Food Security in Terms of Economic Affordability of Food: Analysis, Opportunities and Prospects

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Abstract. This article analyzes the access of population of Ukraine to food and the real financial opportunities of its citizens. Empirical coefficients of elastic demand for basic foodstuffs according to the average income of the population per household were determined. The average annual indicators of change in total income and food expenditure per household were calculated. These calculations showed that the indicator “Economic affordability of food” almost a third does not ensure food security of the population of Ukraine. Based on the methodology presented in this research, the necessary total income of the population to ensure food security by the indicator “Economic affordability of food” and scenarios for its provision by changing the structure of food costs, coefficients of elasticity of demand for household income and resources and other variables were determined.

1. Introduction.
An important component of the national and economic security of the state is its food security. Compared to other issues related to the economic development, the problem of food security is one of the most important in the structure of economic security. It includes food security of countries and regions, food independence, food security for the life and health of population, as the products of life are an important resource of the country. The level of food security of population with necessary, high-quality and safe food is a particularly important indicator, which serves not only as a social and economic factor, but also is considered strategic for social stability and economic sovereignty and preservation of the most valuable social resource - national health.

Food security is determined by two components - economic and physical affordability. The availability of food is realized through the possibility of its purchase, taking into account the purchasing power, price and its availability in the appropriate quantity and quality. The issue of food security has a special place in the concepts of national security of most developed countries. Ukraine’s integration into the world community highlights this issue, because only if the population is guaranteed food under any circumstances, the state can pursue an independent policy.

Ensuring food security in Ukraine requires maintaining an appropriate level of food self-sufficiency, which involves the use of state support for domestic agricultural producers and use of control measures for imported products to protect their own producers from the foreign competition. However, society needs to be provided with useful, healthy and fairly cheap food, and the issue of their quality has become especially relevant in recent years. In this context, it is very important to assess the state of food security in Ukraine and identify the main issues. Given the difficult economic
situation in Ukraine, the issue of food security remains open and requires the development of approaches to its solution.

2. Analysis of recent research and publications.
The assessment of key issues of food security of the state is quite thoroughly conducted in the works of such scientists as: V. Dudar (2016) [1], D. Krysanov (2017) [2], O. Varchenko (2017) [2], P. Sabluk (2019) [3], Y. Luzan (2019) [3], H. Tkachuk (2019) [4] and others. The regulation of issues of methodological support for the assessment of the state of food security of Ukraine according to the developed indicators is carried out by the current legal acts and methodical recommendations. Theoretical and methodological aspects of the assessment of state food security are presented in the scientific works of O. Kardash (2015) [5], A. Mostova (2017) [6] and others. The formation of directions for improving food security in the context of globalization was considered by S. Bokov (2016) [7], O. Bokov (2016) [7], S. Konokhov (2019) [8], O. Popko (2019) [9], N. Stezhko (2014, 2016, 2021) [10, 11, 12, 13], M. Sychevsky (2019) [14] and others. Despite the fact that domestic and foreign experts and lawmakers have made a significant contribution to the formation of methodological foundations for the analysis of food security, most of the methods considered in regulations and author’s research leave aside the need to further develop a strategy based on analytical indicators. As a result, food security assessment is carried out in fragments, it is quite difficult to identify problem components and outline priority vectors of strategic planning. The development and implementation of the food security strategy requires in-depth analytical framework in order to identify existing issues and to develop recommendations for their elimination in the long run [15-21].

3. The research objective.
The purpose of the research is to analyze the access of the population of Ukraine to the main types of food and the real financial capabilities of citizens on the basis of identified inconsistencies and differences to calculate macroeconomic indicators of economic development to maintain food consumption at rational consumption levels.

4. Presentation of the main material.
Food security, the content of which is given in the Guidelines for calculating the economic security of Ukraine, is determined by two processes that characterize the state of food production in order to meet the needs of each member of society in food, their balance and accessibility to the population. It is due not only to the availability and sufficiency of food, but also the possibility of purchasing it. Based on the content of food security, its level is assessed on the basis of the main seven indicators, two of which are related to the affordability of products and the differentiation of food costs by social groups [15].

Economic affordability of food is determined by the quantitative measure of the dependence of the change in expenditures on household income on the basis of spatial (group) coefficients of elasticity or econometric models of the relationship.

The empirical coefficients of elasticity are calculated by the following ratios:
1. Order of the Ministry of Economic Development and Trade of Ukraine dated October 29, 2013 No. 1277 “On approval of Guidelines for calculating the level of economic security of Ukraine”:
   - for each j group on average per capita equivalent total income:
     \[ R_{\text{elasticity } y_i/x}^{(j)} = \frac{\Delta_{\text{relatively } y_i}^{(j)}}{\Delta_{\text{relatively } x}^{(j)}} \]  
   - average for all groups:
     \[ \overline{R}_{\text{elasticity } y/x} = \frac{\Delta_{\text{relatively } y}^{(j)}}{\Delta_{\text{relatively } x}^{(j)}} \] 

where: \( \Delta_{\text{relatively } y_i}^{(j)} \) — relative increase in expenditures on \( y_i \) foodstuffs by \( j \) income group; \( i = 1, 4; j = 1,11; \)
According to the presented in Table 1 and Figure 1 calculations, it is shown that really significant level of elasticity of demand for income has developed for meat, fish and milk. In particular, on average, each percent of revenue growth is accompanied by an average relative increase in demand for meat and meat products by 0.49 % ($K_{\text{elasticity}_{yy}/\text{x}}=0.49$), for fish and fish products by 0.5 % ($K_{\text{elasticity}_{yy}/\text{x}}=0.5$) and for milk and dairy products - by 0.406 % ($K_{\text{elasticity}_{yy}/\text{x}}=0.406$).

![Figure 1. Coefficients of elasticity of food costs on total income](image)

**Table 1.** Empirical coefficients of elastic demand for basic food products by average income of the population in 2019 (per one household)

| Average per capita equivalent total income, UAH | Middle of the interval (x) | Average monthly total expenditures on food, UAH | Empirical coefficients of elasticity of demand for food by income: ($K_{\text{elasticity}_{yy}}$) |
|------------------------------------------------|----------------------------|-----------------------------------------------|---------------------------------------------|
|                                                |                           | Bread and bakery products (y) | Meat and meat products (y) | Milk and dairy products (y) | Fish and fish products (y) | Bread and bakery products | Meat and meat products | Milk and dairy products | Fish and fish products |
| up to 3,000,0 | 2,500.0 | 560.0 | 671.7 | 354.3 | 161.0 | - | - | - | - |
The change in the coefficients of elasticity of demand for meat and meat products by individual groups of the population by levels of per capita income confirms the hypothesis regarding the differentiation of consumption by individual social groups. Quite high elasticity has developed precisely for those groups where the income level is low. For example, for the population with incomes (per one household) from 4,000 to 6,000 UAH per month, each percent of their growth provides an increase in the cost of meat and meat products by 2.0%. At the same time, for groups with fairly high incomes, their increase has little effect on the growth of demand for this type of food. These patterns are confirmed by a fairly high level of deprivation, which developed in Ukraine in 2017-2018 due to the lack of funds for these types of food. For example, as of 2017 - 2018, the lack of funds for the consumption of dishes with meat, chicken, fish (or their vegetarian equivalent) every other day indicated as of 2017 about 24.5%, and in 2018 - 16.9% of the population of Ukraine, while in the EU-28 this figure averages 7.9% (2017) and 7.0% (2018) [16].

Differentiation of the cost of food by social groups, which is determined by the ratio between the cost of food 20% of households with the highest incomes and the cost of food 20% of households with the lowest income, in Ukraine in 2014 - 2019 increased by 0.3 percentage points - from 1.5 (2014) to 1.8 (2019), with the highest level in meat (Kdifferentiated=2.03), fish (Kdifferentiated=2.0) products and fruits (Kdifferentiated=2.5) [3, p.223].

These patterns of relationship between food costs (y) and income (x) are also confirmed by the identified regression power dependences, which for certain types of food have the following form:

- for bread and bakery products (y1):
  \[ \bar{y}_{1x} = 317.35 \times x^{0.086} \]  \hfill (7)
- for meat and meat products (y2):
  \[ \bar{y}_{2x} = 24.0 \times x^{0.441} \]  \hfill (8)
- for milk and dairy products:
  \[ \bar{y}_{3x} = 21.1 \times x^{0.376} \]  \hfill (9)
- for fish and fish products:
  \[ \bar{y}_{4x} = 2.74 \times x^{0.526} \]  \hfill (10)

The parameters for the independent variable in power models (7-10) are theoretical coefficients of elasticity, in their values they almost coincide with the average empirical coefficients of elasticity, which are shown in the Table 1.

For example, the highest level of elasticity was formed for fish and fish products (a=0.526), i.e. each percentage increase in income is accompanied by the increase in demand for this type of food by

1Economic deprivation of food:
1. Insufficient funds not to deny themselves the most necessary inexpensive foodstuffs.
List of deprivations (deprivation), supplemented to harmonize with the EU-SILC nutrition program.
2. Lack of funds for the consumption of dishes with meat, chicken, fish (or their vegetarian equivalent) every other day.

\begin{table}
| Income (UAH) | 3,000 | 4,000 | 5,000 | 6,000 | 7,000 | 8,000 | 9,000 | 10,000 | 11,000 |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| % Growth of | 3.500 | 4.500 | 5.500 | 6.500 | 7.500 | 8.500 | 9.500 | 10.500 | 11.500 |
| Average growth rates, % (K_{avg}) | 5.500 | 6.500 | 7.500 | 8.500 | 9.500 | 10.500 | 11.500 | 12.500 | 13.500 |
| Average coefficients of elasticity, (K_{elasticity}) | -0.624 | -0.706 | -0.788 | -0.870 | -0.952 | -1.034 | -1.116 | -1.200 | -1.282 |
\end{table}
0.526 %. The given quantitative measures of dependence of demand for separate foodstuff confirm its rather close connection with volumes of average per capita equivalent total incomes, it is a question first of all of meat, fish and dairy foodstuff.

The identified dependencies are based on the actual consumption of food and the cost of their purchase, which occurred as of 2019. But the consumption of certain foods differs significantly from the rational consumption standards adopted by the order of the Ministry of Health dated September 03, 2017 No. 1073.

A comparison of rational consumption standards and the average annual actual volumes that have developed in recent years, from 2017 to 2019, makes it possible to determine what amounts of income can provide food consumption at the level of rational standards.

The algorithm for determining the required additional income and its testing includes a consistent solution of the following tasks (Table 2):

**Table 2. Average annual changes in total income and food expenditures for 2014 - 2019**

(\text{per one household})

| Expenditures on food: | Legend | Average annual growth rate, \(\bar{T}_{\text{increase},x}\) | Coefficients of elasticity of food costs by income, \(K_{\text{elasticity},yi/x}\) | Ratio of consumption by rational standards and actual indicators, \(R_{i}\) | Specific weight, in % to food costs for 2019 (B) | Required amount of growth in total income, % (\(\Delta_{\text{incr}}\)) |
|----------------------|-------|---------------------------------|---------------------------------|----------------------|---------------------------------|---------------------------------|
| - Total income       | x     | 24.5                            | 1.035                           | 13.9                 | 3.08                            |
| - bread and bakery products | \(y_{1}\) | 18.9                            | 0.88                            | 1.035                | 13.9                            | 3.08                            |
| - meat and meat products | \(y_{2}\) | 22.0                           | 1.023                           | 1.493                | 22.8                            | 50.43                           |
| - milk and dairy products | \(y_{3}\) | 23.3                           | 1.084                           | 1.9                  | 11.1                            | 97.56                           |
| - fish and fish products | \(y_{4}\) | 22.25                          | 1.035                           | 1.6                  | 5.5                            | 62.1                            |
| - sugar, confectionery | \(y_{5}\) | 16.2                           | 0.753                           | 1.32                 | 6.6                            | 24.1                            |
| - eggs               | \(y_{6}\) | 18.8                           | 0.874                           | 1.028                | 2.3                            | 2.45                            |
| - oil, fats          | \(y_{7}\) | 15.3                           | 0.71                            | 1.083                | 7.0                            | 5.9                             |
| - vegetables         | \(y_{8}\) | 32.2                           | 1.5                             | 0.978                | 9.4                            | -3.3                            |
| - potato             | \(y_{9}\) | 35.5                           | 1.65                            | 0.919                | 4.11                           | -13.360                         |
| - fruits             | \(y_{10}\) | 24.3                          | 1.13                            | 1.533                | 5.9                            | 60.0                            |

Calculated by the author on the basis of statistics given in the statistical collections [17] and relations [11-13].

- based on the ratio of the average annual growth rate of total household income (\(\bar{T}_{\text{increase},x}\)) and the average monthly expenditure on \(i\) type of food (\(\bar{T}_{\text{increase},yi}\)) for 2014 – 2019, the average annual coefficients of elasticity by the ratio are determined as follows:

\[
K_{\text{elasticity},yi/x} = \frac{\bar{T}_{\text{increase},yi}}{\bar{T}_{\text{increase},x}},
\]

where:

\[
\bar{T}_{\text{increase},yi} = \left( \frac{n-1}{\sum_{i=1}^{n} y_{i}} \times 100 - 100 \right);
\]

\[
\bar{T}_{\text{increase},x} = \left( \frac{n}{\sum_{i=1}^{n} x_{i}} \times 100 - 100 \right),
\]

\(n=1,6;\) \(n\) – number of periods for which average annual indicators are calculated.

- the coefficients of the ratio between the volumes of food according to rational standards and the actual consumption of the \(i\) type of food are determined as follows:
The share of food expenditures in the total expenditures of households in 

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The condition of increasing the share of food expenditures in the structure of total population expenditures, consumption at the level of rational consumption determines what should be the macroeconomic indicators of economic development to maintain food 

resources and other variables.

changing the structure of food costs, coefficients of elasticity of demand for income or household 

indicator “Economic affordability of food” can be used in developing scenarios for its provision by 

ensure food security of the population of Ukraine.

As of 2018 - 2019, the share of food expenditures in the total expenditures of households in Ukraine is about 48.4 %. In the EU-28, the share of such expenditures averages 13.1 %, with the minimum share being in Luxembourg (7.8 %) and the maximum (26.9 %) in Romania [18].

Based on the actual level of food expenditures (48.4 %) in the first scenario, it is possible to determine what should be the macroeconomic indicators of economic development to maintain food consumption at the level of rational consumption standards. All other four scenarios are based on options for changing the share of food expenditures in the structure of total population expenditures, from 0.4 (Scenario 2) to 0.266 (Scenario 5) (Table 3). All calculations were carried out under the condition of increasing the ratio between macroeconomic indicators, which developed as of 2019.

Table 3. Volumes of macroeconomic indicators for providing food according to rational standards according to the options of changing their share in the total expenditures of the population (d)

| Macroeconomic indicators | Actual level 2019 | Scenarios for options for changing the share of food expenditures in total income (d) |
|--------------------------|------------------|-----------------------------------------------------------------------------|
|                          | Scenario 1       | Scenario 2                                                                 |
|                          | Scenario 3       | Scenario 4                                                                 |
|                          | Scenario 5       |                                                                          |
|                          | d=0.484          | d=0.400                                                                     |
|                          | in % until 2019  | in % until 2019                                                             |
|                          | d=0.355          | in % until 2019                                                             |
|                          | d=0.3            | in % until 2019                                                             |
|                          | d=0.266          | in % until 2019                                                             |
| Food expenditures, billion UAH | 1818,15         | 2374,16                                                                    |
|                          | 2374,16          | 2374,16                                                                    |
|                          | 2374,16          | 2374,16                                                                    |
|                          | 2374,16          | 2374,16                                                                    |
|                          | 2374,16          | 2374,16                                                                    |
|                          | 2974,16          | 130,6                                                                      |
|                          | 2019             | 2019                                                                       |
|                          | 2019             | 2019                                                                       |
|                          | 2019             | 2019                                                                       |
|                          | 2019             | 2019                                                                       |
|                          | 2019             | 2019                                                                       |
According to the calculations presented in the Table 3, it is seen that the provision of food at rational consumption rates, even while maintaining the share of food costs at 0.484 (Scenario 1; \(d = 0.484\)), necessitates the GDP growth of 31.5 %. Given the preservation of the average annual GDP deflator index, which developed in 2016 - 2019 \(\left(I_{def} = 114.0\%\right)\), the GDP growth in relative prices should be at the level of 15.4 % \(\% \left(I_{rel} = I_{def} / I_{eq}\right)\). Such increase can be achieved in four years, subject to annual growth of 3.7 %. According to the Scenario 2 \(d = 0.4\) over the next five years, annual GDP growth should be at least 6.8 %. And to achieve a ratio between food expenditures and total expenditures of the population at 0.35 (Scenario 3) or 0.3 (Scenario 4) while maintaining the structure of food consumption and elasticity of income demand in the next decade is almost impossible.

Thus, food security in terms of food affordability is primarily related to the opportunities for economic growth of the national economy as a whole.

5. Conclusions.
In Ukraine, there is a threat to food security indicator “Economic affordability of food” and “Differentiation of food costs by social groups”.

The share of food expenditures in total household expenditures in recent years has ranged from 48.4 to 51.0 %, which is almost 3.7 times higher than the EU-28 average and indicates both low economic development and the low standard of life of the population.

Today in Ukraine there is a very significant differentiation of consumption of animal products by the levels of per capita total resources and equivalent income, which is confirmed by the high level of derivation for these types of foodstuff.

The developed and presented methodology of determining the necessary additional income for the provision of food at rational standards is universal and can be used in the development of strategies and mechanisms for food security.

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