Analysis of Structural Changes in Food Accessibility Assurance in Russia and Its Macreregions Through Food Security

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Abstract. This article dwells upon the food security of the country in the context of structural changes in national and regional agriculture. The physical availability indicators of food for Russia and its Central and Far Eastern Federal Districts were calculated for the period from 2014 to 2018. The authors analyzed structural changes in the production of the main food types across household categories. The authors determined the intensity and orientation of structural changes in food resources. It is established that structural changes in food accessibility assurance in the Far East (as compared with the country as a whole and the Central district) associated with regional production are by and large regressive. The article shows that the physical availability of food products in the Far Eastern region during the sanctions and countersanctions features negative dynamics. To condition positive structural changes in regional agriculture, it is necessary that the government support agricultural businesses of various legal entity types.

1. Introduction

Nowadays, the agribusiness industry (ABI) of Russia is suffering from the COVID-19 pandemic while still struggling to recover completely from the recession of 2014 (caused by economic sanctions and counter-sanctions). The ABI and its central component (agriculture) are characterized by structural imbalances that hinder the further development of the agricultural sector and the provision of people and processing facilities with quality food products and agricultural materials in volumes sufficient to achieve food security. That is why it is interesting to analyze the structural changes in the provision of Russia and its regions with the main types of food.

2. Relevance, scientific merit of the problem, short literature review

Food is crucial for the well-being and development of humanity as a whole. Key problems determining the existence and development of human society (in the context of the implementation of
the right to life) include the excessive availability of food for some people and starvation for others [1, p. 102].

Agriculture, as a sector of any country's economy, is directly involved in the production of food in its basic form, and it drives the food security of countries. It is the largest industry in the world, employing about 38% of the planet's land surface (pastures and plowland included) and using about 70% of the world’s fresh water intake [2, p. 73]. Agriculture is the oldest way of people's interaction with nature to produce crops and breed animals through the transformation of natural resources to obtain certain benefits.

That is why food security assurance is a result of combined agricultural, political, and logistical efforts [3, p. 440]. Although the global production of food over the last fifty years was ahead of the demand, food security has not yet been achieved, especially on the planetary level. According to the UN data, agricultural production needs to be increased by 75% to provide sufficient amounts of food to the world's population by 2050. [4, p. 11].

The current population of Earth is over seven billion people, which presents a threat to agriculture's ability to fulfill the demand in food without putting at risk the sustainability of natural resources [5]. Moreover, the prevalence of urban residents over rural conditions a production structure that has a negative impact on the reproduction of agricultural workers and supports their mass transition from producers to consumers.

Structural deformations can be observed in the production of the main agricultural product types as well. In Russia, the structural deformations inherited from the shock reforms of the economy in the 1990es present a significant problem in assuring food security today.

Structural changes yield results only if they lead to the achievement of equal marginal utility by all economic agents, if they comply with advanced trends, and if they do not aggravate the qualitative and quantitative parameters of the related changes. Building up an efficient structure of agricultural producers requires structural changes that would help completely satisfy society's needs in food security and increase food independence and security levels.

Russia is the largest country in the world by land area, and it has a relatively low population density (8 ppl. / km²). Therefore, it has specific features and problems in food safety assurance that vary (often significantly) across regions. As a result, the structural changes in the agribusiness industry and their impact on food security, as well as the regional features, require more detailed research.

3. Problem statement
The purpose of this research is to study the dynamics of structural change indicators in production and food resources and identify structural problems in food security.

The study focuses on structural changes in the production of the main types of food and the resources used in it in Russia, Central Federal District (CFD), and Far Eastern Federal District (FEFD). The subject matter of this research covers the features of evaluating structural changes and their impact on food security.

In this research, the authors used generic economic methods (grouping, comparison); special structural indicators (weight, index, orientation, intensity, average annual structural change rate [6]); and the physical availability parameter of food (food adequacy coefficient).

The novelty of the research resides in using structural change assessment instruments to evaluate food security.

4. Theory
This research is based on the papers in food security problems [7; 8; 9; 10; 11; 12; 13; 14; 15], and structural change analysis studies [16; 17; 18; 19; 20; 21].

The conventional interpretation of food security states that it is one of the key elements of national security epitomized in the situation when all people have physical and economical access to sufficient and safe food necessary for an active and healthy life at any given time. Food security must be monitored at all stages: from food production to its exchange, distribution, and consumption.
The new Food Security Doctrine of the Russian Federation identifies three groups of indicators: the food independence of a territory; economic and physical accessibility of food; and product compliance with the requirements of the technical regulations law of the Eurasian Economic Union [22].

Food security is a state in which the stoppage of food supply from abroad does not lead to a food crisis [23]. In other words, food independence is primarily determined by the development level of agriculture and the capacity to produce sufficient amounts of agricultural outputs that would be of decent quality and sold at prices affordable to the majority of people.

Economic accessibility stands for the ability of various groups of people to purchase sufficient amounts of diverse food products at free-equilibrium prices and using state funds to pay for food supply to some specific consumer groups. The economic availability of food is determined by both the market offer and monetary means available and the possibility of producing food for household consumption through subsistence farming. The physical availability of food stands for the ceaseless supply of products from producers to final consumers.

The physical availability of food will be assessed using food adequacy coefficient \( \left( K_{\text{food group}} \right) \) according to the following formula:

\[
K_{\text{product group}} = \frac{Q_{\text{product group}}}{N \cdot R_{\text{product group standard}}},
\]

where \( Q_{\text{продуктовая группа}} \) is the food output in the region (in natural units); \( N \) is the population count in the region; and \( R_{\text{product group standard}} \) is the rational (recommended) food consumption value.

Critical value: \( K_{\text{product group}} \geq 1 \).

Structural indicators necessary for the research [24] include:

1. Structural change weight \( (M) \), i.e. the number of economic elements comprising this structural change (in natural or cost values). It is calculated as the difference between the quantitative parameter of the structural change during the current \( (P) \) and basic \( (P_0) \) periods.

2. The average structural change rate \( (V) \) over the period of \( (T) \):

\[
V = \left( \frac{P}{P_0} - 1 \right) \cdot 100,
\]

where \( P, P_0 \) are the same as in the structural change weight indicator.

3. The structural change index \( (I) \) describes the dynamics of the agricultural structure. It is a ration of structural change weight to the basic economic indicator for the period under analysis.

4. The structural change intensity over the period of \( (S') \) reflects the change rate of its weight over a time unit:

\[
S' = \sum_{i=1}^{n} |W'_i - W^0_i|,
\]

where \( W'_i \) and \( W^0_i \) are the specific weights of the structural indicator in the final and the initial years of the period under analysis respectively.

5. The structural change orientation as a measure of monotony is within the interval of \([-1; 1]\), and it is calculated using the following formula:

\[
M'_{\text{период}} = \frac{C'_\text{период}}{S'},
\]
where \( \Sigma_{t_{\text{period}}} \) is the sum of all components, for which differences \( (W_i - W_i^0) \) have the same indices; \( W_i \) and \( W_i^0 \) are the same as in formula (4).

5. Practical significance, proposals and implementation results, experiment results

In the practical section of the research, all of the calculations were carried out by the authors and they are relevant for Russia as a whole, and two of its macroregions (CFD and FEFD). The choice of these two regions is justified below. The Far East is the largest region of Russia in terms of land area occupying 36.1% of the country. At the same time, it is the least populated region only with 6% of the country's population living there. Central Federal District is a territory featuring the highest density of production businesses and population (it occupies 4% of Russia’s land area and is home to 27% of its population).

The author’s calculations showed that in 2018, the FEFD achieved the physical availability criterion in just one food group, the potato (1.348). The physical availability of meat, milk, and vegetables was below the average and amounted to 0.378, 0.332, and 0.321 (Table 1). Moreover, the physical availability of the main food types in the Far East reduced over 2014-2018, which is made evident by the negative deviation values of the food adequacy coefficient across all food types.

| Table 1. The dynamics of physical availability level for food (Russia / CFD / FEFD). |
|---------------------------------|--------|--------|--------|--------|----------|----------|
|                                 | 2014   | 2015   | 2016   | 2017   | 2018     | Average, 2014 to 2018 |
| Meat and meat products (in meat equivalent) | 0.880 / 1.232 / 1.002 / 0.958 / 0.389 / 0.570 / 0.382 / 0.387 |
| Milk and milk products (in milk equivalent) | 0.353 / 0.350 / 0.345 / 0.336 / 0.322 / 0.343 / 0.347 |
| Eggs and egg products, pcs | 0.921 / 0.945 / 0.980 / 1.016 / 0.968 / 1.221 / 1.245 / 1.273 / 1.298 / 1.323 |
| Potato | 2.011 / 2.290 / 1.951 / 1.919 / 1.830 / 1.640 / 1.600 / 1.580 / 1.530 / 1.497 |
| Vegetables | 0.440 / 0.456 / 0.462 / 0.436 / 0.447 / 0.448 / 0.439 / 0.436 / 0.434 / 0.431 |

A similar trend in the physical availability of food for residents is observed in the Central Federal District. However, the CFD regions feature higher import dependence in vegetables, milk, and dairy products than Russia as a whole. This means that to reduce the food dependence of macroregions on imports, it is necessary to increase the outputs of agricultural produce.

Figures for Russia as a whole signify that such products as potatoes, eggs, meat, and meat products are physically available to its population. According to the UN WHO data, the availability of vegetables, milk, and dairy products in Russia is below the recommended standards.

One shall further analyze the structural changes in the production of the key types of agricultural products across the main categories of agricultural land users: agricultural businesses (AB), owner-operated farms (OOF), and subsidiary holdings (Table 2).

The structural changes in agricultural businesses and owner-operated farms are positive for the country as a whole and the Central District. In other words, the import substitution program for these territories is efficient.
The agricultural businesses of the Far East of Russia saw negative structural changes in grain and vegetable production over 2014-2018. The weight of structural change amounted to a) (-73.41) thousand tons for grain crops; and b) (-26.71) thousand tons for vegetables. The subsidiary holdings featured negative structural changes across all of the food types analyzed; the average annual change rate over the period was (-9.05)%, (-6.93)%, (-3.24)%, (-3.12)%, and (-1.88)% for milk, grain, potato, vegetables, and meat respectively. Farm businesses and agricultural organizations saw a positive structural change in milk but these types of companies take up 12.55% and 16.6% of the regional milk production. Subsidiary holdings producing, on average, 71% of milk, reduced their milk output by 13.75% as compared to the 2014 values. In meat production, we must focus on the combination of two structural indicators: the change weight for subsidiary holdings (negative) and the proportion of this group of land users in the regional meat production (50.4%).

Table 2. The analysis of structural changes in the production of the main types of food across 2014-2018 (Russia / CFD / FEFD).

|                        | Grain crops | Potato | Vegetables | Meat from cattle and poultry | Milk |
|------------------------|-------------|--------|------------|------------------------------|------|
|                        | Structural change weight in thousands of tons (millions of tons for Russia as a whole) |          |            |                              |      |
| Agricultural businesses| -73.4 / 1,693.1 / 1.9 | -26.7 / 1031.9 / 1.8 | -1.3 / 253.6 / 0.5 | -106.5 / 401.5 / 1.9 | 0.8 / 716.4 / 1.9 |
| Owner-operated farms   | 0.3 / 739.1 / 6.2 | -14.6 / 46.7 / 0.5 | -36.5 / -253.6 / 0.6 | -106.5 / -401.5 / -1.9 | 1.1 / 88.0 / 0.6 |
| Subsidiary holdings    | -1.9 / 15.3 / -0.04 | -36.5 / -253.6 / -0.6 | -10.6 / -63.4 / -0.3 | -106.5 / -401.5 / -1.9 | -36.5 / -253.6 / -1.9 |
| Average annual structural change rate in % | 0.3 / 1.8 / 0.5 | 0.2 / 8.9 / 7.1 | 0.3 / 6.5 / 5.0 | 0.3 / 3.6 / 2.5 | 0.2 / 8.9 / 7.1 |
| Agricultural businesses| -1.8 / 1.6 / 2.5 | -5.8 / 8.9 / 7.1 | 0.2 / 6.5 / 5.0 | 0.3 / 3.6 / 2.5 | 0.2 / 6.5 / 5.0 |
| Owner-operated farms   | 0.03 / 2.8 / 3.8 | 1.3 / 7.5 / 4.2 | 1.3 / 5.7 / 4.0 | 4.6 / 6.2 / 5.8 | 4.6 / 6.2 / 5.8 |
| Subsidiary holdings    | -9.1 / -1.3 / -3.4 | -1.9 / -6.9 / -3.2 | -1.9 / -6.9 / -3.2 | -9.1 / -22.1 / 12.8 | -1.9 / -6.9 / -3.2 |
| Structural change index in % | 1.3 / 8.8 / 2.4 | -13.9 / -20.8 / 40.9 | -25.9 / -53.2 / 27.8 | 13.1 / 19.3 / 13.1 | 1.3 / 8.8 / 2.4 |
| Agricultural businesses| -0.2 / 15.1 / 23.5 | -17.9 / 43.7 / 22.7 | 6.8 / 31.7 / 21.8 | 25.3 / 35.0 / 32.8 | 25.3 / 35.0 / 32.8 |
| Owner-operated farms   | -9.1 / -30.2 / -4.3 | -14.6 / -16.0 / -7.6 | -9.1 / -22.1 / -12.8 | -13.8 / -28.9 / -32.8 | -13.8 / -28.9 / -32.8 |
| Subsidiary holdings    | -15.2 / -20.1 / -4.3 | -14.6 / -16.0 / -7.6 | -9.1 / -22.1 / -12.8 | -13.8 / -28.9 / -32.8 | -13.8 / -28.9 / -32.8 |
Such a combination of structural parameters also signifies that it is desirable to strengthen the regional structural policy in animal farming.

The analysis of structural changes in agricultural production across producer groups shall be complemented with the analysis of structural changes in the resource structure for the main types of food (Table 3).

At the national level, the structural changes in food resource inventory are characterized by negative orientation, which signifies that the stock of food was more depleted in 2014-2018 than before the crisis. The rates of food store depletion in the country are quite high, and it amounted to 9.3% for the period under analysis.

**Table 3.** Calculating intensity and orientation parameters for structural changes in food resources (Russia / CFD / FEFD).

| Food group                | The specific weight of the resource type in % | $d_{2014}$ | $d_{2018}$ | $d_{2018} - d_{2014}$ |
|---------------------------|-----------------------------------------------|------------|------------|----------------------|
|                           | Resource stocks at the beginning of the year  |            |            |                      |
| Potato                    | 40.10 / 39.65 / 34.66                         | 41.59 / 44.96 / 42.55 | 1.49 / 5.31 / 7.89 |
| Vegetables                | 28.38 / 28.48 / 20.45                         | 28.78 / 22.34 / 22.67 | 0.40 / -6.14 / 2.22 |
| Fruit                     | 21.03 / 27.13 / 11.85                         | 14.69 / 13.31 / 20.02 | -6.34 / -13.82 / 8.17 |
| Meat and meat products    | 7.34 / 3.05 / 9.66                            | 6.97 / 2.35 / 9.40   | -0.37 / -0.70 / -0.26 |
| Milk and milk products    | 4.81 / 3.73 / 2.33                            | 4.23 / 2.94 / 2.89   | -0.58 / -0.79 / 0.56 |
| Eggs and egg products     | 2.59 / 1.71 / 5.26                            | 2.71 / 1.63 / 3.29   | 0.12 / -0.08 / 1.97  |
| Structural change intensity in % |                     | 9.3 / 26.84 / 21.08       |
| Structural change orientation |                                      | 0.57 / -0.60 / 0.79    |
|                           | Resource production                           |            |            |                      |
| Potato                    | 57.37 / 51.09 / 58.62                         | 55.31 / 43.38 / 8.08 | -2.06 / -2.71 / -10.54 |
| Vegetables                | 59.40 / 34.04 / 45.51                         | 61.46 / 33.84 / 30.88 | 2.06 / -0.20 / -14.63 |
| Fruit                     | 26.37 / 15.26 / 7.34                         | 31.73 / 15.16 / 6.61 | 5.37 / -0.10 / -0.74 |
| Meat and meat products    | 76.18 / 44.36 / 22.25                         | 85.92 / 47.56 / 28.49 | 9.74 / 3.20 / 6.24   |
| Milk and milk products    | 72.92 / 37.98 / 38.67                         | 79.01 / 40.47 / 50.43 | 6.09 / 2.49 / 11.77  |
| Eggs                      | 94.59 / 54.91 / 72.70                         | 94.64 / 54.18 / 58.38 | 0.05 / -0.73 / -14.32 |
| Structural change intensity in % |                     | 25.37 / 9.43 / 58.24       |
| Structural change orientation |                                      | 0.84 / 0.10 / -0.38     |
|                           | Resource import including international       |            |            |                      |
| Potato                    | 2.53 / 9.26 / 6.73                            | 3.11 / 10.41 / 9.37 | 0.58 / 1.15 / 2.65  |
| Vegetables                | 12.22 / 37.48 / 34.05                         | 9.76 / 43.82 / 46.46 | -2.46 / 6.34 / 12.41 |
| Fruit                     | 52.60 / 57.60 / 80.81                         | 53.58 / 71.53 / 73.37 | 0.98 / 13.93 / -7.44 |
| Meat and meat products    | 16.48 / 52.59 / 68.08                         | 7.11 / 49.88 / 62.11 | -9.30 / -2.71 / -5.98 |
| Milk and milk products    | 22.26 / 58.29 / 56.07                         | 16.76 / 56.58 / 46.68 | -5.50 / -1.71 / -9.39 |
| Eggs                      | 2.81 / 43.38 / 24.97                         | 2.65 / 44.19 / 38.326 | -0.16 / 0.81 / 13.35 |
| Structural change intensity in % |                     | 19.05 / 26.65 / 51.22       |
| Structural change orientation |                                      | -0.84 / 0.67 / 0.11      |
In the Far East, the intensity of structural changes in food stores was 21.083% with a positive orientation of 0.79. The Central Federal District features a structural change intensity of 26.84% with a negative change orientation (-0.6) caused by a significant reduction of vegetable and fruit stocks.

In resource production, the negative orientation of all product groups in the FEFD is combined with the high intensity (58.24%), thus indicating unsatisfactory structural changes in regional food production. Central Federal District, on the contrary, features a positive orientation (0.1), along with the structural change intensity of 9.43%, which indicates weak but positive changes in the structure of agricultural production in the CFD.

The intensity of the aggregated structural change of food imports (including international) in the Far East of Russia amounted to 51.22% in the period, and its orientation is positive (0.11). However, the increase of import share in the assurance of food availability in the region does not comply with the goals and objectives of the country’s economic policy, while the positive orientation indicates regressive structural changes in food imports in the FEFD, rather than positive ones. The intensity of the aggregated structural change in food imports in the Central Federal District, including the international imports, amounted to 26.65% with a positive orientation of changes (0.67). In other words, the import volumes of meat and meat products, milk and milk products, and eggs in the regions of this district are not decreasing. The low rate of structural changes in agricultural production prevents the complete fulfillment of the territory’s growing need for food.

Thus, to reduce the food dependence of the region on imports, it is necessary to increase the volumes of agricultural outputs in the Far East, including shifting agricultural policy priorities towards the active support of producers.

6. Conclusion

Having analyzed the impact of structural changes in agriculture on the food security of the Far East of Russia during the sanction and counter-sanctions period (2014-2018), the authors must note the following:

Trends to increase imports have formed in many food groups. It means one may carefully claim that import dependence in food has been overcome in the country in general, as well as in the Far East of Russia and the Non-Blacksoil Region. The regressive nature of structural changes in the Far East is more prominent than for the country as a whole and the Non-Blacksoil Region. The orientational changes in food stocks, production, and imports for the CFD were the same as for Russia as a whole (except the positive changes in the specific weight of meat and meat products in these structures that are different from the all-Russian values). The level of self-sufficiency for the main types of food in the Far Eastern Federal District is below the criteria of food security and it has no real opportunities for growth in terms of its structural components. The Central Federal District, on the contrary, saw the increase in the self-sufficiency level for the main agricultural products in 2018 as compared to 2014. It exceeded the all-Russian figure and the 100% criterion value for meat, meat products, and potatoes.

The physical availability of food for the residents of the Far East in the period under analysis was reduced for all of the main food types. The aggregate structural change in food imports is negative and does not comply with the country’s and region’s goals in terms of food imports and self-sufficiency.

The insufficient rate of developing positive structural changes in animal farming in the Far East requires a more active import substitution policy in terms of stimulating various agricultural production businesses, especially those involved in animal farming.

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