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Analysis and modeling of factor determinants of food provision at consumer market of Ukraine

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ABSTRACT

The present study investigates socio-economic nature of the issue of food provision at consumer market of Ukraine. It is entity content and main macroeconomic functions oriented at production, sales and consumption of food, undertaken by the state to maintain the ongoing process of social reproduction and security guaranteeing in the country. It is hypothesized that the change in income of population, Consumer Price Index, total expenditures of households on food and agricultural production per capita have the largest influence on food provision of consumer market in the country. Based on system approach the authors suggest their understanding of the factor determinants grouped by certain features, which influence the condition of food provision of consumer market in the country. Application of factor grouping method contributed to identification of parameters that show the links of economic factors and the condition of food provision. Correlation-regression analysis allowed revealing and assessing the dependence of the level of main food products' consumption in the country on the major groups of factor determinants. The assessment of standardized regression coefficients contributed to determining the input of each suggested factor in the condition of food provision of consumer market. Strong interrelation between socio-economic factors and the volumes of consumption of main food groups by Ukrainian population, in particular vegetable and animal products, is found. The results of conducted analysis confirm that the condition of food provision at consumer market depends on how efficient the mechanisms of macro- and microeconomic regulation of trade and food policy of Ukraine are.

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INTRODUCTION

The issue of food provision at consumer market of Ukraine currently is gaining increasing importance in the context of guaranteeing the political, fuel, energy, economic and, especially, food security by Ukraine. From the viewpoint of economic efficiency, the food provision is essential for outlining the development perspectives of consumer market and national economy in general. It depends on many economic, socio-demographic, infrastructural, ecological and political factors. The complex nature of this problem requires gradual analysis of domestic factors and the range of parameters. The problem of food provision is vastly researched by domestic scientists. In particular, Haydutskyi (2004) has analyzed the world experience, comparing it with domestic realities and has outlined the tendencies of food provision of the country's population for the perspective. Ivanyuk (2015) has defined the main conditions and components of food security forming in a country and has analyzed the condition of domestic food security as well as represented the structure of food consumption by population. She has substantiated that agrarian sector is the systemically important element of national economy that combines various branches of agriculture with the major goal to provide consumer market with food. Shorikov and Babenko (2014) pay utmost attention to the development and management of innovation technologies at agrarian enterprises, contributing to faster saturation of consumer market with food. The meeting of consumers' needs at Ukrainian domestic market, in particular for quality goods at affordable prices, through the change of the mechanism of consumer market development is studied by Kolomiyets and Popadynets (2016). Characteristics of food security and the level of food accessibility can be found in the works by Pashaver (2018). Koshchiy (2013) has examined the problem of food security and meeting the Ukrainian population's needs for food, has analyzed the volumes of production and consumption of main food products by Ukrainian population and has estimated the quantitative and qualitative characteristics of Ukrainians' diets. Shushpanov (2016) has outlined modern features of food consumption by various demographic and socio-economic groups of population (by gender, age, marital status, social status, income and place of residence) in Ukraine and has identified the groups of risk among population, who deem the food as one of the leading health determinants. Somewhat more detailed analysis of the impact of such factor as consumer income on food provision at consumer market is conducted by the Popadynets *et al.,* (2017), who define major approaches that contribute to the forming of purchase behaviour of consumers both in Ukraine and the range of EU (European Union) Member States. They have constructed the general model of differences in purchase behaviour of population at the consumer market of EU Member States and Ukraine, which shows the existence of substantial differences, in particular regarding the food products. Among the main products of consumer basket, the strongest fluctuations of demand are found for such food products as bread, cereals and fruits and the least – for meat, fish and seafood. The research concludes that considering of the peculiarities of the researched differences will allow domestic consumer not only to take into account personal income while buying a product, but also to link the purchase behaviour with national traditions and level of awareness. There are various approaches to the research of the impact of certain factors separately or aggregately on food provision of consumer market or on the development of national economy and strengthening of food security in a country. Dauchet *et al.,* (2006) have examined the issue of the deficit of certain food products' consumption among population and defined the impact of products' quality on public health. Zhang, *et al.,* 2016 have examined the consumers' trust in food. They have confirmed that the trust can be established through various ways, including the personal relations and different organization mechanisms imposed by government, private companies or NGOs. The authors have also revealed that existing governmental structures managing the food are losing the consumers' trust, and on this basis, they have defined alternative trust mechanisms and ways to provide food to consumer market. Mayett-Moreno and Oglesby (2018) in their study have outlined the relevance of food policy and management for solution of food security issues in heterogeneous food chain in the context of defining the UN food and agricultural policies based on interviews with food chain agents and secondary data for 2014-2018. Wong *et al.,* (2018) have examined the food market in terms of ecological problems it generates, because three billion tons of food is wasted annually, estimated as the third part of the total produced food. This has the

catastrophic impact on ecology. Production of most of these wastes is directly related to unwillingness to sell, purchase and consume suboptimal food lagging behind regular products in terms of appearance standards, date labelling, or damaged packaging. The study of Nagyová, *et al.,* 2016 has confirmed that the efficiency of agricultural production, closely related to the policy of support, which partially provides the financial affordability of enterprises, is one of the decisive factors influencing the economic stability of consumer market, in particular regarding the food products. The paper also confirms that subsidies are an important instrument in the EU Member States for maintenance of economic stability of economies in general and food provision in particular. Toderasc (2017) mentions that wholesale trade at consumer market once used to be the major factor of food security strengthening in the EU Member States, which in time was altered by supermarkets and shops. In addition, the new role of institutes called wholesale trade has moved to retail trade at consumer market in the chain of consumer goods supply. Nichols and McConnell (2012) prove that information factor plays an important role in forming of demand at consumer food market. Indeed, the new technology has significantly facilitated the consumers' access to information on the condition of consumer market almost from any place. Díaz-Bonilla (2015) in his study reveals the impact of monetary, financial and fiscal policies on the condition of food provision and food security. The author determines that the issues of trade and food security should be considered in the context of general macroeconomic structure, because food provision can have different consequences depending on the impact of various structural policies (initially defined factors) on it. The current study hypothesize that the change in income of population, Consumer Price Index, total expenditures of households on food and agricultural production per capita have the largest influence on food provision of consumer market in the country. To verify the hypothesis the factors that can be conditionally grouped depending on food consumption, price policy, economic affordability of food products and the country's self-provision with vegetable and animal products have been selected. The factors selected for research form the consumer food market in Ukraine. The research was conducted in Dolishniy Institute of Regional Research of NAS of Ukraine in 2018.

MATERIALS AND METHODS

The research of the condition of food provision at consumer market in Ukraine is carried out by the method of grouping of factors. The most difficult task at this stage is to identify the parameters that show the links of economic factors and the condition of food provision to the fullest extent and as accurately as possible. In order to select independent factors, the qualitative nature of interrelations of various features are examined and the method of correlation analysis is used. Initially, all the factors are verified for correlation with resulting feature and only those with correlation rate over 0.6 are selected. Afterwards, the factors are verified for the absence of multi-collinearity (linear relationship between two or more factors). In order to conduct correct analysis of the economic factors' impact on the condition of food provision at consumer market, at first all the factors are standardized, i.e. reduced to one row. All calculations related to data standardization are done in Statistica 7. Correlation-regression analysis is carried out to evaluate the factors of food consumption differences. The analysis contributes to revealing and evaluation of the dependence of main food commodities' consumption level in the country on the group of socio-economic factors (change in income levels (X_1); Consumer Price Index (X_2); total expenditures of households on food (X_3); agricultural production per capita (X_4)). For complex assessment of socio-economic factors that influence the level of current consumption of crop and animal husbandry production (in particular such categories as, meat and meat products (Y_1), milk and diary (Y_2), eggs (Y_3), fish and fish products (Y_4), sugar (Y_5), vegetable oil and other vegetable fats (Y_6), potato (Y_7), vegetables and melons (Y_8), fruits, berries, nuts, grape (Y_9) and bread and cereals (Y_{10})) the regression analysis was carried out. Change in income levels (X_1), Consumer Price Index (X_2), total expenditures of households on food (X_3) and agricultural production per capita (X_4) are the independent variables. Modeling of the connection of economic factors and the condition of food provision at consumer market of Ukraine (dependent variable (Y) – volumes of agricultural production) is carried out based on data for 2010-2017. It is worth mentioning that in order to develop reliable regression model with an opportunity to predict the volumes of food provision of consumer market the time range should be at least 5 years. That is why this time lag was chosen. The model of food provision at

consumer market is developed through establishment of connection between agricultural production and economic factors of impact. Based on the established connection the multi-factor regression dependence is constructed. Verification of the quality of multiple regression equation through general coefficients of correlation and determination, Fisher's criterion and standard deviation shows the close reliable connection between factor and resulting features. Economic-mathematical model is developed through stepwise regression with F-inclusion and initial standardization of factors' and resulting feature's values.

RESULTS AND DISCUSSION

The paper aims to define the impact of selected factors on the condition of food provision at domestic Ukrainian market and to develop the models of the impact across certain factor determinants. The condition of food consumption in Ukraine is defined by consumption norms developed by specialists in food hygiene according to gender, age and professional groups taking into account the geographical and social conditions. There are rational and minimal food norms. If population consumes food products close to rational norms, it means that the task of food accessibility is solved and the level of food provision is high. The norms of rational nutrition recommended by Ukrainian Scientific and Research Institute of Food Hygiene stipulate daily caloric content of 2928 kcal (National Institute of Strategic Research, 2014). The norms of minimal food consumption define the bottom limit of the necessary intake of nutrients. The norms are considered as the limit reference points of food provision. If rational nutrition norms are of recommendatory nature, the minimal norms of food consumption in Ukraine are calculated at state level and regulated by the Law of Ukraine «On Subsistence Level» (Supreme Council of Ukraine, 2017) and approved by the Order of Cabinet of Ministers of Ukraine. The results of correlation estimation show that the level of consumption of all production types (Y_1- Y_{10}) strongly depends on the change of income volumes and Consumer Price Index (Table 1).

Table 1: Research of connection between the level of consumption of vegetable and animal products and socio-economic factors in Ukraine in 2010-2017 (correlation analysis)
(State Statistics Service of Ukraine, 2018a; State Statistics Service of Ukraine, 2018b; State Statistics Service of Ukraine, 2018f)

Type of production	2005	2010	2012	2013	2014	2015	2016	2017
Meat and meat products (Y1)	-2.154	0.1642	0.5537	0.8069	0.5537	-0.15	0.2226	2.471
Milk and diary (Y_2)	1.3334	-0.4109	0.2164	0.859	0.4383	-1.45	-0.9847	2.4747
Eggs (Y_3)	-1.355	0.3649	0.9383	1.0947	0.6777	-0.78	-0.9383	2.4747
Fish and fish products (Y_4)	0.969	0.5963	0.0745	0.8944	0.1491	-1.71	-0.969	2.318
Sugar (Y_5)	-1.095	-0.6082	1.3381	-0.122	1.3381	0.061	-0.9123	2.467
Vegetable oil and other vegetable fats (Y_6)	-1.619	1.2603	0.1459	0.7031	0.7031	-0.41	-0.7827	2.4189
Potatoes (Y_7)	2.1846	-0.5618	-0.7267	-0.536	-0.27	0.054	-0.1432	2.4745
Vegetables and melons (Y_8)	-1.938	-0.7769	0.2956	0.5804	0.7674	0.376	0.6962	2.4745
Fruits, berries, nuts, grape (Y_9)	-1.952	-0.5399	0.2055	0.8333	1.0294	0.14	0.284	2.4717
Bread and cereals (Y_{10})	1.9342	0.1402	-0.0459	-0.038	0.081	-1.24	-0.8329	2.4742
Change of income volumes, % to previous year (X_1)	1.3863	0.3211	-0.0418	-1.259	-1.353	0.707	0.2391	2.4743
Consumer Price Index, (December to December of previous year, %) (X_2)	-0.277	-0.6115	-0.8669	-0.812	0.7688	1.882	-0.0825	2.4742
Total expenditures of households on food, %, monthly average per one household (X_3)	1.6539	0.9123	-0.6121	0.2531	-0.942	-1.02	-0.2413	2.4724
Agricultural production per capita, UAH (Ukrainian Hryvnya) (X_4)	-1.449	-0.2851	0.606	1.1657	1.0846	-0.18	-0.9405	1.0934

Correlation coefficients (Yn-Xn)

Y_1-X_1	0.997214	Y_1-X_2	0.998082	Y_1-X_3	0.995831	Y_1-X_4	0.725497
Y_2-X_1	0.999626	Y_2-X_2	0.999518	Y_2-X_3	0.999226	Y_2-X_4	0.887074
Y_3-X_1	0.999510	Y_3-X_2	0.999590	Y_3-X_3	0.998821	Y_3-X_4	0.793952
Y_4-X_1	0.934758	Y_4-X_2	0.930411	Y_4-X_3	0.946517	Y_4-X_4	0.609334
Y_5-X_1	0.995490	Y_5-X_2	0.996801	Y_5-X_3	0.993274	Y_5-X_4	0.642108
Y_6-X_1	0.973854	Y_6-X_2	0.976159	Y_6-X_3	0.974076	Y_6-X_4	0.821910
Y_7-X_1	0.999852	Y_7-X_2	0.999626	Y_7-X_3	0.999336	Y_7-X_4	0.773550
Y_8-X_1	0.999338	Y_8-X_2	0.999694	Y_8-X_3	0.998217	Y_8-X_4	0.695638
Y_9-X_1	0.997471	Y_9-X_2	0.998642	Y_9-X_3	0.995896	Y_9-X_4	0.723243
Y_{10}-X_1	0.999624	Y_{10}-X_2	0.999236	Y_{10}-X_3	0.999554	Y_{10}-X	0.878814

At the same time, the dependence between agricultural production per capita is moderately defined (coefficients of correlation close to 0.7-0.8). Consumption of products by the country's population is strongly dependent on total expenditures of households on food. The conducted research proves that the level of consumption of such goods as bread and cereals, sugar, vegetable oil and eggs strongly depends on the volumes of production in the country (coefficients of correlation close to 0.9). Consumption of meat, fish and fruits has the high level of correlation with socio-economic factors of the country's development, in particular the total expenditures or the Consumer Price Index. In order to verify a suggestion on close relationship between socio-economic factors and volumes of vegetable and animal products consumption the correlation analysis is carried out (Table 2). Consumer Price Index has the strongest impact (reverse) on meat consumption, as far as regression coefficient amounts to 0.7011. To put this into perspective, the rate of income influences the consumption of fruits, berries, nuts and grape the most (regression coefficient amounts to -0.756498); the volumes of production in the country significantly influence the consumption of sugar (regression coefficient amounts to 0.995457).

The growth of agricultural production in a country creates potential opportunities to strengthen social situation of employees, develop social infrastructure and improve the population welfare. Moreover, growth of crops and animal husbandry production in Ukrainian regions should secure the adequate growth of the income of population. People feel the approaching socio-economic and financial problems in a country in the first place through their purchase power, in particular affordability to buy food at

Table 2: The dependence of the level of main food products consumption on certain factors in Ukraine in 2010-2017 (regression analysis)

Food products	Regression equation	Coefficients of determination*	Validity**
Meat and meat products	Y_1=-0.4173X_1-0.7011X_2-0.4208X_3+0.6521X_4	R=0.91194955 R^2=0.83165199 R_{ac}^2=0.66330398	F=4.9401 p<0.11115 σ=0.58026
Milk and diary	Y_2=-0.1174X_1-0.0126X_2+0.8943X_3+0.5551X_4	R=0.776506 R^2=0.602961 R_{ac}^2=0.191116	F=0.759323 p<0.636438 σ=1.091383
Eggs, units	Y_3=0.2021X_1-0.3783X_2-0.0132X_3+1.0650X_4	R=0.98105 R^2=0.96246 R_{ac}^2=0.88738	F=12.81922 p<0.07367 σ=0.33559
Fish and fish products	Y_4=-0.1220X_1-0.1381X_2+1.0058X_3+0.5921X_4	R=0.957394 R^2=0.916603 R_{ac}^2=0.749808	F=5.495405 p<0.159839 σ=0.500192
Sugar	Y_5=0.5553X_1-0.1595X_2-0.5114X_3+0.9954X_4	R=0.892644 R^2=0.796812 R_{ac}^2=0.390437	F=1.960780 p<0.365090 σ=0.780745
Vegetable oil and other vegetable fats	Y_6=-0.0604X_1-0.0286X_2+0.2130X_3+0.8070X_4	R=0.771668 R^2=0.595472 R_{ac}^2=-0.213585	F=0.736008 p<0.645413 σ=1.101628
Potatoes	Y_7=0.0322X_1+0.5158X_2+0.7485X_3-0.2325X_4	R=0.837101 R^2=0.700738 R_{ac}^2=0.102215	F=1.170779 p<0.508966 σ=0.947515
Vegetables and melons	Y_8=-0.7214X_1-0.2021X_2-0.9356X_3-0.5170X_4	R=0.966614 R^2=0.934342 R_{ac}^2=0.803026	F=7.115200 p<0.127005 σ=0.443818
Fruits, berries, nuts, grape	Y_9=-0.7565X_1-0.0848X_2-0.6182X_3-0.2143X_4	R=0.97852 R^2=0.95749 R_{ac}^2=0.87248	F=11.26293 p<0.08321 σ=0.35710
Bread and cereals	Y_{10}=0.1215X_1+0.0902X_2+0.9833X_3+0.3591X_4	R=0.811650 R^2=0.658776 R_{ac}^2=-0.023671	F=0.965315 p<0.566014 σ=1.01176

*R – coefficient of multiple correlation, R^2 – coefficient of determination, R_{ac}^2- adjusted coefficient of determination.
**F (df) – Fisher's F-criterion (with the defined degree of freedom (df)), p – probability, σ – standard deviation

consumer market. Purchase power of Ukrainian families grew in 2016 compared to 2011, although not across all the parameters. If to analyze the dynamics, the purchase power in 2016 reached the level of 2010, which remains to be the negative rate for economy. However, Consumer Price Indices for non-food items for children grow each year, causing the fall in parents' purchase power and family's welfare and their inability to meet the children's needs. For example, purchase power of population in 2010-2017 reduced the most for food in 2015 (145 %). Consumer Price Index reached its maximum in 2015 as well and amounted to 144 %, although in 2012-2013 the Index significantly fell down to 99.7 % in 2013 (Table 3).

Economic science proves that the share of expenditures on purchase of food exceeding 50 % threshold testifies to the low level of population's standards of living and is one of the poverty indicators. In Ukraine in 2010-2017, population spent in average 58.2 % of total expenditures to buy food (Table 4).

In conditions of financial and economic crisis in Ukraine, the political instability and fluctuations of exchange rate, the level of purchase power of working age population that influences the parameters of meeting the needs and interests of population is unsatisfactory and is caused by insufficient food provision of consumer market. In 2012, the prices for food products grew in Ukraine by 6 %, and in 2017 reduced by 2.4%; in 2015, the level of their increase was 6.9 %. In the period under research, the nominal wages grew by 18.5 %, improving the purchase power of population. Overall, in 2010-2017 the cost of food at consumer market grew 1.3 times with nominal wages increased 1.8 times in the period. It is worth emphasizing that the volumes of crops and animal husbandry production depend on capital investment in agriculture, which is also the direct impact of capital investment on consumer market provision with food. Growth of investment, replacement of outdated equipment and forming of qualitatively new infrastructure can positively influence the volumes of agricultural production. For this purpose, the resulting features of independent variable through the linear regression analysis are researched (Table 5). It is worth paying attention to the fact that with the growth of capital investment by 1 %, the volumes of crop production can grow by 0.70 %. As far as the coefficient of determination (R^2) equals 0.49609116 (shows that the connection between parameters is not strong), the growth of crop production by 49.61 % is influenced by the factor of regression model (capital investment), and by 50.39 % – the other factors; the model is adequate. In the course of construction of the regression model of animal

Table 3: Consumer price indices and households' expenditures on food in Ukraine in 2010-2017 in percentage (State Statistics Service of Ukraine, 2018b; State Statistics Service of Ukraine, 2018f; State Statistics Service of Ukraine, 2018c)

Period	Consumer price index for food and non-alcohol beverages	Consumer price Index	Increase	Growth rate
2010	109.5	108.5	-1.00	-0.91
2011	99.8	103	3.20	3.21
2012	96.3	98.8	2.50	2.60
2013	98.7	99.7	1.00	1.01
2014	123.9	125.7	1.80	1.45
2015	145	144	-1.00	-0.69
2016	103.7	111.7	8.00	7.71
2017	124.9	118.9	-6.00	-4.80

Table 4: The share of total and cash expenditures of Ukrainian households for food in 2010-2017, in percentage in total structure (State Statistics Service of Ukraine, 2018d)

Factors	2010	2011	2012	2013	2014	2015	2016	2017	2017/2010
Cash expenditures of households on food, monthly average per one household	51	49.8	46.5	48	46	46.1	48.5	50.1	-1.76
Total expenditures of households on food, monthly average per one household	60.4	58.6	54.9	57	54.1	53.9	55.8	58.2	-3.64

husbandry and capital investment volumes, the weak dependence was found (coefficient of correlation below 0.4). Therefore, it can be confirmed that the link between animal husbandry production volumes and capital investment volumes is weak.

Model of food provision at consumer market and capital investment in agriculture of Ukraine can be shown using Eq. 1

$$Y = 0{,}00001 + 0{,}704339 * X \quad (1)$$

However, in order to find structural changes that influence the condition of food provision at consumer market it is not sufficient to talk only about the link with the factor of capital investment in agriculture growth and level of consumption. It is worth paying attention to such factor as export and import of crop production. This suggestion helps us find the dependence between these factors and the level of consumer market provision. For example, there is a direct link between the export of crop production in Ukraine (X_1) and the volumes of crop production (Y), because the coefficient of correlation r amounts to 0.3471. Cheddok scale shows weak connection between the factors (because 0.3<r<0.5). Therefore, it can be confirmed that the volumes of production are directed at meeting the domestic needs of the country (Table 6). However, crop production volumes correlate with the volumes of crop production import (X_2) (coefficient of correlation amounts to 0.715289).

Therefore, if the crop production import grows by 1 % in Ukraine, the volumes of production will grow by 7.15 %. The selected factor influences food provision of crop production at 51.16 %, and other factors – at 48.84 %.

Crop production model (Y) with the change of import volumes in Ukraine (X_2) can be shown using Eq. 2.

$$Y = 0.00004 - 0.7153 * X_2 \quad (2)$$

Table 5: Data for construction of regression model of food provision at consumer market and capital investment in agriculture of Ukraine in 2010-2017
(State Statistics Service of Ukraine, 2018b; State Statistics Service of Ukraine, 2018f; State Statistics Service of Ukraine, 2018c)

Year	Non-standardized data			Standardized data		
	Y_1	Y_2	X	Y_1	Y_2	X
2010	1771.2	2067.1	2.3	-2.15527	0.232225	0.991337
2011	1968.2	2076.6	2.4	-0.6803	0.314124	1.33615
2012	2078.6	2128.7	2.1	0.14628	0.763272	0.301711
2013	2128.6	2184.3	2.2	0.520637	1.242593	0.646524
2014	2199.9	2108.4	1.6	1.05447	0.588268	-1.42235
2015	2099.3	1996.6	1.7	0.301264	-0.37555	-1.07754
2016	2137.7	1827.2	1.8	0.58877	-1.83593	-0.73273
2017	2089	1932.4	2	0.224146	-0.92901	-0.0431
r_1=0.7043339, R_1^2=0.49609116			t(12)= -2.43041; F=5.9069 >$F_{tabl.}$			

Table 6: The results of regression dependence between the crop production provision and its import volumes in Ukraine in 2010-2017
(State Statistics Service of Ukraine, 2018f; State Statistics Service of Ukraine, 2018c)

Period	Y	X_1	X_2
2010	-2.15527	-0.74946	-1.64039
2011	-0.6803	-0.76332	-1.00704
2012	0.14628	-0.65737	0.392977
2013	0.520637	-0.62727	1.227541
2014	1.05447	-0.18632	-0.26958
2015	0.301264	0.224647	1.246054
2016	0.58877	0.625063	-0.03444
2017	0.224146	2.134045	0.08487
Coefficient of correlation	0.715289	Coefficient of determination	0.511639
Adjusted coefficient of determination	0.430246	Standard deviation	0.285295
Fisher's F-criterion	6.2859 > F_{tabl}	Degrees of freedom	1, with p=0.0461
Student's t – criterion, t(11)	2.507189	Significance value	0.0461

It is worth mentioning that the tendency towards the reduction of crop production volumes can have less threatening impact for the branch if the government conducts active export policy in the sphere of food provision. With the purpose of comprehensive analysis of structural changes in economy that influence the food provision of consumer market in Ukraine, the condition of food provision of consumer market and the selected socio-economic factors in Ukraine are analyzed. Analysis is based on finding the strength and quality of relations between the resulting variable and economic factors. The resulting variable, i.e. the condition of food provision of consumer market, is examined through two variables – volumes of crop production (Table 7) and animal husbandry production (Table 8). Analysis reliability is verified by Constant Y and Constant X parameters and Student's t-test, and the density of connection – by the coefficient of determination.

Based on correlation matrix the level of connection between the factors influencing the phenomenon under research and their nature was defined. In

Table 7: Research of connection between the crop production volumes and economic factors in Ukraine (correlation analysis) (State Statistics Service of Ukraine, 2018b; State Statistics Service of Ukraine, 2018f; State Statistics Service of Ukraine, 2018c; State Statistics Service of Ukraine, 2018d; State Statistics Service of Ukraine, 2018e)

Factors		Coefficient of correlation	Coefficient of determination	Student's t - criterion, t(3)	Significance value	Constant Y	Constant X
Agricultural production per capita (UAH)	X_1	0.7045	0.4963	2.2196	0.0772	0.7045	0.7045
GDP (Gross Domestic Product), in actual prices (UAH)	X_2	0.7119	0.5068	2.2666	0.0728	0.7119	0.7119
GDP Volume Index (%)	X_3	-0.6315	0.3988	-1.8211	0.1282	-0.6315	-0.6315
Labour productivity at agricultural enterprises, per 1 employed in agricultural production (UAH)	X_4	0.6031	0.3637	1.6905	0.1517	0.6031	0.6031
Number of farms (units)	X_5	-0.9236	0.8530	-5.3864	0.0030	-0.9236	-0.9236
Cash expenditures of households on food (%, monthly average per one household)	X_6	-0.8269	0.6837	-3.2879	0.0218	-0.8269	-0.8269
Total expenditures of households on food (%, monthly average per one household)	X_7	-0.8656	0.7492	-3.8649	0.0118	-0.8656	-0.8656

Table 8: Analysis of the level of economic factors' impact on the volumes of animal husbandry production in Ukraine (correlation matrix) (State Statistics Service of Ukraine, 2018b; State Statistics Service of Ukraine, 2018f; State Statistics Service of Ukraine, 2018d; State Statistics Service of Ukraine, 2018e)

Factors		Coefficient of correlation	Coefficient of determination	Student's t - criterion, t(3)	Significance value	Constant Y	Constant X
Share of agricultural products produced by farms (%)	X_1	0.7817	0.6111	2.8029	0.0379	0.7817	0.7817
GDP per capita (UAH)	X_2	-0.7123	0.5073	-2.2691	0.0725	-0.7123	-0.7123
Labour productivity at agricultural enterprises, per 1 employed in agricultural production (UAH)	X_3	-0.8247	0.6802	-3.2609	0.0224	-0.8247	-0.8247
Total expenditures of households on food (%, monthly average per one household)	X_4	0.1318	0.0174	0.2973	0.7782	0.1318	0.1318
Disposable income of population per capita (UAH)	X_5	-0.7171	0.5142	-2.3006	0.0697	-0.7171	-0.7171
Nominal average monthly wages of regular employees, in average per one regular employee (UAH)	X_6	-0.8063	0.6501	-3.0477	0.0285	-0.8063	-0.8063

Table 9: Results of multiple regression model of the dependence of food provision at consumer market of Ukraine on economic factors (State Statistics Service of Ukraine, 2018b; State Statistics Service of Ukraine, 2018f; State Statistics Service of Ukraine, 2018d)

Factors	Parameters of regression equation			
	Standardized regression coefficients	Standard deviation	Student's t - criterion, t(3)	Significance value
Intercept		0.0028		1.0000
Export of agricultural products (X_1)	0.9187	0.0157	58.5141	0.0003
Import of agricultural products (X_2)	-0.3652	0.0430	-8.4973	0.0136
Labour productivity at agricultural enterprises, per 1 employed in agricultural production, UAH (X_3)	-0.7810	0.1214	-6.4316	0.0233
GDP per capita, in actual prices, UAH (X_4)	0,4015	0.0810	4.9568	0.0384
Regression analysis				
Coefficient of multiple correlation 0.99999084	Fisher's F-criterion		27304.99> F_{tabl}	
Coefficient of determination 0.99998169	Degrees of freedom		4.2 with p=0.00041	
Adjusted coefficient of determination 0.99994507	Standard deviation of estimation		0.00741	
Correlation analysis				

Factors	Partial coefficients of correlation	Semi-partial coefficients of correlation	Acceptable deviation	Coefficient of determination	Student's t - criterion, t(3)	Significance value
Export of agricultural products (X_1)	0.9997	0.1771	0.0371	0.9629	58.5141	0.0003
Import of agricultural products (X_2)	-0.9864	-0.0257	0.0050	0.9950	-8.4973	0.0136
Labour productivity at agricultural enterprises, per 1 employed in agricultural production, UAH (X_3)	-0.9767	-0.0195	0.0006	0.9994	-6.4316	0.0233
Labour productivity at agricultural enterprises, per 1 employed in agricultural production, UAH (X_3)	0.9616	0.0150	0.0014	0.9986	4.9568	0.0384

particular, cash and total expenditures of households for food and number of farms have the most influence on crop production volumes. The connection is reverse (coefficients of correlation amount to r_6 = -0.827; r_7 = -0.866; r_5 = -0.924 accordingly). Among the structural factors of economy such independent factors as GDP and agricultural production per capita have significant influence on the resulting variable (r_2 = 0.712; r_1 = 0.705). Such factors as labour productivity at agricultural enterprises and monthly average nominal wages of regular employees have the strongest reverse impact on the volumes of animal husbandry in Ukraine (coefficients of correlation amount to r_3 = -0.8247; r_6 = -0.8063 respectively). All the other factors have the moderate impact according to the Chaddok scale (coefficients of correlation vary within 0.6-0.7). Total expenditures of households on food correlate rather weakly, because animal products are the commodity category with rather high demand elasticity. Therefore, the volumes of production fall when the prices grow. It is well known that the final goal of any changes in food branch is to provide the best access to food for population. In order to achieve the goal it is necessary to solve numerous intermediate tasks or to realize current aims directed at improvement of labour productivity in the branch and maintenance of decent labour conditions, including the high labour remuneration level and export oriented agricultural production. In order to achieve the intermediate and final goals and to define the input of each component into the system of food provision related to structural changes in economy, the economic-mathematical model based on multi-factor correlation-regression analysis is constructed. Quality and reliability of the results of modeled relationship between economic factors and the condition of food provision at consumer market (dependent variable (Y) – volumes of agricultural production) is verified through coefficient of correlation and determination, standard deviation and Fisher's criterion, which exceeds the table values, with the 4.2 degree of freedom and the level

of trust p = 0.00041. Economic and mathematical model is developed through stepwise regression with F-inclusion with initial standardization of factors' and resulting feature's values. The results of the research of the quality and reliability of constructed multiple linear regression are given in Table 9.

It is worth mentioning that independent variables in regression model are both the stimulating (export of agricultural products (X_1), GDP per capita in actual prices, UAH (X_4)), and deterrent factors (import of agricultural products (X_2), labour productivity at agricultural enterprises per 1 employed in agricultural production, UAH (X_3)). The multiple linear model of food provision at consumer market (Y) is represented by Eq. 3.

$$Y = 0.9187 * X_1 - 0.3652 * X_2 - 0.7810 * X_3 + 0.4015 * X_4 \quad (3)$$

The results of analysis show that the condition of food provision at consumer market depends on the efficiency of implementation of the mechanisms of trade and food policy regulation in Ukraine. Having estimated the standardized regression coefficients, the input of each suggested factor to the condition of food provision at consumer market can be defined.

CONCLUSION

The export of agricultural products has the strongest impact on food provision of consumer market in Ukraine, because the coefficient of regression is 0.9187. It can be explained by the fact that the higher the volumes of exported vegetable and animal products are, the more the producers are interested in the increase of production capacity and growth of labour productivity and the volume of trade nomenclature. According to the multiple regression equation, the factor of labour productivity at agricultural enterprises calculated per 1 employed in agricultural production is the second by the influence on the resulting variable (standardized regression coefficient is -0.7810). The parameter is the deterrent factor in the multi-factor model, because the fall in labour productivity of agricultural employee negatively affects the volumes of agricultural production. GDP is an important component of the assessment of food provision at consumer market. Its volumes per capita substantially influence the volumes of crop and animal husbandry production, which is confirmed by the regression coefficient (0.4015). The resulting variable is the least influenced by import of agricultural products (standardized regression coefficient is -0.3652). Inefficient foreign economic policy of government, unreasonable quotas and improper protection of national producer lead to the reduction of the volumes of agricultural production, and therefore, to incomplete food provision of consumer market. Partial coefficients of correlation show the impact degree of certain factor on the resulting variable, when the impact of the rest of factors is eliminated. It is worth emphasizing that estimation of factors by partial coefficients of correlation is not equivalent to the estimation by standardized regression coefficients. Volumes of agricultural products' export (among which the vegetable products occupy the largest share) have the strongest direct impact on the condition of food provision of consumer market. The GDP volume has the least impact compared to the other parameters. Therefore, the conducted analysis of major factor determinants that influence the condition of food provision of consumer market in Ukraine confirms the insufficient level of consumption of main food products (in particular animal products), substantial differentiation of food consumption among certain groups of population (caused by the growth of expenditures of food and national currency devaluation) and high share of agricultural import at unreasonable level of vegetable products' export. These factors are caused also by poor economic affordability of food, inefficient mechanism of food self-provision and low quality and ecological level of food. To solve the problem of food provision of consumer market in Ukraine, it is necessary to direct the endeavors of state and regional authorities and agricultural enterprises of all ownership forms at: improvement of population's purchase power; reduction of tax burden on agricultural producers; optimal market balance of food procurement for export and import; minimizing the disparity of prices for agricultural and industrial products, when the money from sold agricultural products do not cover the production costs; raising the level of culture, education, staff and social maintenance of a village; planning of stable public orders for rural producers, which secure favourable conditions for realization of products at domestic market.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

%	Percent
σ	Standard deviation
df	P–probability
Eq.	Equation
EU	European Union
F(df)	Fisher's F-criterion (with the defined degree of freedom
GDP	Gross domestic product
Kcal	Kilocalorie
R	coefficient of multiple correlation
R^2	coefficient of determination
R_{ac}	Adjusted coefficient of determination
UAH	Ukrainian Hryvnya

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