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STATE AND PROSPECTS FOR THE DEVELOPMENT OF THE VEGETABLE MARKET IN UKRAINE

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СТАН ТА ПЕРСПЕКТИВИ РОЗВИТКУ РИНКУ ОВОЧІВ В УКРАЇНІ

The review of the subject field of the econometric analysis of the functioning of the vegetable market in Ukraine was performed. The theoretical principles of vegetable market modeling were described externally. Characterization of the state of the domestic vegetable growing market in modern conditions has been carried out. The econometric model of the vegetable market was developed and evaluated. The economic formulation of the problem has been carried out. A linear multivariate regression model was constructed. The forecast of vegetable market indicators has been carried out.

After forecasting the independent variables of the multifactorial linear model over time, the value of the average sales prices of vegetable crops by agricultural enterprises for the period 2022—2028 was calculated.

It was concluded that the influence of the yield of vegetables, the level of average monthly wages, the number of employed population aged 15—70 in agriculture, forestry and fisheries, the volume of import of vegetable crops will cause a gradual increase in the average price of vegetables, and in 2028 the indicator will reach 12,269 UAH 4/ton.

The analysis of the Ukrainian vegetable market in wartime reflects the complex challenges and opportunities faced by agricultural enterprises in this context. It is necessary to actively work on the restoration and strengthening of the infrastructure to ensure efficient transportation and storage of vegetables. Favorable soil and climatic conditions and the potential for the development of organic production provide advantages for positioning Ukrainian vegetables as high-quality and environmentally friendly products. It is necessary to actively seek alternative sources of financing and develop strategies for managing price fluctuations to ensure production stability. It is important to respond flexibly to changes in the economic environment by adapting marketing and sales strategies to remain competitive.

A number of scientific and special research methods were used in article. Analysis, synthesis, classification, generalization of economic and methodological literature, scientific publications for the systematization of theoretical and practical knowledge on market modeling. The method of graphic analysis (formation of tables, diagrams, graphs) was used for clarity of the obtained research results. Correlation-regression analysis was used to determine the influence of factors on the bank's activities and indicators; linear and non-linear programming — to determine predictive indicators, etc.

Здійснено огляд предметної області економетричного аналізу функціонування ринку овочів в Україні. Охарактеризовано теоретичні засади моделювання ринку овочів. Висвітлена характеристика стану вітчизняного ринку овочівництва в сучасних умовах. Проаналізовано моделі, що використовуються для моделювання ринку овочів. Розроблено та оцінено економетричну модель ринку овочів. Здійснено економічну постановку задачі. Побудовано лінійну багатофакторну регресійну модель. Здійснено прогноз показників ринку овочів. Провівши прогнозування в часі незалежних змінних багатофакторної лінійної моделі, розраховано значення середніх цін реалізації овочевих культур аграрними підприємствами за період 2022—2028 рр. Таким чином, вплив урожайності овочів, рівня середньомісячної заробітної плати, кількості зайнятого населення у віці 15—70 років у сільському, лісовому та рибному господарстві, обсягу імпорту овочевих культур спричинить поступове зростання середніх цін овочів та у 2028 році показник сягне 12 269,4 грн/тону. Узагальнено економічні висновки щодо доцільності та напрямків використання моделі. Зроблено висновок про те, що аналіз українського ринку овочів в умовах війни відображає складні виклики та можливості, які стикаються аграрні підприємства у даному контексті; необхідно активно працювати над відновленням та зміцненням

інфраструктури для забезпечення ефективного транспортування та зберігання овочів; сприятливі ґрунтово-кліматичні умови та потенціал для розвитку органічного виробництва надає переваги для позиціонування українських овочів як якісних та екологічно чистих продуктів; необхідно активно шукати альтернативні джерела фінансування та розробляти стратегії управління ціновими коливаннями для забезпечення стабільності виробництва; важливо гнучко реагувати на зміни в економічному середовищі, адаптуючи стратегії маркетингу та продажу для збереження конкурентоспроможності. У роботі використано ряд наукових і спеціальних методів дослідження. Аналіз, синтез, класифікація, узагальнення економічної та методичної літератури, наукових видань для систематизації теоретичних та практичних знань з питань моделювання ринків. Метод графічного аналізу (формування таблиць, діаграм, графіків) використовувався для наочності отриманих результатів дослідження. Кореляційно-регресійний аналіз використовувався для визначення впливу факторів на діяльність та показники банку; лінійне та нелінійне програмування — для визначення прогнозних показників тощо.

Інформаційною базою дослідження виступили нормативно-правові акти, результати наукових досліджень вітчизняних та зарубіжних вчених, опублікованих у наукових виданнях, статистична інформація.

Key words: Econometric analysis, vegetable market modeling, vegetable market, linear multivariate model, research methods, agricultural economics, quantitative models, economic processes.

Ключові слова: Економетричний аналіз, моделювання ринку овочів, ринок овочів, лінійна багатofакторна модель, методи дослідження, економіка сільського господарства, кількісні моделі, економічних процеси.

STATEMENT OF THE PROBLEM IN A GENERAL FORM AND ITS CONNECTION WITH IMPORTANT SCIENTIFIC OR PRACTICAL TASKS

The full-scale war in Ukraine, unleashed by Russia in 2022, caused significant damage to the country's economy. Agriculture and, in particular, the vegetable growing industry were significantly negatively affected by military operations and the occupation of territories. The issues of analysis of the current situation on the market of vegetable products and prospects for its development, taking into account the consequences of the war and as a result of the economic crisis in Ukraine, remain insufficiently researched. Therefore, an urgent task is the implementation of econometric modeling of the domestic vegetable market to identify trends and forecast indicators in the future short-term period.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

The scientific works of many scientists are devoted to the question of vegetable market research. Among them, we can single out the contribution of the following scientists: Logosha R.V., Mazur K.V., Krychkovsky V.Yu. [1], Karpenko L.F. [2], Cherednichenko O.O., Chaika E.A. [3] and other. Research in the conditions of war is limited due to the difficulty of collecting primary data, mostly analytical reviews based on expert assessments.

FORMULATION OF THE GOALS OF THE ARTICLE (STATEMENT OF THE TASK)

The purpose of the study is to substantiate the theoretical and methodological aspects and practical recommendations for the development of the domestic vegetable market based on the construction of an econometric model. The main focus is on analyzing the impact of the war on supply chains, logistics, and export potential of industry. There is a lack of comprehensive market research with analysis of all components of the marketing environment. Therefore, there is a need to conduct a thorough analysis of the Ukrainian vegetable market with an assessment of the impact of the war.

Tasks of research — to construct linear multivariate regression model and to constructed, to make economic conclusions regarding the expediency and directions of using the model.

The object of the study is the process of modeling the domestic vegetable market.

The subject of the research is defined as practical and theoretical issues of the market modeling process.

The information base of the research was provided by normative legal acts, the results of scientific research by domestic and foreign scientists, published in scientific publications, and statistical information.

PRESENTATION OF THE MAIN RESEARCH MATERIAL

Agriculture is one of the most promising branches of Ukraine. This is due to the fact that our state has large areas, 70% of which are occupied by agricultural land. Also, Ukraine has one of the largest chernozem reserves in the world. All the above conditions indicate that agriculture plays a very important role in the formation of GDP. The agricultural sector annually brings about 40% of all foreign currency income, has a positive effect on exports, especially after the signing of the Association Agreement between Ukraine and the EU and the implementation of the Agreement on a Deep and Comprehensive Free Trade Area with the EU.

Cultivation and sale of vegetables is an important part of the country's agriculture sector, because it provides the population with various types of crops of different ripening periods. This fact is confirmed by the fact that vegetables are an important component of a person's daily diet, and therefore are indispensable food products. At the same time, vegetable farmers support the employment level of the rural population, provide income in the form of taxes and fees to the budgets of various levels, and also perform certain socio-economic functions.

It is worth noting that according to the draft Law of Ukraine "On Food Safety" food security is a socio-economic and ecological state in the state, in which all its citizens are stably and guaranteed to be provided with food in the required quantity, assortment and appropriate quality [1]. Therefore, healthy and high-quality nutrition requires the use of a wide range of vegetable products within reasonable limits.

The UN report "The State of Food Security and Nutrition in the World 2023" states that, according to estimates between 691 and 783 million people in the world faced hunger in 2022, roughly affecting approximately 9.2 percent of the world's population, compared to 7.9 percent in 2019.

According to forecasts of the Food and Agriculture Organization of the United Nations (FAO), in 2030, almost 600 million people will be chronically undernourished. This is approximately 119 million more than in the scenario in which there was neither a pandemic nor a war in Ukraine, and approximately 23 million more than in the case of a war in Ukraine [3]. Restrictions on the export of Ukrainian food by Russia through sea corridors, crops destroyed by the Russians and mined fields lead to a reduction in the production of food products in Ukraine, which, among other things, went to countries where people are suffering from

hunger. This leads not only to a slowdown in the fight against hunger and malnutrition in the world, but also to an increase in the number of starving people worldwide.

Vegetables are an important source of trace elements necessary for a healthy diet, so they must be included in a person's daily diet. However, it is believed that today's consumers, even with higher incomes, are unable to achieve this goal.

Therefore, there is a need to model the market of vegetable products in order to make relevant forecasts, since not only the aspect of providing healthy food depends on the efficiency of the functioning of the vegetable market, but also the possibility of obtaining income on small farms, the development of rational crop rotations based on the diversification of product supplies, the introduction of irrigation opportunities and others measures to reduce risks for product manufacturers.

That is, this concept is considered from the point of view of providing food products that are necessary to ensure the vital activity of the human body and its development. Taking into account the concept of healthy nutrition, the basis of the national food pyramid should be publicly available and traditional products with a high level of biological value, which were used by previous generations for centuries, and these are primarily vegetables (70—75%) and fruits (30—25%) [2].

Agricultural economics has played a key role in the development and application of econometrics for positive modeling purposes. With a variety of competitive commodity markets and an abundance of publicly available data, agriculture provides a ready-made field of application for the development of a variety of statistical regression techniques.

In many cases, the heterogeneity of agricultural production, imperfect forecasts of product prices, production risks and other characteristics contribute to the development and improvement of econometric methods.

It is common knowledge that quantitative models prevail in economics. Therefore, they are formalized using mathematics. The reasons for using mathematical models to describe economic processes are different: firstly, it is unrealistic to build physical economic models, since it is impossible to create a physically true copy of the economic version in technical sciences.

The second reason can be explained by the fact that all subsystems and components in the economic system are strongly interconnected, which makes certain economic experiments impossible. In this case, the researchers have both their own past experience and the experience of

Table 1. Designation of the investigated factors

Marking	Description
Dependent variable	
Average prices, y	average sales prices of vegetable crops by agricultural enterprises, hryvnias/ton
Independent variables	
Production volume, x1	volume of production (gross harvest) of vegetables, thousand tons
Sown areas, x2	sown areas of vegetables, thousand ha
Yield, x3	yield of vegetables, ts from 1 ha of harvested area
Vegetables for 1 person, x4	volume of vegetable production per person, kg/year
Salary, x5	average monthly salary, hryvnias/month
Employed population, x6	employed population aged 15-70 in agriculture, forestry and fisheries, thousands of people
Price index, x7	price index of crop products sold by enterprises, % compared to the previous year
Export, x8	export of vegetables, thousands of US dollars
Import, x9	import of vegetables, thousands of US dollars
Inflation, x10	inflation rate, % to the previous year

Source: developed by the authors.

other economists and mathematical modeling experiments. Therefore, mathematical models are the most acceptable method of analysis.

The study based on data for 2003—2021 on the influence of various economic and production factors on the pricing of the vegetable market. Since the data for 2022 are quite anomalous due to the full-scale invasion of the Russian Federation into Ukraine, it was decided not to take them into account in the general model, as they may distort the overall picture of the impact.

In our case, the average selling price of vegetable crops by agricultural enterprises will be the dependent variable, UAH/t, and ten different socio-economic indicators were chosen as the independent variables. Let's introduce the notation of dependent and independent variables (see Table 1).

We will find the value of the F-criterion using the formula (1):

$$F = \frac{\sum_{i=1}^n (\hat{Y}_i - \bar{Y})^2}{\sum_{i=1}^n (Y_i - \hat{Y}_i)^2} \cdot \frac{n-2}{n-2} \quad (1),$$

Where $\hat{Y}_i$ — the estimate is obtained on the basis of a regression model;

$\bar{Y}$ — values for all studies Y_i ;

Y_i — the value of the resulting variable;

n — is the sample size.

the obtained values entered in the table 2.

At the level of significance $\alpha = 0.05$ and the degrees of freedom $f_1 = 1$ and $f_2 = 17$, the table F will be equal to 4.45. Therefore, according to the conducted direct selection, it is necessary to include the values of sown areas, productivity, wages, employed population, export and import of vegetables into the model.

Table 2. F-test for factors

Factor	The meaning of the F-criterion
Sown areas, x_2	9,73
Yield, x_3	40,66
Vegetables for 1 person, x_4	17,09
Salary, x_5	16,99
Employed population, x_6	0,43
Price index, x_7	32,73
Export, x_8	11,32
Import, x_9	0,13

Source: developed by the authors.

Having built a model of the dependence of average prices for 1 ton of vegetables on the factors listed above, it was found that the p-value of the Sown area (x_2) and Export (x_8) indicators significantly exceeds the norm of 0.05 (Table 3), so it was decided to exclude given factors.

As a result, we got a model with the following values: $R^2 = 0.958$, adjusted R^2 is 0.946, standard error of estimation = 294.796.

Table 3. Meaning of p-value

	Coefficients	Standard Error	t Stat	P-value
Constant	5439,237	2959,009	1,838	0,091
Sown areas, x_2	-5,940	8,546	-0,695	0,500
Yield, x_3	16,894	7,020	2,406	0,033
Salary, x_5	0,223	0,040	5,563	0,000
Employed population, x_6	-0,967	0,513	-1,884	0,084
Import, x_9	-0,003	0,002	-1,437	0,176
Inflation, x_{10}	-0,004	0,002	-1,865	0,087

Source: developed by the authors.

Table 4. Regression statistics

Multiple R	0,979
R Square	0,958
Adjusted R Square	0,946
Standard Error	294,796
Observations	19

Source: developed by the authors.

Table 5. Coefficients of the regression model

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Константа	3976,940	2014,011	1,975	0,031
Урожайність, x_3	10,579	5,966	1,773	0,048
Зарплата, x_5	0,221	0,032	6,902	0,000
Зайняте населення, x_6	-1,106	0,336	-3,294	0,005
Імпорт, x_9	-0,005	0,001	-3,474	0,004

Source: developed by the authors.

The value of R^2 means that the variation of average prices for 1 ton of vegetables in Ukraine for 2003—2021 is 95.8% due to the above factors, which is a good estimate for the constructed model.

In the table 5 presented other obtained values for our constructed model. As we can see, all p-values are within the permissible range from 0.000 to 0.05.

The model built during the research is presented in formula (2.4). It can be used to estimate the impact of each factor on average prices for 1 ton of vegetables.

$$Y = 3976,94 + 10,58x_3 + 0,22x_5 - 1,11x_6 - 0,01x_9 \quad (2).$$

That is, with an increase in productivity by 1 hryvnia per hectare per year, the average selling price of vegetable crops by agricultural enterprises rises to UAH 10.58/t, and when the average monthly wage increases by UAH 1, it increases by UAH 0.22. With the increase in the number of employed population aged 15—70 in agriculture, forestry and fishing per 1 thousand people, the average price of selling vegetables decreases by UAH 1.11, and the cost of import of vegetable crops increases by USD 1 thousand. The USA provokes a reduction in the price by 0.01 hryvnias.

CONCLUSIONS AND PROSPECTS OF FURTHER INVESTIGATIONS IN THIS DIRECTION

The war in Ukraine had a devastating effect on vegetable production and agriculture in general. Military operations have created a threat to the safety of agricultural workers and product supply chains. Fighting in areas where vegetables are grown has resulted in the destruction of crops and infrastructure. The forced evacuation of the population from agricultural regions reduced the labor force, which negatively affected production. The destruction of irrigation systems, warehouses and transport infrastructure complicated the process of growing vegetables. Restrictions on access to fuel, fertilizers and seeds reduced the yield and quality of products. The vegetable season of 2022 has become the most difficult in the recent history of Ukraine. The Russian invasion radically changed the situation in the industry. On the eve of the war, the area under vegetables amounted to more than 3.3 million hectares, of which 1.28 million hectares were under potatoes, and 452.8 thousand hectares were under vegetables.

In 2023, the Ukrainian vegetable market continued to function in the conditions of war. This year can be called a period of business adaptation: panic subsided, manufacturers developed optimization strategies, work in extreme conditions became routine. The redeployment of production from the occupied southern regions to the north and west of the country continued actively. This process was accompanied by high price volatility due to the situation both in the domestic market and abroad. At the same time, there was a shortage of labor, especially skilled labor, a small number of consumers on the domestic market and their low solvency in Ukrainian farms. Despite the increase in the area of certain vegetable crops, the overall market was shrinking, some items were being replaced by imports. Therefore, the task of constructing an econometric model of the domestic vegetable market is important for scientists and practitioners.

The war disrupted supply chains and logistics, leading to shortages of some vegetables and rising prices. Due to the destruction of infrastructure and difficulties with logistics, the costs for farmers to transport and store their products have increased, which has also affected prices. Pricing in the vegetable market determines the availability, quality and variety of products for consumers and has an important social and societal impact on their lives and health. There was no significant shortage of vegetables in Ukraine, because many farmers reoriented part of their agricultural land to vegetable production in 2023. Many businesses have also relocated from the affected regions.

Due to the increase in fuel and fertilizer prices, the costs of producing and transporting vegetables have increased. The devaluation of the hryvnia and the decrease in the incomes of the population led to a decrease in the demand for expensive vegetables. At the same time, competition from cheap imports from the EU, Turkey, and Egypt intensified. This threatens the profitability of domestic vegetable producers.

Due to the war, the consumer preferences of Ukrainians changed. The demand for inexpensive and long-storable vegetables has increased. There is also a tendency to support local producers. The number of internally displaced people from the East who need food and products has increased. At the same time, the demographic situation worsened due to human losses at the front.

There is an urgent need to modernize the production and logistics of vegetables in Ukraine. The introduction of innovative varieties and technologies, the development of greenhouses are also relevant. There is a growing demand for

organic products. Digital marketing tools are increasingly being used for promotion.

These factors can vary significantly depending on the specific circumstances of the conflict and its impact on various spheres of life in Ukraine. Individual business plans must be adapted to the specific conditions and requirements of the vegetable market in this context.

To develop a marketing strategy for the development of the vegetable market in Ukraine during the war, it is necessary to use the obtained model of the vegetable market, as well as:

- To focus on domestic producers and suppliers of vegetables.

- To promote Ukrainian brands and support local farmers.

- To take into account logistical restrictions due to the war, involve alternative channels of delivery and distribution of vegetables in the regions.

- To conduct marketing activities to raise awareness of the benefits of eating fresh vegetables and their importance for health, especially in the stressful conditions of war.

- To use digital marketing and social networks to promote Ukrainian vegetables, recipes and useful information about nutrition.

- To launch promotions and discounts on Ukrainian vegetables in retail chains, establish partnerships with supermarkets.

- To focus consumers' attention on seasonal offers.

- To use patriotic marketing, emphasizing the support of the Ukrainian producer.

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