* = a_0 + \sum_{i=1}^{\frac{n}{2}} \left[a_1 \, sin\left(\frac{2\pi}{n} it\right) + b_1 \, cos\left(\frac{2\pi}{n} it\right)\right]. \tag{18}$$

Quantitative forecasting was used, which were called predictions concerning economic phenomena of the quantitative type, prepared for a four-year period, i.e. for the years 2017–2020. A trend model (development tendency) was used for prediction when there were seasonal fluctuations along with the development tendency or a constant average horizontal. In the case of a satisfactory level of the coefficient of determination, this method was selected to predict a given phenomenon. In the case of too large forecast errors, more advanced statistical methods were applied — the harmonic analysis. The obtained predictions were considered reliable as their errors did not exceed 10%. When preparing the study, a research hypothesis was put forward which assumes that econometric forecasting is an imperfect tool for forecasting economic categories in markets with a strong influence of government support.

In this paper, the correctness of the prepared forecasts was verified on the basis of the real data from the aforementioned databases, based on selected error rates: PE (percentage error) and MAPE (mean absolute percentage error), which inform about the size of errors and the absolute mean the size of forecast errors for the test period, expressed as a percentage, which allows for the comparison of the forecast accuracy of various models (Xinqiang et al., 2021, p. 565). Other indicators used are as follows: Pearson's correlation index, informing about the relationship between the forecast and the actual values; linear determination indicator informing about the percentage of the forecast explained by the presented model and error discrepancy coefficient, U^{Δ}, calculated according to the formula:

$$U^{\Delta} = \sqrt{\frac{\sum_{t=1}^{T-1}\left(\Delta y_t - \Delta y_t^*\right)^2}{\sum_{t=1}^{T-1}\Delta y_t^2}}, \tag{19}$$

where: $\Delta y_t = y_{t+1} - y_t, \Delta y_t^* = y_{t+1}^* - y_t^*$ and y_t — is the observed value; y_t^* — predicted value. This indicator is used for the purpose of evaluation of precision of progressive tendency forecast, therefore, the values of this coefficient close to zero indicate a high accuracy of forecasting a development tendency (Grabowski & Welfe, 2011, pp. 782–784).

The strengths of the methodology lie in the use of various prognostic models depending on the determination coefficient and the long research period on the basis of which the forecasts were made, as well as the use of several different indicators to verify their reliability. The weak sides of the methodology might be observed in the time-consuming nature and the high degree of complexity of the prepared forecasting model.

4. Results

4.1. The econometric forecasting process

The sugar beet harvest for the EU was predicted for the data from years 1993–2016. A linear model of the development tendency was used for this purpose. The estimated model took the following form: $\hat{y}$ =2238.55–33.57t. This means that in the analysed period (from year to year), the sugar beet harvest in the EU drops by 33.57 thousand hectares. The coefficient of determination was at the level of R^2=0.75, which means that 75% of the total variability of the area was explained by the model. On its basis, a forecast was made for five subsequent periods, i.e. 2017–2021 (Chart 1).

For the forecasts calculated in this way, the RMSE error amounted to 135.47 thousand hectares, which is 7.45% of the average sugar beet harvest in the EU (in the analysed period). So the forecasts are acceptable. The projected decline in the sugar beet harvest for 2021 is 167.85 thousand hectares compared to 2016, which constitutes as much as 11.71% decrease in the harvest of crops.

The prediction of raw sugar production for the EU was made for the data from years 1993–2017. For this purpose, harmonic analysis was used. Other forecasting models were burdened with too large errors that made it impossible to make forecasts with their application. The first, third, fourth, sixth, eighth, tenth and eleventh harmonics entered the estimated model. The harmonics adopted for the model explain 90.42% of the variability of raw sugar production in the EU. The estimated model is as follows:

$$
\begin{aligned}
\hat{y} = {} & 17.758 + 0.530\,sin\left(\frac{\pi}{12.5}t\right) - 0.527\,cos\left(\frac{\pi}{12.5}t\right) - 0.732\,sin\left(\frac{3\pi}{12.5}t\right) - \\
& -0.575\,cos\left(\frac{3\pi}{12.5}t\right) + 1.074\,sin\left(\frac{\pi}{3.125}t\right) + 0.195\,cos\left(\frac{\pi}{3.125}t\right) + 0.624\,sin\left(\frac{\pi}{2.1}t\right) - \\
& -0.230\,cos\left(\frac{\pi}{2.1}t\right) + 0.321\,sin\left(\frac{\pi}{1.5625}t\right) - 0.679\,cos\left(\frac{\pi}{1.5625}t\right) + \\
& +0.842\,sin\left(\frac{\pi}{1.25}t\right) - 0.176\,cos\left(\frac{\pi}{1.25}t\right) - 0.449\,sin\left(\frac{11\pi}{12.5}t\right) - 0.527\,cos\left(\frac{11\pi}{12.5}t\right).
\end{aligned} \tag{20}
$$

On its basis, a forecast was made for four subsequent periods, i.e. 2018–2021 (Chart 2). The following forecasts were obtained for the volume of sugar production in the European Union after the abolition of sugar quotas. For the forecasts calculated in this way, the RMSE error (expired forecasts) amounted to 0.518 million tonnes, which is 2.92% of the average raw sugar production in the EU (in the analysed period). The forecast error is small. The forecasts are therefore acceptable, very accurate.

The fourth harmonic has the largest share in explaining the variability of raw sugar production in the EU — 21.27% (having a period of 25/4=6.25 years), and the third harmonic 15.48% (having a period of 25/3=8.33 years), The 10th harmonic 13.23% (having the period 25/10=2.5 years), the 11th harmonic 12.52% (having the period 25/11=2.27 years) and the eighth harmonic 10.06% (having the period 25/8=3.13 years). According to the model, the instability on the sugar market in the European Union is predicted, expressed by a high amplitude of fluctuations in the sugar production level. In the first two years after the abolition of sugar quotas, the prediction assumes an increase in sugar production by EU producers. However, in the third year after freeing the market, a large decrease in the volume of production is assumed.

The forecast of sugar consumption for the EU was made for data from years 1993–2016. A linear model of the development tendency was used for this purpose. The estimated model took the following form: $\hat{y}=12.4397+0.3201t$. This means that in the analysed period (from year to year), sugar consumption in the EU increases by 0.3201 million tonnes. The coefficient of determination was at the level of $R^2=0.9088$, which means that almost 91% of the total variability of sugar consumption was explained by the model. On its basis, a forecast was made for four subsequent periods, i.e. 2017–2020 (Chart 3).

For the forecasts calculated in this way, the RMSE error (expired forecasts) amounted to 0.702 million tonnes, which constitutes 4.27% of the average sugar consumption in the EU (in the analysed period). So the forecasts are acceptable. The projected increase in sugar consumption in the EU for 2020 is 1.883 million tonnes compared to 2016, which represents as much as 9.65% increase in consumption.

The linear model assumes that the growth rate of sugar consumption will continue in the coming years.

The prediction of the second factor determining competitive advantage, which is the self-sufficiency index, calculated on the basis of forecasts of sugar production and consumption in the European Union, indicates the annual decrease in the degree of internal supply. Despite the planned increase in production in the first years of the forecast, the permanent upward trend in sugar consumption contributed to the deteriorating results of the self-sufficiency index. The consequence of the presented trends is the deteriorating competitive position of the EU sugar industry on the internal market.

4.2. The verification of the correctness of forecasts

In 2021, the forecasts prepared in 2016 were checked by comparing them with actual data. Table 1 presents the results which show the percentage degree of overestimation of the forecast data on an annual basis and collectively for the entire period under examination, i.e. for the years 2017–2020.

The first indicator on the basis of which the accuracy of the prepared forecasts was verified is PE (percentage error), which for all the forecasts was 3.14%. This is a very low error rate, which points to accurate forecasts. However, as indicated by the annual values, the value of the synthetic index was influenced by the fact that the forecasts were underestimated six times, which resulted in a significant reduction of the analysed index. Therefore, the MAPE (mean absolute percentage error) indicator, which shows the absolute value of the forecast values, is much more accurate. Its average value for all three prepared forecasts was 9%, which significantly reduces their accuracy. It is also proved by the fact that the range in which the forecast errors were included was almost 40% due to their underestimation reaching over 18% and overestimating them by over 20%. The forecasts discussed were most erroneous in the case of sugar consumption. On the other hand, the lowest errors were characteristic of the forecasts for the sugar production volume.

Table 2 presents the indicators verifying the reliability of the prepared forecasts. In the case of the verification of the correlation between the forecasts and the actual values using the Pearson correlation index, the obtained results proving a high dependence of the forecasts on the actual values in the case of sugar beet cultivation area and consumption, although in the mentioned cases there was a negative correlation proving that the forecast increase was accompanied by decline in actual values and vice versa. This affects the assessment of the forecasting process carried out, as the direction of changes on the sugar market in the European Union ran contrary to the forecast.

Coefficient of determination informs the percentage in which the forecast was consistent with the actual data. After conducting the research, it can be stated that 2 forecasts were estimated quite accurately, being more than 50% similar to the real data. They concerned data on sugar beet harvest and sugar consumption forecasting. Whereas, the forecast of sugar production is slightly differs from actual data.

A completely opposite interpretation was provided by the error discrepancy coefficient indicator, U^{Δ}, because in accordance with the obtained values of this indicator, the forecast for sugar production was the best. The forecast of sugar beet cultivation area can also be positively assessed. Despite the fact that the value of the index exceeded 1, it is a minor breach and therefore the forecast can be considered accurate. However, the consumption forecast should be assessed negatively.

5. Discussion

The presented research and analyses have shown, how difficult it is to prepare accurate forecasts, despite the use of advanced forecasting tools and a long trial period. On the one hand, the functioning of sugar quotas in the EU created a concentration of production independent of the production plants location, yet, on the other hand, it contributed to the monopolization of production, which resulted in the development of unfair competition on the European market (Maitah et al., 2016, pp. 236–241). Therefore, EU central policy makers decided to abolish sugar quotas. Scenarios of the further functioning of the market were difficult to predict. Many entities started creating projections but, given the fact that various methods were used, different results were achieved. After four years of operation of the EU sugar market with no limits on the production, the correctness of the prepared forecasts may be verified.

The research discussed here confirms the difficulties in forecasting economic categories in the changing and unpredictable environment. Although statistical tools indicate a low level of errors, they appear to be less accurate than assumed when compared with actual data. Contradictory results were achieved depending on the criteria and verification indicators used. Indicators based on the analysis of errors in forecasts present low values, but this was due to the fact that the direction of forecasts was also wrongly estimated, which had a significant impact on the size of the synthetic indicators.

When other forecast verification indicators were used, the obtained results were neither consistent nor uniform. Depending on the adopted components building the index, the obtained results were inconsistent with the previous ones. This is essential for the negative assessment of not only the forecasted values, but also the indicators for their verification.

The conducted research provides the explanation why there are such discrepancies in forecasting in the literature.

6. Conclusion

The considerations included in the study concerned the presentation of various views and scenarios for the functioning of the EU sugar market during the reduction of government support. The first of the most important stages of this process was the lifting of production limits in 2017. It is necessary for EU decision-makers to adopt the directions of likely changes on the sugar market in order to develop the schedule and scope of the changes. Therefore, it is essential to so important to try to forecast the most important categories characterizing the EU sugar market. There are many conflicting predictions in the literature. In 2017, forecasts were prepared with the use of econometric models, which this article verified to be true in comparison with real data and with using various statistical indicators.

In the course of the research, it was shown that the aggregate indicators of forecast errors reached low values, not exceeding 17%, which indicated slight discrepancies between forecasts and actual values. However, the analysis of the annual deviations revealed that their range was almost 40 percentage points, which, taking into account the incorrect estimation of the directions of the forecasted values, significantly reduced their credibility. Conflicting results were also obtained when examining other indicators. As the Pearson correlation index of over 0.7 indicated a significant correlation between the real data and the forecast values for the consumption or acreage of sugar beet cultivation, and interpreting the error discrepancy coefficient index, which did not exceed 1 for the forecast of the sugar production volume, which allows to conclude that this forecast shows the smallest differentiation in comparison to the actual data obtained. In this way, the hypothesis that econometric forecasting is an imperfect tool for forecasting economic categories in markets with a strong influence of government support was proven to be true. Therefore, it can be assumed that the abolition of the regulations applied under the CAP on the EU sugar market will contribute to greater transparency of its operation and improve the accuracy of forecasts. In this way, EU decision-makers will receive more reliable tools to forecast the effects of further limits in the application of the instruments of state intervention.

Hass (2018, pp. S32–S36) stated that the only determinant influencing the categories characterizing the sugar market is the price level on the world markets. Therefore, it gave grounds to further research related to the accuracy of forecasting changes on the EU sugar market undergoing the process of its liberalization.

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Appendix

Table 1.
Errors of sugar market forecasts (in %)

Indicator	Category		
	sugar beet harvest	sugar production	sugar consumption
		PE	
2017	–1.10	9.17	12.63
2018	–3.21	–5.22	16.71
2019	–18.04	–3.32	17.91
2020	–15.24	7.12	20.24
4 years summary	–9.40	1.94	16.88
MAPE	9.40	6.21	16.88

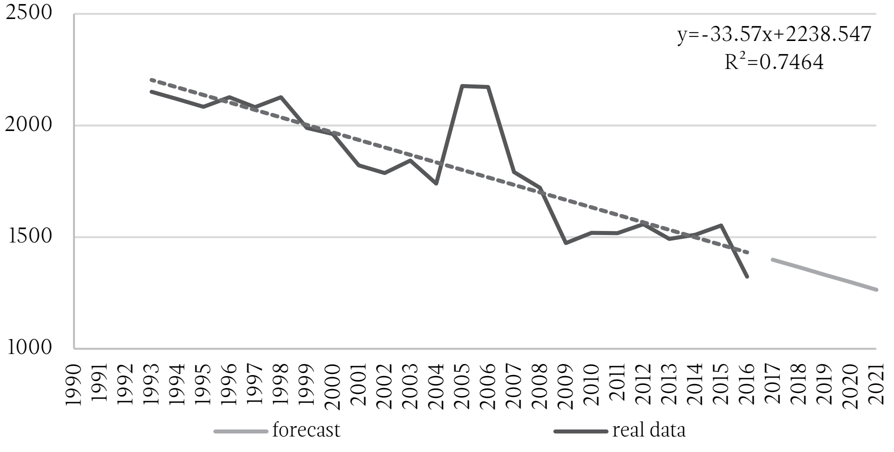
Source: Own preparation based on the own conducted research.

Table 2.
Indicators verifying the accuracy of forecasts

Indicator	Category		
	sugar beet harvest	sugar production	sugar consumption
Pearson's correlation	–0.76	0.37	–0.74
coefficient of determination (%)	57.27	13.45	54.28
error discrepancy coefficient (U^{Δ})	1.14	0.96	2.17

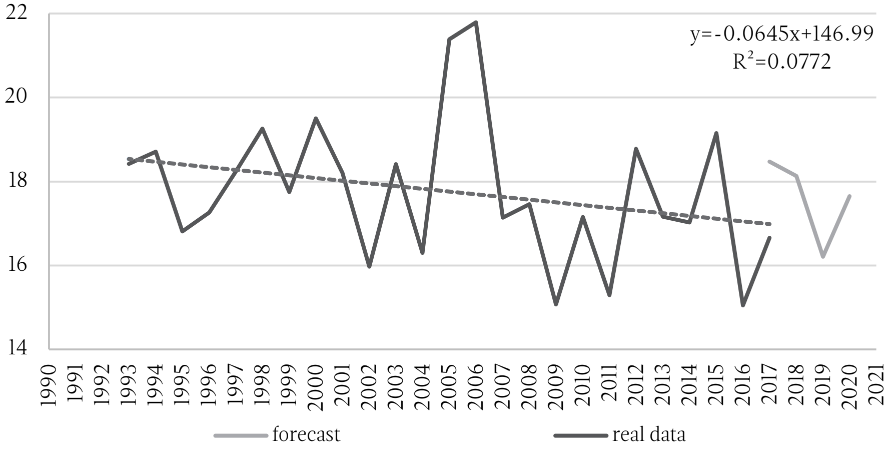
Source: Own preparation based on the own conducted research.

Chart 1.
The forecast of sugar beet harvest: linear model (in millions of hectares)



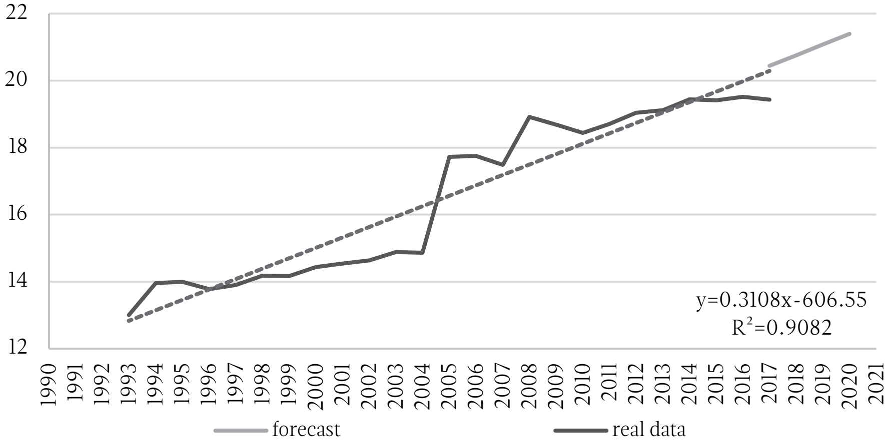
Source: Own preparation based on the data from the statistics of the European Association of Sugar Manufacturers and Institute of Agricultural and Food Economics — National Research Institute.

Chart 2.
The forecast of raw sugar production in the EU: harmonic model (in millions tones)



Source: Own preparation based on the data from the statistics of the European Association of Sugar Manufacturers and Institute of Agricultural and Food Economics — National Research Institute.

Chart 3.
The forecast of sugar consumption in the EU: linear model (in millions tones)



Source: Own preparation based on the data from the statistics of the European Association of Sugar Manufacturers and Institute of Agricultural and Food Economics — National Research Institute.