DEVELOPMENT OF PRICING MODELS IN THE SUGAR MARKET AND THEIR FORECASTING ON COMMODITY EXCHANGES

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Introduction. One of the main classical functions of a commodity exchange is the formation of market prices based on the current ratio of supply and demand. The exchange generates the exchange price of the product, which becomes an indicator of domestic and world prices. The identification of prices on stock exchanges allows agricultural producers to plan their production, anticipate market trends, and governments to make appropriate policy decisions regarding agriculture. The exchange pricing mechanism is the most popular today primarily for agricultural producers. This is due not only to the need to reduce seasonal price fluctuations, but also to set competitive prices, which are often inaccessible due to the market's highly political position. Therefore, leveling the pressure of the processing dictate is one of the important factors in creating a competitive environment where direct producers have the opportunity to get the price level that will ultimately be determined by the supply and demand for their products. Exchange trading in this context is the most effective mechanism in the fight against monopoly manifestations, and the concentration of supply and demand is the most important force. The exchange pricing mechanism is a modern and progressive method of determining market prices for products, especially for agricultural products. The advantages of the exchange pricing mechanism include the ability to form price levels under the influence of high concentration of supply and demand for the corresponding product, rapid attraction of speculative capital, flexibility and mobility in managing price volatility, price forecasting, minimizing the risk from seasonal fluctuations and other market changes, trade diversification and selection of the best trading strategies among alternative ones, in order to ensure optimal pricing policy of economic entities. Therefore, the prices that are formed (set) in the course of exchange trading are among the most competitive in the market, in addition, competition occurs not only in the physical market, and a characteristic feature of exchange trading is a developed futures market, where transactions are made, including for agricultural products that will mainly be grown or produced. That is, the object of trading is the future crop, which, thanks to trading in the corresponding derivatives, receives price confirmation. Modern world exchanges serve as an indicator of global pricing, including for the main types of agricultural products (grains, oilseeds), emphasizing that the main instruments of modern exchange trading are such types of derivatives as futures and options, which are used as financial instruments for insurance of price risks or for speculative purposes. The mechanism for forming prices for agricultural products depends simultaneously on the futures prices of various contracts that are issued and traded on the exchange, because this makes it possible to forecast and hedge prices in the near and long term without stopping. The relationship between futures contract prices is obvious, but there are also differences caused by different expiration dates. Thus, the exchange pricing mechanism assumes the consistency of the futures and spot markets and their structuring. The lack of developed exchange trading of commodity derivatives, primarily futures on the domestic market of agricultural products, confirms the inability to form transparent and flexible prices. And most importantly-due to the lack of a mechanism for avoiding monopoly manifestations, prices in Ukraine are significantly behind the world ones. In this case, it is the commodity producers and agriculture as a whole that bear the most price losses from inefficient pricing. One of the world's traditional commodities is sugar. On world exchanges, this product is traded under contracts that are positioned as one of the most liquid on the exchange market of agri-food products – in recent years, they have taken leading positions in the futures rating. A futures contract is an agreement between two parties on an exchange for the future delivery of a certain amount of the underlying asset at a price specified in the contract. Based on this, the seller undertakes

to deliver a certain amount of sugar to the buyer in the sugar futures contract at a pre-agreed price. In this way, buyers and sellers insure themselves against a possible rise in sugar prices in the future.

The overall state of the world sugar market is monitored by monitoring the physical and exchange markets, in the second case-exchange trading on the world's leading "sugar" exchanges: New York Mercantile Exchange and London Mercantile Exchange in the context of the main types of sugar (raw sugar and white sugar). The assessment of the market conditions for raw sugar from cane is tracked based on the terms of delivery of FOB Brazil ports and CIF Black sea, white sugar of FOB Brazil ports, and of FOB Thailand ports (category sugar ICUMSA-45-meets the highest quality standard according to the International Commission For Uniform Methods Of Sugar Analysis (an international regulatory body that analyzes the product and sets global standards).

There are 4 main types of sugar futures contracts traded on world exchange platforms: two ("Sugar No. 11 Futures", "Sugar No. 16 Futures") on the Intercontinental Commodity Exchange – ICE; one ("White Sugar Futures (No. 407)") on the London International Financial Futures and Options Exchange – Liffe; one ("Sugar white") on the Zhengzhou Commodity Exchange – ZCE. The most popular contract is "Sugar No. 11 Futures", which is a benchmark for the price of sugar in the world and sets the price for the physical supply of unrefined cane sugar (table 1).

Thus, in accordance with the "Sugar No. 11 Futures" trade raw sugar of cane origin, the corresponding countries are also producers. The term contract "Sugar No. 16" (designation of the SF contract) sets the price for the physical delivery of unrefined cane sugar produced in the United States (or another country when the supplier pays the duty) to one of the us sugar refineries specified by the recipient.

The "White Sugar Futures No. 407" is designed to meet the insurance needs of producers, buyers and sugar traders for the purchase and sale of white sugar (beet or cane refined sugar of the current crop with a sucrose content of 99.8 %, humidity not exceeding 0.06 %) with a delivery volume of 50 tons originating from countries: Algeria, Argentina, Australia, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Egypt, El Salvador, France, Germany, Guatemala, India, Italy, Korea, Malaysia, Mauritius, Mexico, Morocco, Mozambique , Netherlands, Pakistan, Philippines, Poland, Portugal, Russia, Romania, Saudi Arabia, Singapore, South Africa, Spain, Sudan, Thailand, Turkey, UAE, Ukraine, UK, USA [1].

Table 1

Description of the sugar futures contract «Sugar No. 11 Futures»

Parameters	The "Sugar № 11" fixed-term contract is the main reference point for the entire world trade in raw cane sugar.
The designation of the contract	SB
Scope of delivery under the contract	12,000 pounds or 50.8 tons
Price scale	The price is determined in cents and hundredths of a cent per pound
The minimum price fluctuation	± 0.01 cents per pound, equal to $ 11.20 per contract
Months of delivery under the contract	March, may, July, October
Termination of the contract	Upon the fact of physical delivery, FOB
Sugar standard	Unrefined centrifugal cane sugar that has undergone 96-degree polarization
Daily limit of the contract	Doesn't have
Sugar-producing countries (cane cultivation)	Argentina, Australia, Barbados, Belize, Brazil, Colombia, Costa Rica, Dominican Republic, El Salvador, Ecuador, Fiji, Antilles, Guatemala, Honduras, India, Jamaica, Malawi, Mauritius, Mexico, Mozambique, Nicaragua, Peru, Philippines, South Africa, Swaziland, Thailand, Taiwan, Trinidad, USA, Zimbabwe
Terms of notification of intent to deliver the contract	The first business day after the end of the last day of trading in this futures contract
Last day of trading a futures contract	Last business day of the month preceding the delivery month
The time of trading	Local time: 03.30-14.00

Source: compiled by the author based on [1]

The "Sugar White" futures contract, which is traded on the Zhengzhou commodity exchange in China, also applies to white sugar, but with a delivery volume of 10t. It is the exchange price of the product that serves as a price indicator for the market, which does not allow the value of the product to change significantly in the direction of increasing or decreasing depending on someone's subjective interests.

Since a liquid stock market, many interested players who look for an adequate value of the goods, if the stock market is impossible to sell goods at non-market price, write it off, to carry out the operation, cost parameters which differs significantly from the market price (just a lot of questions from market participants and regulatory authorities).

Note that futures contracts for sugar are not limited to futures. The Intercontinental commodity exchange in the United States and the London International Futures and Options Exchange are trading a new instrument as a "futures option". This contract provides for the initial delivery of securities in the form of sugar futures, and then for these futures the delivery of sugar itself. The purpose of this instrument, as well as futures, is to insure the buyer or seller against an increase or fall in the price of sugar, but in addition the buyer (seller) insures itself against a possible change in the price of futures.

Forward is an agreement to buy or sell a specific product on a specific date in the future at the price fixed at the time of signing the agreement. Most transactions are over – the-counter. Each contract is made individually. There is no movement of funds at the time of signing the contract. At this time, the risk of non-fulfillment of the contract is shared by both parties. It is almost impossible to "close" a contract before it expires. The contract provides for the delivery of physical goods, mainly up to a year. The contract is intended for the delivery of physical goods in the future can be used in the "forward cover" operation (carrying out a number of simultaneous opposite transactions in the "spot" and "forward" markets) or as part of a marketing strategy for establishing long-term trade relations. The main users are those who are interested in establishing long-term trade relations, as well as trading partners who have long-term cooperation and trust each other.

The price at the time of entering into a forward contract is set via an electronic system, with the participation of a broker, or through direct negotiations between the supplier and the client. Sometimes forward contracts are entered into through centralized exchange server systems, but this is not very common. The most common method is to conduct direct negotiations between the buyer and the seller.

In the forward market, the parties agree on contracts for the delivery of goods in a few months instead of the current time, as is the case in the spot market. Forward markets generate forward contracts with associated prices. These prices reflect the cash market values for a specific underlying asset that will be delivered in the future based on prices agreed today. This series of forward prices reflects the relative demand for the underlying asset over time and allows producers to plan production and consumers to plan consumption.

Option – the right to buy or sell a particular product on a certain date in the future (or earlier) at a set price. Transactions are both exchange-traded and over-the-counter. Individual ordering of contracts is carried out in OTC turnover. At the time of execution of the contract, the buyer pays the seller a premium (option price). If the option is over-the-counter, the buyer risks that the seller will not fulfill its obligations. Modern commodity options are usually based on a futures contract, not the commodity itself. The terms of exchange options coincide with the terms of futures contracts (usually up to a year). Sellers of stock options are required to pay a margin. The buyer of the option limits the maximum amount of losses. Selling options reduces the cost of keeping the product. Stock options are used for hedging and obtaining short-term funds. Over-the-counter options are used as part of a marketing strategy to establish long-term trading relationships. Buyers of options are currently mainly producers and consumers from developed countries, as well as those who are willing to pay a premium (sometimes very high) to reduce risk. Sellers of options are holders of the product who want to reduce the cost of preserving it, as well as those who do not have a clearly developed hedging strategy.

A kind of modern-style futures market today has a contract called "swap", which was preceded by contracts (spot or forward), concluded in a Central place with the execution of operations through the system of open voice trading. A "swap" agreement is an agreement to exchange certain funds at certain time intervals. This is a series of interconnected forward contracts with cash settlement. Transactions are made through a Bank or a large trading company. Contracts are made individually. The movement of funds occurs immediately after the conclusion of the contract. Additional funds may be required. Both parties are at risk of not fulfilling the contract. Delivery of physical goods is not provided (this is a purely financial instrument). The swap deal is designed to fix future prices for a long period. The main users are hedgers engaged in

financial transactions, consumers who want to fix their expenses for a long time in order to maintain competitiveness.

Review of the recent research and publications sources. In General, the issues of exchange markets are presented in the works [2-6]. In particular, in [2] it is noted that stock exchange mergers can lead to increased efficiency; however, increasing levels of concentration can potentially lead to the exercise of market power. The work has been studied the market power repercussions of stock exchange mergers and find that the industry's concentration levels have not significantly increased and the concentration levels do not influence exchanges' profitability in the post-merger period. The profitability of the merging exchanges in the post-merger period is largely influenced by efficiencies in revenue generation and cost management. The absence of evidence that stock exchange mergers lead to the exercise of market power suggests that there does not appear to be an immediate need for regulatory agencies to be overly concerned about mergers among stock exchanges leading to the exploitation of market power to the detriment of consumer welfare. The paper [3] focuses on commodity financialization and the gradual integration between commodity and financial markets, investigating to what extent shocks in stock markets impact commodity price volatility, and the persistency of the phenomenon. The work [4] motivated by previous studies documenting significant return and volatility effects of economic policy uncertainty (EPU) on the stock market, this study examines whether EPU has an effect on the dynamic conditional correlations between stock and commodity returns. In the paper [5], authors investigate the hedging versus the financialization nature of commodity futures vis-à-vis the equity market using a ARMA filter-based correlation approach. In the paper [6], authors examine stock market integration among five selected emerging stock markets (Brazil, China, Mexico, Turkey and others) and developed markets of the US, UK and Germany.

Task statement. The objectives of the study are to analyze 4 major types of futures contracts for sugar: two ("Sugar No. 11 Futures", "Sugar No. 16 Futures") on the Intercontinental Commodity Exchange – ICE; one ("White Sugar Futures (No. 407)") on the London International Financial Futures and Options Exchange – Liffe; one ("Sugar white") on the Zhengzhou Commodity Exchange – ZCE.

Basic material and results. Since one of the main types of agricultural products sold on commodity exchanges is sugar, the analysis of prices and their prediction is carried out on the example of this product. Futures contracts are mainly used to sell sugar on world commodity exchanges:

- two ("Sugar No. 11 Futures", "Sugar No. 16 Futures") on the Intercontinental Commodity Exchange - ICE;

- one ("White Sugar Futures (No. 407) ") on the London International Financial Futures and Options Exchange – Liffe;

- one ("Sugar White") on the Zhengzhou Commodity Exchange – ZCE).

Let us consider the dynamics of the prices of these futures contracts. The Figure 1 shows the dynamics of prices for Sugar No. 11 Futures on the Intercontinental Commodity Exchange – ICE. According to Fig. 1 we can conclude that the futures price is volatile. The maximum prices for the analyzed period were typical for 2016-2017, when there was a shortage of sugar on the world market. Now prices are low.

Fig.1. Dynamics of prices for Sugar No. 11 Futures [7]

The Figure 2 shows the dynamics of sugar futures prices on the London International Financial Futures and Options Exchange.

Fig.2. Dynamics of prices for White Sugar Futures (No. 407) [8]

According to Fig. 2 we can conclude that the dynamics of prices for sugar futures on the London intercontinental financial futures and options exchange is very similar to the Intercontinental Commodity Exchange – with peak prices in 2016 and 2017. Now prices are at the minimum level for the analyzed period.

**Fig.3. Dynamics of futures contract prices for Sugar White [9]**

In contrast to our markets and European markets, sugar futures prices are still rising in the Chinese market.

Among the factors that determined the price of sugar on world trading platforms, it is necessary to point out the following main ones. The reason for the rapid decline over the past two years is that last year the world continued to overproduce sugar. The deficit of 2015/2016 MG stimulated the growth of sugar prices. Since mid-2016, raw sugar has skyrocketed from 10 cents to 24 cents/pound on the New York stock exchange. Accordingly, high world sugar prices and favorable weather conditions caused an increase in acreage. As a result, sugar production increased, and 2017/2018 MG became a record harvest season, after which world prices began to decline.

In 2017/2018, combined with dry weather conditions, low global sugar prices caused a reduction in production, especially in Brazil and the EU. Prices seem to have recovered a bit and started to rise, but India's large reserves and unstable policies are making adjustments. However, Sucden forecasts that sugar

prices will fluctuate between 12.5 and 15 cents / pound until the end of 2019, after which they will start to rise due to the 2019/2020 MY deficit. The main sugar producers in the world are Brazil and India, and China and Russia have increased their sugar production. Therefore, the price of white sugar on world markets has been significantly reduced. For example, over the past year – from mid-October 2018 to early September 2019 – the price of sugar on the London stock exchange has slipped from $ 387 to $ 304 per ton.

Let's analyze the dynamics of the FAO sugar price index (Fig. 4).
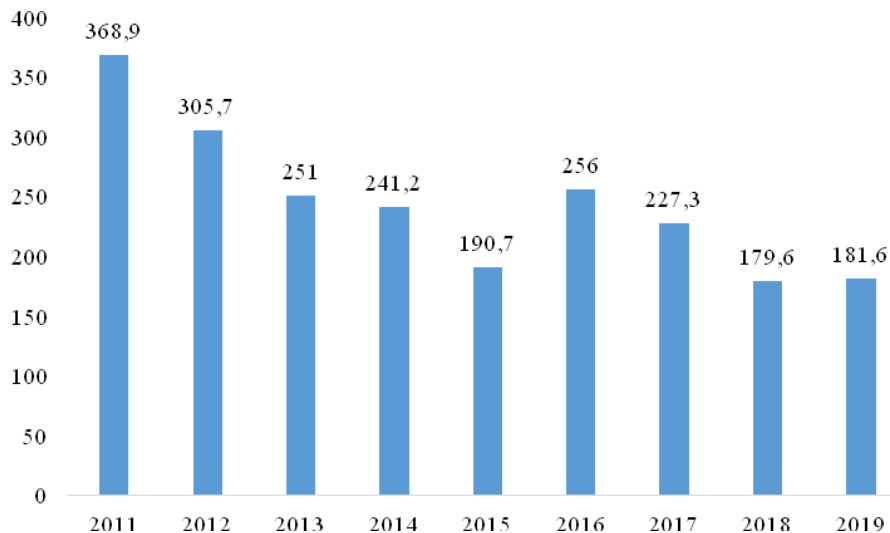
Fig.4. Dynamics of the FAO sugar price index, % [10]

The average value of the FAO sugar price Index in November 2019 was 181.6 points, which is 3.3 points (1.8%) higher than in October 2019. The current increase in international sugar prices is due to the emergence of a growing number of forecasts, according to which the consumption of sugar in the world in the 2019/2020 MG season will exceed the volume of its production. Adverse weather conditions in Thailand, India, France and the United States only increase the likelihood of a decline in production and a reduction in inventories in the world. The last few weeks have seen sharp fluctuations in the price of sugar futures, which is associated with the actions of large speculative capital, without causing optimism through the state of crops and instability in the crude oil markets.

The main factors that determine the dynamics of sugar prices include the following main ones. First, this is the stocks of sugar in the warehouses. This is a factor that affects all products. Just like for sugar, a low inventory level indicates high demand, weak supply, or a combination of the two. Through a long sugar supply cycle, when there are problems with storing sugar products, this also significantly affects the price of sugar.

Second, this is the dollar exchange rate. The US dollar is the main currency used in international financial transactions. This factor is important for most commodities and especially for sugar, since sugar futures are priced in dollars in both London and New York. The decrease in the value of the US dollar relative to the currency of the buyer of the product leads to the fact that in this way the buyer must spend less than their own currency on a certain amount of goods. A less expensive product is the reason for an increase in demand, as well as prices.

Third, it is the cost of oil. Another important factor that affects the price of sugar is the price of oil. This is because sugar can be considered a source of energy. The value of the energy source depends on the caloric content of the sources and the price of energy. The latter is dominated by the price of oil. In practice, farmers that grow sugar cane in Brazil can produce sugar or ethanol from their canes. Ethanol competes with gasoline in the transportation fuel market. Thus, lower gasoline prices also mean lower ethanol prices and therefore less demand for sugar cane for ethanol production, so there could potentially be an excessive supply of raw sugar. A large amount of raw sugar will reduce the price of sugar.

Fourth, it is the weather conditions. Sugar is produced mainly in warm countries. But, for example, a drought in Brazil can damage sugar canes and slow down the production cycle. Wet weather is also not ideal for sugar production. Sugar canes require dry air. Fluctuations in the production cycle due to weather conditions are another driving factor in the price of sugar.

Fifth, this is the state regulation. Government contributions and import tariffs also play a role in the sugar trade. Governments are distorting sugar markets, and the result is excessive sugar cane production. Europe is now the second largest sugar exporter in the world. However, in the US, import tariffs are intended to protect domestic farmers, so prices for consumers in the US have been raised. Therefore, American consumers are now looking for different types of sweeteners.

And another factor is trends in consumer behavior. Promoting a healthy lifestyle reduces sugar consumption in developed countries. Governments and institutions have begun to educate consumers, and as a result, consumers are becoming more aware of the health aspects of sugar. As healthy eating trends are gaining momentum in mature sugar markets, this may slow the growth of sugar demand in the future.
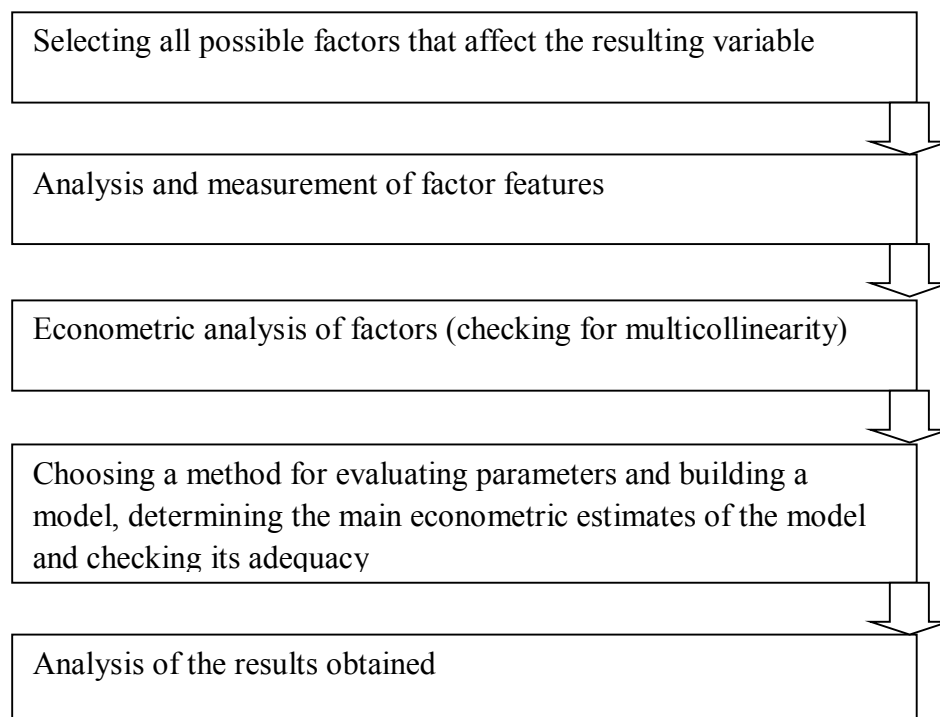
According to the calculations of the analytical Agency F. O. Licht, in 2020/2021 MY, the world sugar market may find itself in a significant deficit of 4.6 million tons after a smaller deficit of 4.2 million tons in 2019/2020 MY. The global sugar market is entering a deficit phase, which should provide more favorable conditions for producers. After the market reaches equilibrium in 2021/2022, the balance is expected to return to surplus. In 2024/2025 MY, global sugar production may reach about 200 million tons, an increase from 184 million tons in 2018/2019 MY, and consumption will also grow to 200 million tons, compared to 185 million tons in 2018/2019 MY. According to the forecast of the Dutch international financial company Rabobank, a shortage of sugar is expected in the world market in 2019-2020.

In this article, correlation and regression analysis will be used to predict the price of sugar on the London Intercontinental futures and options exchange. The multiple correlation-regression model describes the correlation relationship for the entire population. Based on observations, a selective multiple linear correlation and regression model can be constructed:

$$\tilde{y} = b_0 + b_1 x_1 + b_2 x_2 + \cdots + b_m x_m \tag{1}$$

where $\tilde{y}$ is theoretical value of the resulting variable, b_0, b_1, b_2,…b_m estimates of unknown parameters β_0, β_1, β_2,…β_m.

The stages of building a multiple linear correlation and regression model are shown in Fig. 5.

Selecting all possible factors that affect the resulting variable

Analysis and measurement of factor features

Econometric analysis of factors (checking for multicollinearity)

Choosing a method for evaluating parameters and building a model, determining the main econometric estimates of the model and checking its adequacy

Analysis of the results obtained

Fig.5. Stages of building a multiple linear correlation and regression model

In accordance with the proposed correlation and regression model, the dependent variable Y will be the average annual price of White Sugar Futures (No. 407). And as independent variables such factors are: X1 – this is a sugar production in the previous year; X2 – this is the average annual price of oil.

An equation that expresses the correlation between several features is called a multiple regression equation. The parameters of the regression equation, as well as in the case of pair correlation, are found by the method of least squares. Multiple regression coefficients show the degree to which the average change in

the result attribute occurs when the corresponding factor attribute changes by one (one of its own value), provided that all other factors included in the regression equation remain constant (fixed) at the same (usually average) level. Regression coefficients, which have different physical meaning and units of measurement, do not give a clear idea of what factors most significantly affect the effective feature.

Let's analyze the dynamics of the indicators included in the model. For Fig. 6 the dynamics of the average annual value of the White Sugar Futures contract (No. 407) is given.
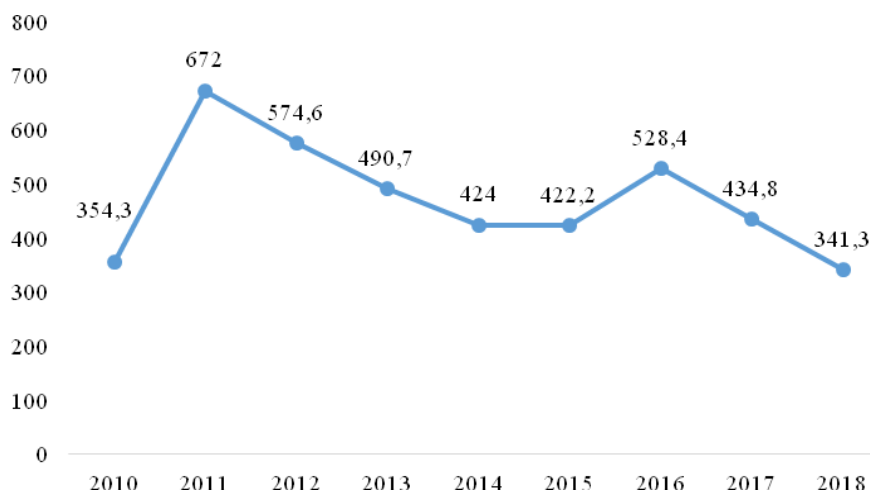

Fig.6. Dynamics of the average annual price of White Sugar Futures (No. 407), USD USA [11]

The dynamics of the price of White Sugar Futures (No. 407) reached its maximum values in 2011 and then until 2015 there was a stable decrease in the average annual price, in 2016 prices rose again, but did not reach the values of 2011, and the last two years there was a fall in prices again. For Fig. 7 shows the dynamics of world sugar production in the previous year, that is, in this case, we use the lag variable.
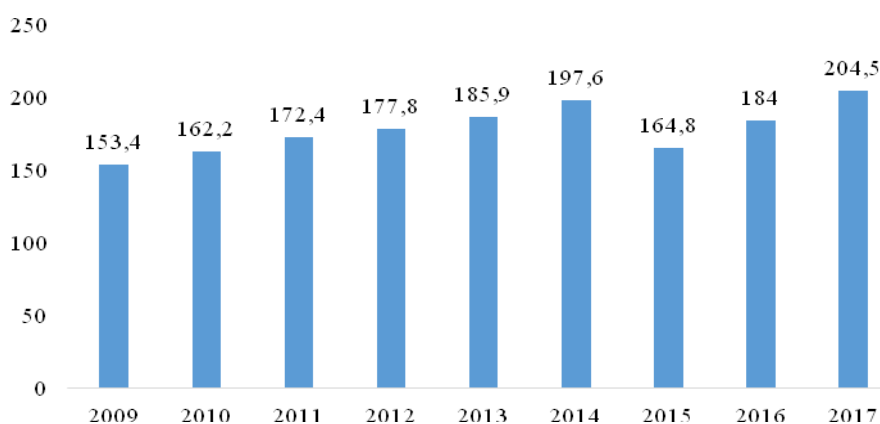

Fig.7. Dynamics of world sugar production, millions of metric tons [12]

According to Fig. 7 we can conclude that the dynamics of production has approximately the opposite dynamics in comparison with the price level. For Fig. 8 here is a comparative dynamics of prices for sugar and oil on world commodity exchanges. Based on data analysis [13], we can conclude that there is a link between sugar and oil prices on world commodity exchanges. Let's build a correlation matrix of dependent and independent variables (table.2).

Table 2

Correlation matrix

Value	Y	x_1	x_2
Y	1		
x_1	-0,46336	1	
x_2	0,570316	-0,72235	1

Based on table 2, we can conclude that there is an average or higher average tightness of the relationship between the dependent and independent variables, so it is advisable to include all of them in the price prediction model. The initial data for correlation and regression analysis are summarized in table 3. The sample is formed from indicators for 2010-2018.

Table 3

Initial data for correlation and regression analysis

Years	Y – the average price of White Sugar Futures (No. 407), USD. USA	x_1 – sugar production in the previous year	x_2 – the average annual price of oil
2010	354,3	153,4	590
2011	672,0	162,2	600
2012	574,6	172,4	590
2013	490,70	177,8	585
2014	424,0	185,9	576
2015	422,20	197,6	570
2016	528,40	164,8	600
2017	434,80	184,0	530
2018	341,30	204,5	400

Calculations were performed using the Excel 2010 table processor using the least squares method. The following correlation dependence of the average annual price of White Sugar Futures (No. 407) on the volume of sugar production in the previous year and the average annual price of oil is obtained.

$$Y=131,016-0,6848X_1+0,8254X_2 \qquad (2)$$

Regression coefficients show how much the average annual price of White Sugar Futures (No. 407) changes on average when each of the factors changes with fixed values of other factors included in the equation. For example, an increase in global production by 1 metric ton reduces the average annual price of White Sugar Futures (No. 407) by an average of 0.68 cents, while an increase in the average annual cost of oil by 1 dollar increases the average annual price of White Sugar Futures (No. 407) by an average of 0.82 cents.

The analysis of indicators of the correlation and regression model is shown in table 4. In particular, the multiple correlation coefficient is 0.5751, which indicates that there is an average close relationship between the average annual price of White Sugar Futures (No. 407) and the factors included in the model. The multiple determination coefficient is 0.3308. This indicates that the variation in the average annual price of White Sugar Futures (No. 407) due to changes in these factors is 3%. This indicates that there are additional factors that significantly affect the price level of White Sugar Futures (No. 407).

Table 4

Indicators of the correlation and regression model

Indicator	Value
The coefficient of multiple correlation	0,5751
The coefficient of multiple determination	0,3308
The adjusted coefficient of multiple determination	0,1077
Standard error	100,8
Number of observations	9

Next, we analyze the quality of the coefficients of the obtained correlation and regression model, which are summarized in table 5.

Analysis of correlation and regression model coefficients

Indicators	Coefficient	Standard error	T-statistics	Signification
Y is the average price of White Sugar Futures (No. 407), USD. USA	131,016	930,31	0,14083	0,8926
x_1 is the sugar production in the previous year	0,6848	3,077	-0,2225	0,8313
x_2 is the average annual price of oil	0,8254	0,809	1,0201	0,3470

The Fisher's F criterion was used for rapid diagnostics of the adequacy of the multiple correlation-regression model. This uses the null hypothesis that all multiple regression coefficients are zero, and the alternative hypothesis that at least one of the multiple regression coefficients is different from zero. To test the null hypothesis, use Fischer's F-statistics with $v_1=k$ and $v_2=n-k-1$ degrees of freedom:

$$F = \frac{\frac{\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2}{k}}{\frac{\sum_{i=1}^{n}(y_i - y_i)^2}{n-k-1}}$$

(3)

If F empirical > F criterion (α is the significance level), then the null hypothesis with a confidence probability p=1-α is rejected, and this indicates the adequacy of the model. To do this, we define the table value of the F-criterion of the normal distribution and compare it with the calculated value of F=6.48. Determine the number of degrees of freedom:

$$k_0 = 9 - 1 = 8$$
$$k_1 = 2 - 1 = 1$$
$$k_2 = 8 - 1 = 7$$

The table value of the Fisher criterion is F=5.59 less than the calculated value. Therefore, with a probability of 0.95, we can say that the model is accurate and adequate.

Conclusion. The exchange pricing mechanism is a modern and progressive method of determining market prices for products, especially for agricultural products. The advantages of the exchange pricing mechanism include the ability to form price levels under the influence of a high concentration of supply and demand for the corresponding product, rapid attraction of speculative capital, flexibility and mobility in managing price volatility, price forecasting, minimizing the risk of seasonal fluctuations and other market changes, trade diversification and selection of the best trading strategies among alternative ones, in order to ensure optimal pricing policy of economic entities.

The main indicators of exchange prices on commodity exchanges should also include the price level (quotation) for transactions with real goods and futures transactions; base prices, offer prices, demand prices, sale prices; average prices for the period; the price gap of futures transactions; price indices (Paasche, Laspeyres, Fischer); the average square deviation of prices.

On commodity exchanges, in the conditions of existing market relations, the analysis and forecast of prices are carried out using fundamental and technical methods. The purpose of their use is the same-to determine the direction of price movement on the commodity exchange market, and the methods of implementation are different. Thus, the fundamental method is based on studying the conditions in which the market operates, and the technical method is based on determining its effectiveness. Regression coefficients show how much the average annual price of White Sugar Futures (No. 407) changes on average when each of the factors changes with fixed values of other factors included in the equation. For example, an increase in global production by 1 metric ton reduces the average annual price of White Sugar Futures (No. 407) by an average of 0.68 cents, while an increase in the average annual cost of oil by 1 dollar increases the average annual price of White Sugar Futures (No. 407) by an average of 0.82 cents.

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Чичуліна Ксенія Вікторівна, кандидат технічних наук, доцент, доцент. Національний університет «Полтавська політехніка імені Юрія Кондратюка». **Розроблення моделей ціноутворення на ринку цукру та їх прогнозування на товарних біржах.** Розглянуто динаміку цін на ф'ючерсні контракти на ринку цукру, зокрема: два – «Sugar № 11 Futures», «Sugar № 16 Futures» – на Intercontinental Commodity Exchange ICE; один – «White Sugar Futures (№ 407)» – на London intercontinental financial futures and options exchange Liffe; один – «Sugar White» – на Zhengzhou Commodity Exchange ZCE. З метою прогнозування ціни на цукор на London intercontinental financial futures and options exchange Liffe застосовано кореляційно-регресійний аналіз та представлено основні етапи побудови множинної лінійної кореляційно-регресійної моделі. Наведено динаміку середньорічної вартості ф'ючерсного контракту White Sugar Futures (№ 407). Для експрес-діагностики адекватності множинної кореляційно-регресійної моделі використано F-критерій Фішера. У цілому визначено, що до основних показників цін на товарних біржах також слід віднести рівень цін (котирування) за операціями з реальним товаром і ф'ючерсними операціями; базові ціни, ціни пропозиції, ціни попиту, ціни продажу; середні ціни за період; розрив цін ф'ючерсних операцій; індекси цін (Пааше, Ласпейреса, Фішера); середнє квадратичне відхилення цін. На товарних біржах в умовах сформованих ринкових відносин аналіз та прогноз цін здійснено за допомогою фундаментального і технічного методів. Мета їх використання одна – визначити напрям руху цін на товарному біржовому ринку, а методи реалізації різні. Так, фундаментальний метод ґрунтується на вивченні умов, відповідно до яких функціонує ринок, а технічний – на визначенні його ефективності. Коефіцієнти регресії показують, наскільки в середньому змінюється середньорічна ціна White Sugar Futures (№ 407) при зміні кожного з факторів за фіксованих значень інших факторів, включених у рівняння. Так, зростання обсягу світового виробництва на 1 метричну тонну скорочує середньорічну ціну White Sugar Futures (№ 407) в середньому на 0,68 цента, зростання середньорічної вартості нафти на 1 долар США збільшує середньорічну ціну White Sugar Futures (№ 407) в середньому на 0,82 цента.

Ключові слова: товарні біржі, ціноутворення, ринок цукру, прогнозування.

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Development of Pricing Models in the Sugar Market and Their Forecasting on Commodity Exchanges.

The article considers the dynamics of prices for futures contracts in the sugar market, in particular-two («Sugar No. 11 Futures», «Sugar No. 16 Futures») on the Intercontinental Commodity Exchange – ICE; one («White Sugar Futures (No. 407)») on the London International Financial Futures and Options Exchange – Liffe (LIFFE); one («Sugar White») on the Zhengzhou Commodity Exchange – ZCE. In this article, in order to forecast the price of sugar on London intercontinental financial futures and options exchange – Liffe. Correlation and regression analysis is applied and the main stages of building a multiple linear correlation and regression model are presented. The dynamics of the average annual value of the White Sugar Futures contract (No. 407) is given. The Fisher F-test was used for rapid diagnostics of the adequacy of the multiple correlation-regression model.

Keywords: commodity exchanges; pricing; sugar market; forecasting.

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Разработка моделей ценообразования на рынке сахара и их прогнозирование на товарных биржах.

Рассмотрена динамика цен на фьючерсные контракты на рынке сахара, а именно два «Sugar № 11 Futures», «Sugar № 16 Futures» в Intercontinental Commodity Exchange ICE; один «White Sugar Futures (№ 407)» на London intercontinential financial futures and options exchange - Liffe; один «Sugar White» на Zhengzhou Commodity Exchange ZCE. С целью прогнозирования цены на сахар на London intercontinential financial futures and options exchange Liffe применен корреляционно-регрессионный анализ и представлены основные этапы построения множественной линейной корреляционно-регрессионной модели. Приведена динамика среднегодовой стоимости фьючерсного контракта White Sugar Futures (№ 407). Для экспресс-диагностики адекватности множественной корреляционно-регрессионной модели использован F-критерий Фишера. В целом определено, что к основным показателям цен на товарных биржах также следует отнести уровень цен (котировки) по операциям с реальным товаром и фьючерсными операциями; базовые цены, цены предложения, цены спроса, цены продажи; средние цены за период; разрыв цен фьючерсных операций; индексы цен (Пааше, Ласпейреса, Фишера), среднее квадратическое отклонение цен. На товарных биржах в условиях сложившихся рыночных отношений анализ и прогноз цен осуществлені при помощи фундаментального и технического методов. Цель их использования одна определить направление движения цен на товарном биржевом рынке, а методы реализации разные. Так, фундаментальный метод основывается на изучении условий, согласно которым функционирует рынок, а технический на определении его эффективности. Коэффициенты регрессии показывают, насколько в среднем меняется среднегодовая цена White Sugar Futures (№ 407) при изменении каждого из факторов при фиксированных значениях других факторов, включенных в уравнение. Так, рост объема мирового производства на 1 метрическую тонну сокращает среднегодовую цену White Sugar Futures (№ 407) в среднем на 0,68 цента, рост среднегодовой стоимости нефти на 1 доллар США увеличивает среднегодовую цену White Sugar Futures (№ 407) в среднем на 0,82 цента.

Ключевые слова: товарные биржи, ценообразование, рынок сахара, прогнозирование.