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DETERMINANTS OF THE DEVELOPMENT OF ECONOMIC PROCESSES IN THE DAIRY MARKET OF UKRAINE

ABSTRACT

The article analyzes economic phenomena and processes in the dairy market of Ukraine and identifies the main factors affecting them. Based on constructing an equations system, the existence of direct and inverse relationships between the determining factors of the development of the dairy market of Ukraine was established. Determining factors were checked for multicollinearity. A dependence equation was calculated for the volumes of retail turnover of milk and dairy products based on such influencing factors as average monthly salary, consumer price index, and the volume of milk product imports. The equation shows the presence of a close relationship between the determined factors and the volume of retail turnover of milk and dairy products and also between the volume of dairy products produced and the consumption of milk per capita and the production of milk by farms of all categories — appreciable. Partial coefficients of elasticity were calculated to forecast further directions of influence of determining factors on economic phenomena and processes in the dairy products market. A controlled factor has been identified, which Ukrainian dairy processing enterprises can influence by promoting their products on the market.

Keywords: economic-mathematical modeling, the system of equations, direct and inverse relationships, dairy products market of Ukraine, production of milk and milk products

JEL Classification: C59, O13, Q11, Q13

INTRODUCTION

Milk and dairy products are important components of a healthy diet for everyone. They provide its normal vital activity due to the present microorganisms, vitamins, and minerals, which are balancedly combined and easily absorbed by the majority of people's bodies. Dairy products are especially necessary for the proper development of children and the maintenance of vital functions in older people, as they are an important source of calcium for them. Supplying the population with milk and milk products is an important food security task in every country, including Ukraine. In the global market, despite the surplus of milk and dairy production, there is a stable demand for certain types of dairy products, particularly cream butter and cheeses, which indicates significant opportunities for Ukrainian producers to export quality dairy products. Therefore, it is necessary to ensure the proper functioning of Ukraine's dairy processing complex, as well as the stability of key indicators that characterize it. However, the dairy industry does not operate in isolation; it is influenced by various factors in the marketing environment. From this perspective, it is crucial to establish the key determinants shaping economic processes in the Ukrainian dairy product market in order to forecast their impact on the future. It is also essential to identify the determinants that dairy processing enterprises can influence through their marketing activities and accordingly define directions for improving its individual components, which will contribute to adaptation to new operating conditions.

LITERATURE REVIEW

The dairy industry is an essential component of the agro-industrial complex of Ukraine. It can satisfy all the needs of the country in the main types of dairy products and needs investments since it stimulates its development [17]. Investments in the dairy industry are closely related to the application of innovation, which ensures the expansion of the range and the origin of new types of dairy products [18].

The dairy processing industry plays a significant role in ensuring the economic security of the country. M. Lysenko [16] the main problems of economic security in Ukraine's dairy sector and their causes has been identified, including the quality and sufficiency of dairy raw materials. The importance of the development and efficient operation of dairy processing enterprises in Ukraine has been substantiated A. Penchuk [20].

The macro- and microenvironment also influence the dynamics of changes in the dairy industry in the market of essential goods during the pandemic [3] and the martial law in Ukraine. At the international level, the sale of dairy products is ensured by compliance with the requirements of EU food legislation and the application of innovation in plant-based dairy alternatives [15]. L. Großmann and D. Clements [8] argued that plant-based alternatives to dairy products, such as cheese, yogurt, butter, and ice cream, are essential in a plant-based product portfolio.

Domestic and foreign scientists carried out scientific research on the dairy market using economic and mathematical modeling. In particular, modeling and forecasting methods were used by N. Shyian, V. Moskalenko, O. Shabinskyi, and V. Pechko [25] in forecasting milk prices; M. Chernyakov and M. Chernyakova [5] in forecasting the processes of regulation of production, processing, and sale of milk and dairy products; Yu. Bahteev, M. Bahteeva, G. Kuryaeva and A. Tuskov [1] in modeling the optimal range of dairy products.

In recent years, the volume of retail turnover of milk and dairy products in terms of value indicators has been growing. The volume of manufactured dairy products in natural terms has remained approximately at the same level, despite the increase in prices for milk and milk products. In the domestic dairy market, Ukrainian products are replaced by imported products. To a large extent, this is because the price of domestic dairy products and raw materials for their production exceeds the cost of similar imported products. The modern price mechanism of the milk and dairy products market contributes to the profitable management of the dairy industry. However, it does not ensure food security and a sufficient level of consumption of dairy products by the population [13].

However, the economic processes in the dairy market of Ukraine are also affected by other factors, the quantitative impact of which can be established based on the use of economic and mathematical modeling. Forecasting their changes will allow milk processing enterprises to forecast the level of demand for the products they offer.

Demand for dairy products from countries with growing populations and rising disposable incomes are driving the growth of the global dairy market.

Consumers are developing new tastes for dairy products and changing their preferences over time, improving the outlook for the dairy market. Focusing attention on consumer requests, M. Grębowiec [7] investigated factors influencing decisions regarding purchasing goods in the dairy market. However, D. Ilie, G. Ladaru, M. Diaconeasa, and Stoian M. [10] investigated factors influencing consumer choice of milk and dairy products in Romania. At the same time, H. Górska-Warsewicz, K. Rejman, W. Laskowski, and M. Czeczotko [6] revealed the role of milk and dairy products and their nutritional contribution to the average Pole's diet.

The dairy industry is developing accordingly, producing different flavors and variations of dairy products. With globalization, the demand for previously popular dairy products in the region is increasing in other countries, such as ghee demand. M. Ratmawati, S. Haerani, S. Baco, K.I. Prahesti and V. Tenrisanna [21] argued that dairy products and their diversification should be developed as a source of animal protein. Such products can be used as food for cooking during educational tourism visits on livestock farms, especially in the new average post-covid period.

With health issues on the rise, obesity, and the increasing prevalence of lactose intolerance, recent trends in the dairy industry indicate a growing demand for specialty dairy products. These are lactose-free milk, skim milk, skim milk powder, and probiotic milk. At the same time, A. Rybowska and K. Gromowska [24] prove that the dairy market is one of the most dynamically developing sectors, offering consumers a vast and constantly growing range of innovative products. Innovative products play an essential role in this range while shaping a changing market in line with the trends and expectations of more informed consumers.

M. Can and H. Can [4] revealed the factors affecting individual consumption of milk and dairy products. D. Ilie, G. Ladaru, M. Diaconeasa, and M. Stoian [10] conducted a study in this direction. In particular, they surveyed Romanian consumers

regarding the consumption of milk and dairy products. Scientists prove that in addition to the price and availability of the product in the store, consumers pay attention to the behavior and availability of environmental certification, country of origin, and income level.

M. Kupracz [14] points to the awareness of consumers about products. They mainly choose regional and traditional products, produced taking into account the observance of epidemiological rules and norms.

N. Kosar, N. Kuzo, J. Binda, N. Hayvanovych and N. Pytulyak [12] studied the factors affecting milk consumption per capita in Ukraine, using built models to determine the forecast of milk consumption per capita under the condition of increasing milk prices and reducing the number of cattle in an optimistic scenario development of agriculture in the conditions of martial law.

At the same time, many researchers are uncovering the peculiarities of the regional market for dairy products. In particular, M. Kupracz [14], in his research, proves that consumer requests for traditional food (including dairy products) are characterized by increased demand for products produced by regional producers and depend on the requests of a particular region. Therefore, there is a need to support farmers and dairy product manufacturers in modern conditions. In particular, M. Halamska [9] emphasizes this necessity. O. Bochko [2] points out the need to deconstruct the regional dairy market.

Recently, there has been a decrease in the production of certain dairy products in Ukraine in natural expression [31]. The trend of increasing milk production has been observed in Poland in recent years. In particular, during the eight months of 2021, the Polish dairy industry maintained the production of cheese products, liquid milk, and cream at a level higher than a year ago [11]. The use of advanced technologies in the practical activities of Polish enterprises has resulted in an increase in Poland's competitiveness in the international milk [26], butter [22], and dairy products market. The study of the spatial integration of the milk and dairy products market between neighboring countries Poland and the Czech Republic is of great significance. This study was conducted by researchers who utilized regional data, such as production and processing levels, to obtain their results [23].

The analysis of recent studies and publications shows that no studies reflect the quantitative impact of individual indicators characterizing the macro-environment in Ukraine on the leading indicators reflecting the development of the dairy industry in it.

AIMS AND OBJECTIVES

This article aims to define the determining factors of the development of economic processes in the dairy products market of Ukraine. Based on this purpose, the main objectives of this research are:

- gathering information about the key indicators that characterize the demand and supply in the dairy products market of Ukraine, as well as the factors that influence them;
- constructing a system of equations that will allow to establish the direct and inverse relationships between the identified indicators and factors;
- checking the identified factors for multicollinearity;
- determining the presence of dependencies between the factors and indicators, as well as calculating partial coefficients of elasticity for their further use in forecasting and studying the impact of the war on Ukraine's dairy industry.

METHODS

This study utilized data from the State Statistics Service of Ukraine to analyze the dynamics of the volume of retail turnover of milk and dairy products, as well as the number of dairy products produced from 2005-2020. The main factors affecting these indicators were identified as the average monthly salary, consumer price index, import of dairy products, milk consumption per capita, milk production by farms of all categories, and receipt of milk and dairy products at processing enterprises. Multicollinearity among these factors was assessed using the Farrar-Glober algorithm. The research was conducted separately for factors impacting the volume of retail turnover of milk and dairy products, as well as those affecting the volume of dairy products produced. An econometric model was developed using the least squares method to ensure its adequacy, evaluated through the coefficient of determination, correlation ratio, and Fisher's test.

RESULTS

The direct and reverse dependencies between the economic phenomena and processes at the dairy market require development of an economic and mathematical modeling that is based on the system of equations:

$$\begin{aligned} y_1 &= a_{10} + a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + a_{14}x_4 + u_1 \\ y_2 &= a_{20} + a_{21}x_4 + a_{22}x_5 + a_{23}x_6 + u_2 \end{aligned} \quad (1)$$

where y_1 – volume of retail turnover of milk and dairy products; y_2 – amount of produced dairy products; x_1 – average monthly salary; x_2 – consumer price index; x_3 – import of dairy products; x_4 – milk consumption per head of population; x_5 – milk production by farms of all categories; x_6 – supply of milk and dairy products to processing enterprises, thousand tons; u_1, u_2 – random deviates.

For the multi-factorial econometric models, it is necessary to identify whether there are close dependencies (multicollinearity) between the defined factors that negatively influence quantitative characteristics of the economic and mathematical models.

Multicollinearity is studied by applying the Farrar-Glauber test, which involves three kinds of statistical criteria for checking: multicollinearity of the whole set of factors (χ^2); each factor with others (F-test); each pair of factors (t-test) [19]:

$$\chi_p^2 = -\left(n - 1 - \frac{2m+5}{6}\right) \ln(\det R) \quad (2)$$

where n – amount of studied data; m – number of factors; $\det R$ – correlation matrix determinant;

$$F_j = (z_{jj} - 1) \frac{n-m}{m-1} \quad (3)$$

where z_{jj} - elements of Z matrix, reverse to the correlation one;

$$t_{ij} = \frac{r_{ij.12..m} \sqrt{n-m}}{\sqrt{1-r_{ij.12..m}^2}} \quad (4)$$

where $r_{ij.12..m}$ - partial correlation coefficients, determined by the formula:

$$r_{ij.12..m} = \frac{z_{ij}}{\sqrt{z_{ii}z_{jj}}} \quad (5)$$

Registering multicollinearity, it is necessary to eliminate the factors causing it. Table 1 shows dynamics of the main factors influencing the market of milk and dairy products in Ukraine.

Table 1. Dynamics of the main factors influencing the market of milk and dairy products in Ukraine. (Source: composed by the authors using the data [27-30, 32, 35])

Year	Average monthly salary, UAH(x_1)	Consumer price index (x_2)	Import of dairy products, thousand tons(x_3)	Milk consumption per head of population, kg (x_4)	Milk production by farms of all categories, thousand tons (x_5)	Supply of milk and dairy products to processing enterprises, thousand tons (x_6)
2005	806	113.5	112	21.7	13714.4	5689
2006	1041	109.1	150	22.3	13286.9	5607
2007	1351	112.8	199	22.1	12262.1	6039
2008	1806	125.2	234	22.6	11761.3	5406
2009	1906	115.9	455	19.8	11609.6	4671.2
2010	2250	109.4	273	19.2	11248.5	4737.24
2011	2648	108.0	257	19.1	11086.0	4546.96
2012	3041	100.6	410	19.6	11377.6	4691.59
2013	3282	99.7	548	20.3	11488.2	4545.28
2014	3480	112.1	357	20.3	11132.8	4646.62
2015	4195	148.7	78	19.8	10615.4	4251.18
2016	5183	113.9	105	19.6	10381.5	4182.71
2017	7104	114.4	132	19.3	10280.5	4348.3
2018	8865	110.9	180	19.1	10064	4179.2
2019	10497	107.9	337	19.0	9663.2	3800
2020	11591	102.7	691	18.9	9263.6	3511.8

Multicollinearity was studied separately for the factors influencing the volume of retail turnover of milk and dairy products, and for the factors influencing the amount of produced dairy products.

The correlation and reverse matrices for the factors influencing the volume of retail turnover of milk and dairy products are determined:

$$R_1 = \begin{pmatrix} 1 & -0.163 & 0.319 & -0.661 \\ -0.163 & 1 & -0.557 & 0.188 \\ 0.319 & -0.557 & 1 & -0.313 \\ -0.661 & 0.188 & -0.313 & 1 \end{pmatrix}, Z_1 = \begin{pmatrix} 1.825 & -0.060 & -0.259 & 1.137 \\ -0.060 & 1.451 & 0.808 & -0.059 \\ -0.259 & 0.808 & 1.587 & 0.173 \\ 1.137 & -0.059 & 0.173 & 1.817 \end{pmatrix}$$

The criterion χ^2 is calculated:

$$\chi_{1p}^2 = -\left(16 - 1 - \frac{2 \cdot 4 + 5}{6}\right) \ln(0.341) = 13.803$$

According to the statistical tables with the probability 0.95 and degree of freedom 6, $\chi_{kp}^2 = 12.6$. Considering that $\chi_{1p}^2 > \chi_{kp}^2$ that is the phenomenon of multicollinearity. To determine between which factors this phenomenon exists, the F- and t-test were applied (Table 2).

Table 2. F- and t-criteria for factors affecting the volume of retail turnover of milk and dairy products.

Criteria	Calculated value	Critical value for probability 0.95
F1	2.268	3.36
F2	1.241	
F3	1.613	
F4	2.247	
r12.34	-0.037	-
r13.24	-0.152	-
r14.23	0.624	-
r23.14	0.533	-
r24.13	-0.036	-
r34.12	0.102	-
t12	-0.121	2.201
t13	-0.511	
t14	2.651	
t23	2.087	
t24	-0.121	
t34	0.340	

Thus, the existence of multicollinearity between factors x_1 and x_4 is confirmed, and it can be eliminated by excluding the factor x_4 (milk consumption per head of population) of the further consideration.

The correlation and reverse matrices are determined for the factors influencing the amount of produced dairy products:

$$R_2 = \begin{pmatrix} 1 & 0.804 & 0.884 \\ 0.804 & 1 & 0.915 \\ 0.884 & 0.915 & 1 \end{pmatrix}, Z_2 = \begin{pmatrix} 4.587 & 0.130 & -4.174 \\ 0.130 & 6.136 & -5.729 \\ -4.174 & -5.729 & 9.932 \end{pmatrix}$$

The criterion χ^2 is determined:

$$\chi_{2p}^2 = -\left(16 - 1 - \frac{2 \cdot 3 + 5}{6}\right) \ln(0.0356) = 43.934.$$

According to the statistical tables with the probability 0.95 and degree of freedom 3, $\chi_{kp}^2 = 7.8$. Considering that $\chi_{2p}^2 > \chi_{kp}^2$ that is the phenomenon of multicollinearity. To determine between which factors this phenomenon exists, the F- and t-test were applied (Table 3).

Table 3. F- and t-criteria for factors influencing the amount of produced dairy products. (Source: results of authors' calculations)

Criteria	Calculated value	Critical value for probability 0.95
F4	23.313	3.49
F5	33.385	
F6	58.057	
r45.6	0.025	-
r46.5	-0.619	-
r56.4	-0.734	-
t45	0.088	2.179
t46	-2.838	
t56	-3.895	

Analyzing data from the Table 3, one can conclude that the factor x_6 (supply of milk and dairy products to processing enterprises) is multicollinear with others and therefore, it should be excluded of the further consideration.

Thus, considering the results of the research on multicollinearity and its elimination, the economic and mathematical model of the market of milk and dairy products is like:

$$\begin{aligned} y_1 &= a_{10} + a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + u_1 \\ y_2 &= a_{20} + a_{21}x_4 + a_{22}x_5 + u_2 \end{aligned} \quad (6)$$

To develop such econometric model, data from the Table 1 and Table 4, as well as the least squares method (LSM) are used.

Table 4. Dynamics of the volume of retail turnover and production of milk and dairy products in Ukraine. (Sources: composed by the authors according to the data [33, 34])

Year	Volume of retail turnover of milk and dairy products, million UAH, (y_1)	Amount of produced dairy products, thousand tons, (y_2)
2005	3067	1920.8
2006	3982	1829.3
2007	5363	1917.4
2008	7196	1834.5
2009	7633	1718.6
2010	9938	1710.9
2011	11779	1733.7
2012	14342	1780
2013	16093	1874.4
2014	16226	1951.6
2015	19023	1782.5
2016	23449	1766
2017	27016.7	1765.9
2018	33568.3	1765.8
2019	38311.4	1717.8
2020	44317.7	1777.8

Parameters of both equations of the econometric model (6) of the LSM are calculated:

$$\vec{A} = (X^T X)^{-1} (X^T \vec{Y}) \quad (7)$$

where \vec{Y} - vector of the indicator data; X - matrix of the factors data; \vec{A} - vector of the model parameters.

The corresponding matrices are composed:

$$X_1 = \begin{pmatrix} 1 & 806 & 113.5 & 112 \\ 1 & 1041 & 109.1 & 150 \\ 1 & 1351 & 112.8 & 199 \\ 1 & 1806 & 125.2 & 234 \\ 1 & 1906 & 115.9 & 455 \\ 1 & 2250 & 109.4 & 273 \\ 1 & 2648 & 108 & 257 \\ 1 & 3041 & 100.6 & 410 \\ 1 & 3282 & 99.7 & 548 \\ 1 & 3480 & 112.1 & 357 \\ 1 & 4195 & 148.7 & 78 \\ 1 & 5183 & 113.9 & 105 \\ 1 & 7104 & 114.4 & 132 \\ 1 & 8865 & 110.9 & 180 \\ 1 & 10497 & 107.9 & 337 \\ 1 & 11591 & 102.7 & 691 \end{pmatrix}, X_2 = \begin{pmatrix} 1 & 21.7 & 13714.4 \\ 1 & 22.3 & 13286.9 \\ 1 & 22.1 & 12262.1 \\ 1 & 22.6 & 11761.3 \\ 1 & 19.8 & 11609.6 \\ 1 & 19.2 & 11248.5 \\ 1 & 19.1 & 11086.0 \\ 1 & 19.6 & 11377.6 \\ 1 & 20.3 & 11488.2 \\ 1 & 20.3 & 11132.8 \\ 1 & 19.8 & 10615.4 \\ 1 & 19.6 & 10381.5 \\ 1 & 19.3 & 10280.5 \\ 1 & 19.1 & 10064 \\ 1 & 19.0 & 9663.2 \\ 1 & 18.9 & 9263.6 \end{pmatrix}, Y_1 = \begin{pmatrix} 3067 \\ 3982 \\ 5363 \\ 7196 \\ 7633 \\ 9938 \\ 11779 \\ 14342 \\ 16093 \\ 16226 \\ 19023 \\ 23449 \\ 27017 \\ 33568 \\ 38311 \\ 44318 \end{pmatrix}, Y_2 = \begin{pmatrix} 1920.8 \\ 1829.3 \\ 1917.4 \\ 1834.5 \\ 1718.6 \\ 1710.9 \\ 1733.7 \\ 1780 \\ 1874.4 \\ 1951.6 \\ 1782.5 \\ 1766 \\ 1765.9 \\ 1765.8 \\ 1717.8 \\ 1777.8 \end{pmatrix}$$

Applying the LSM, the parameter estimation is obtained:

$$\vec{A}_1 = \begin{pmatrix} -2141.637 \\ 3.639 \\ 29.077 \\ 2.618 \end{pmatrix}, \vec{A}_2 = \begin{pmatrix} 977.885 \\ 40.580 \\ 0.001 \end{pmatrix}$$

Thus, the economic and mathematical model is like:

$$\hat{y}_1 = -2141.637 + 3.639x_1 + 29.077x_{2t} + 2.618x_{3t} \\
 \hat{y}_{2t} = 977.885 + 40.58x_{4t} + 0.001x_{5t}$$

Results of the research on adequacy of the developed economic and mathematical model are presented in the Table 5.

Table 5. Results of the research on adequacy of the system of economic and mathematical model.		
Indicator	Value	Result
<i>Equation of dependency of the volume of retail turnover of milk and dairy products on the influencing factors</i>		
Determination factor	0.986	There is a close dependency between the studied factors and the volume of retail turnover of milk and dairy products
Multiple correlation coefficient	0.993	
F-test	279.99	F > Fkr=3.49 (degrees of freedom 3 and 12, reliability 0.95), then the model is adequate for the data of the general population
<i>Equation of dependency of the amount of produced dairy products on the influencing factors</i>		
Determination factor	0.461	There is a significant dependency between the studied factors and the amount of produced dairy products
Multiple correlation coefficient	0.679	
F-test	5.56	F > Fkr=3.81 (degrees of freedom 3 and 13, reliability 0.95), then the model is adequate for the data of the general population

The developed economic and mathematical model of the market of milk and dairy products is adequate to the static data of general population and can be used to analyze economic processes.

To assess the factors' impact on the volume of retail turnover of milk and dairy products and the amount of produced dairy products, it is important to consider partial elasticity coefficients, which show a change of the indicator in percent if one of the factors changes by one percent under other constant factors. Partial elasticity coefficients are presented in the Table 6.

Table 6. Impact of the defined factors change on the volume of retail turnover of milk and dairy products and the amount of produced dairy products in Ukraine.

Elasticity coefficients	Value	Result
E_{y_1/x_1}	0.952	Rise of the average monthly salary by 1% results in the increase of the retail turnover of milk and dairy products by 0.952% under other influencing factors stay constant
E_{y_1/x_2}	0.067	Increase of the consumer price index by 1% results in the increase of the volume of retail turnover of milk and dairy products by 0.067% under other influencing factors stay constant
E_{y_1/x_3}	0.041	Growth of the import of dairy products by 1% results in the increase of the volume of retail turnover of milk and dairy products by 0.041% under other influencing factors stay constant
E_{y_2/x_4}	0.431	Growth of milk consumption per head of population by 1% results in the increase of the amount of produced dairy products by 0.431% under other influencing factors stay constant
E_{y_2/x_5}	0.005	Growth of milk production by farms of all categories by 1% results in the increase of the volume of produced dairy products by 0.005% under other influencing factors stay constant

To sum up, the average monthly salary is the determining factor influencing the volume of retail turnover of milk and dairy products in Ukraine, whereas the amount of produced dairy products is influenced by growth of milk consumption per head of population. The war in Ukraine negatively affected the development of economic processes and phenomena in the dairy market of Ukraine. The most significant consequence has been the reduction in the number of cattle. In 2021, the number of cows in Ukraine decreased to 1.61 million heads (6.94%) [36]. Preliminary forecast estimates for 2022 suggest that the number of cows will decrease further to 1.39 million heads (a 13.7% reduction) by the end of the year, which is the lowest recorded figure in Ukraine's history. Despite the significant reduction in the number of cows in households, which produced approximately 3-3.5 million tons of milk, the Ukrainian industrial sector did not experience a significant reduction in milk production, even amidst military actions. However, in the regions where hostilities occurred, the number of cows decreased from 1.14 million heads in 2021 to 1.01 million heads in 2022, indicating an 11.4% decrease [37]. The Union of Dairy Enterprises of Ukraine predicts that 2.7 million tons of milk will be processed in 2022, while Ukrainian processing capacities are sufficient for further processing a larger amount of milk - 5 million tons.

In 2022, there were only 140 milk processing enterprises in Ukraine, which is a reduction of 38 compared to 2021. However, despite this reduction, the volume of exports of dairy products exceeded the volume of imports during the first ten months of 2022. Specifically, exports amounted to USD 210 million, while imports totaled USD 180 million.

In 2022, 10 Ukrainian milk processing companies were authorized to export their products to EU countries, which ensures the competitiveness of Ukrainian dairy products on the world market due to the lower price of raw materials. However, the price of raw materials on European markets increased significantly in 2022 — in the Netherlands, in September 2022, it was 60 EUR cents/l. In Germany — it is 56 EUR cents/l, in Poland — 52 EUR cents/l, while in Ukraine, due to the growth exchange rate - 36-38 EUR cents/l. However, in order for the supply of raw materials for the production of dairy products to increase in Ukraine, state support is needed, which was suspended during the war, and an emphasis on the formation of dairy cooperatives, the share of which in the world among milk processing enterprises reaches 80%.

DISCUSSION AND CONCLUSIONS

The work used an economic-mathematical model based on a system of equations, which established direct and inverse relationships between economic phenomena and processes in the dairy market. Volumes of retail turnover of milk and milk products and volumes of milk products produced are the resulting indicators. The study considered various influencing factors, including the average monthly salary, consumer price index, number of dairy product imports, milk production by farms of all categories, milk consumption per capita, and receipt of milk and dairy products at processing enterprises. The results of the multicollinearity study, which was determined separately for the factors that determine the volume of retail turnover of milk and dairy products and the factors that affect the volume of dairy products produced, allow us to conclude that there is a relationship between the factors of the average monthly salary and milk consumption per capita phenomenon of multicollinearity, to eliminate which the factor of milk consumption per capita was removed from further consideration. Additionally, the arrival factor of milk and dairy products at processing enterprises was found to be multicollinear with others and removed from further consideration.

To develop the econometric model, the authors used the least squares method. The calculated equation of dependency of the volume of retail turnover of milk and dairy products on the influencing factors, including the average monthly salary, consumer price index and volume of imported dairy products, confirms a close relation between the mentioned factors and the volume of retail of population, as well as milk production by farms of all categories, the dependency turnover of

milk and dairy products, whereas between the amount of produced dairy products and milk consumption per head is significant. The performed calculation show that the developed economic and mathematical model of the market of milk and dairy products is adequate to the static data of general population and can be used for the analysis of economic processes at the market of milk and dairy products in Ukraine. According to the partial coefficients of elasticity, the average monthly salary is the main determining factor influencing the volume of retail turnover of milk and dairy products. On the other hand, the growth of milk consumption per capita is mainly determined by the volume of dairy products produced.

The study results showed that economic phenomena and processes in the dairy market of Ukraine are determined mainly by the dynamics of milk consumption per capita, which decreased during 2015-2020. Therefore, milk processing enterprises need to intensify their marketing communications, primarily online, using vertical and horizontal integration measures. At the same time, the purchase of milk and milk products in Ukraine, in addition to consumer preferences, is also influenced by the size of the average monthly salary. Therefore, economic growth in the post-war period, accompanied by an increase in the average monthly wage, will also create conditions for developing the volume of dairy products produced in Ukraine.

However, it's necessary to consider that force majeure circumstances can affect the adequacy of implementing the constructed economic-mathematical model.

Prospects for further research will consist of the identification and analysis of factors affecting milk consumption per capita in Ukraine.

ADDITIONAL INFORMATION

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ДЕТЕРМІНАНТИ РОЗВИТКУ ЕКОНОМІЧНИХ ПРОЦЕСІВ НА РИНКУ МОЛОКОПРОДУКТІВ УКРАЇНИ

У дослідженні проведено аналіз економічних явищ і процесів на ринку молокопродуктів України, визначено основні фактори впливу на них. На основі побудови системи рівнянь установлено існування прямих та обернених зв'язків між детермінуючими факторами розвитку ринку молокопродуктів України, здійснено їх перевірку на мультиколінеарність, розраховане рівняння залежності обсягів роздрібного товарообороту молока й молочної продукції від таких факторів впливу як середньомісячна заробітна плата, індекс споживчих цін та величина імпорту молочних продуктів, яке свідчить, що існує тісний зв'язок між визначеними факторами й обсягами роздрібного товарообороту молока й молочної продукції, а між обсягами виробленої молочної продукції та споживанням молока на душу населення й виробництвом молока господарствами всіх категорій – відсутній. Розраховані частинні коефіцієнти еластичності для подальшого прогнозування напрямів впливу детермінуючих факторів на економічні явища та процеси ринку молокопродуктів. Виділено контрольований чинник, на який молокопереробні підприємства України можуть вплинути через активізацію просування своїх товарів на ринку.

Ключові слова: економіко-математичне моделювання, система рівнянь, прямі та обернені зв'язки, ринок молочних продуктів України, виробництво молока й молокопродуктів

JEL Класифікація: C59, O13, Q11, Q13