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**THE STATISTICAL ASSESSMENT OF THE DEVELOPMENT OF  
BAKERY PRODUCTION IN RUSSIA**

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**Abstract**

According to expert estimates, the volume of the global bread market amounted to USD 203.8 billion in 2018 and may increase by 3.2% by 2025. Manufacturers of bakery products must constantly study consumer needs in order not to lose their respective market. In Russia, there is a decrease in the volume of production of grain products by large bakery enterprises, but at the same time, the indicator of bread consumption per capita is kept at the level of 116-118 kg per year. The satisfaction of the population's demand for bread products is ensured by the growth of production in small business, the share of revenue of which on the market amounted to 25% in 2018. The authors of the article performed a statistical analysis of the economic factors that determined the dynamics of the production of bakery products in the corporate sector in 2008-2018. Research methods used are statistical methods of time series analysis and the method of classical regression. The source of information for the analysis is Rosstat. The calculations showed that the most significant economic factor that determined the dynamics of bread production were the rates of per capita consumption of bakery products, prices for flour, the gross harvest of wheat, and the degree of depreciation of fixed assets at bakery enterprises. Based on the results of the study, the authors formulated conclusions and proposals for the development of bakery production in Russia.

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## 1. Introduction

Bread is a traditional food product for the population, and bakery production and related industries provide the working-age population with jobs. The food security of the country and supply of all population groups with the available product depends on the bakery industry operates (Markhayeva, 2016). Bread products will remain in demand in the future in the conditions of a busy lifestyle. According to the experts from Grand View Research, the volume of the global bakery market in 2018 was estimated to be 203.8 billion US dollars, and that in the 2019-2025 period, the size of the market will grow by 3.2%, mainly due to products which are "convenient" for fast food format, as well as "functional" products (Grand View Research, 2020). But the influence on the structure of product supply on the market of individual consumer preferences associated with food traditions, the standard of living of the population, consumer awareness, and the activity of producers will remain.

Analysis of the conditions for the development of bakery production is of great scientific and practical interest, both in Russia and abroad. The scientists consider the problems of the industry in combination with agricultural production, technological innovations, and market factors. The bread as a commodity differs from others in that the personal taste preferences of consumers have a large impact on demand. Today, it is difficult to achieve efficiency in bread production simply by adjusting prices or focusing on the local market. Therefore, bread producers need to track trends in demand for bakery products and "adjust" their technological processes to suit them. While the former triggers losses from elevated operating costs, the latter leads to loss of revenue and unsatisfied customers and compromises future demand rates (Contreras-Chocata et al., 2020). A new trend in European countries and in the USA is a growing interest in organic products, the implementation of ideas to reduce environmental impact. Currently, the food industry is characterized by increasing demand and establishing procedures to guarantee food safety (Huallpa et al., 2020). At the same time, the most economically profitable and environmentally friendly is the cultivation of wheat-based on organic farming, including for the purposes of baking. This indicates the need to build a field-to-consumer chain. Indeed, bread and its derivatives represent basic food products and a short supply chain, with only one intermediate step between the producer of the raw material (flour) and the consumer, represents the bakery industry (Torelli & Balluchi, 2020). Russian scientists also confirm the fact that there is a growth trend concerning the demand for "non-standard" products that meet the criteria for healthy eating. But they also highlight the problem of imperfect state regulation of the development of the industry in Russia (Bogomolova et al., 2017). Thus, the management of bakery production is based on a systematic analysis of various factors (demographic, economic, institutional, etc.) that determine the development trends in the industry.

## 2. Problem Statement

In our study, we focused our attention on the macroeconomic level of management of bakery production in Russia. In recent years, Russia has recorded a decline in the production in the industrial segment (on large enterprises) (Table 1). The decline in the production of bakery products is reliably described by the parabolic trend equation ( $y(t) = 7320.2 + 19.66t - 13.746t^2$ ). Judging by the parameters of the trend equation, the production in average decline over the period was 13.7 thousand tons per year, and

the production reduction processes are accelerating. According to Rosstat (2020) data, almost 5.8 million tons of bread products were produced in 2018, which is only 77% of the 2008 production volume. This is mainly due to the deterioration of the demographic structure, the transition to a significant increase in bread baking by mini-bakeries and by the population on their own, as well as the reorientation of consumer preferences from traditional bread varieties to more expensive ones due to the spread of the "healthy eating" culture. The trend sees a general decrease in the consumption of bakery products in recent years, while the interest in premium products is growing. Small businesses react more quickly to changes in demand and therefore this allows them to obtain advantages in the market over large enterprises (Bogomolova et al., 2017).

**Table 1.** Dynamics of production and consumption of bakery products on average per capita in Russia, kg per year

	2008	2010	2015	2016	2017	2018	2018 to 2008, %
Production volume of bakery products by large and medium-sized producers, thousand tons	7486	7255	6833	6686	5935	5778	77,2
Production of bread products by large and medium-sized producers per capita, kg per year	52.5	50.8	45.6	40.4	39.3	43.4	82.7
Consumption of bread products per capita kg per year	119	120	118	117	117	116	97.5

Source: authors based on (Rosstat, 2020).

According to Rosstat (2020), the Russian bread market consists mainly of products of national producers (99.8%). The share of imports in the Russian bakery market has ranged from 0.06% to 0.17%. In absolute terms, the volume of imports over five years (2014-2018) decreased by 35.8%, exports, on the contrary, increased by 22.7%. One of the features of the bakery industry in Russia is the concentration of production in large enterprises. However, there is an active change in the structure of production of bakery products by category of products. More than 94% of bakery entities belong to the category of "micro", "small" and "medium" businesses, but large enterprises produce 55% of all the products. For comparison: the share of industrial production of bakery products in Western Europe is typically at 60-62%. Conflicting information on the production and consumption of bread by producers is largely due to the "gaps" in the national government statistics. The current official statistics of Russia do not fully reflect the structure of the domestic market in the context of large, medium, and micro-producers of bakery products. Comparison of government statistics data on production at large enterprises and on average per capita consumption indicates an obvious decrease in the contribution of large producers to providing the Russian population with bread (Table 1).

The data presented in Table 1, shows that large producers provided about 44% of the domestic per capita consumption of bakery products in 2008, while the indicator was only 33% by 2018. Hence, it can be assumed that the rest of the demand is met by mini-bakeries, individual producers, and the self-employed. However, according to Rosstat, individual entrepreneurs produced 606 thousand tons of

nondurable bakery products in 2018, which is only 10% of the volume produced by large and medium-sized enterprises. There is no more detailed information to date. The problem of the lack of objective statistical information was also pointed out by Russian experts. They emphasize that the official statistics do not reflect how much bread is baked in large retail chains, restaurants, etc., and today this is a significant contribution to the indicators of satisfying the demand of consumers of bakery products (Bogomolova et al., 2017).

In the regions of the country, the production of bakery products differs significantly, which is associated, above all else, with the indicators of population density, traditions of bread consumption. In particular, the maximum volume of bread production falls on the Central Federal District (26.8%), in which 27.1% of the population of Russia lives; the Volga Federal District is in the second place (20.% of the total volume of bakery products produced, with 20.5% of the country's population living there), and the smallest volume of bakery production took place in the Far Eastern Federal District (5.6%), which is home for 5% of Russia's population. Annual fluctuations in the production of bakery products do not exceed 1-2%, and the market capacity is steadily growing by 2-4%. Traditional breads with a simple, inexpensive recipe are the most common. The volume of producing therapeutic, prophylactic, and functional varieties of bread products is about 100 thousand tons with a demand of 600-700 thousand tons (Bogomolova et al., 2017). Consequently, Russia has great potential for the development of production of functional and specialized bakery products, as well as products made according to unique recipes. However, a fundamental renewal of a recipe inevitably requires the renewal and modernization of production equipment. As the data of Russian state statistics show, the wear rates of machinery and equipment in large organizations tend to grow, and we can see that such rates amounted to 50% in 2018, while in 2008 they were only 40,3% (Rosstat, 2020).

The activity of large bakery enterprises is characterized by low profitability: in recent years, it has tended to decline, despite the rise in retail bread prices. If in the 1990s, the profitability of the production of bakery products was 12-14%, the average profitability in 2014-2018 in Russia does not exceed 3%. All the facts above lead us to the conclusion about the importance of a quantitative assessment of the influence of economic factors on the dynamics of the production of bakery products in the industrial segment of the bakery industry in Russia. The factors that most influence the entire production and distribution process specific to the bakery industry must be found in a mathematical algorithm (Pop et al., 2019).

### **3. Research Questions**

Earlier, we listed the main problems of bakery production in Russia. This allows us to form a system of factor indicators. The effective indicator  $y$  is the volume of production of bakery products in large organizations, in thousand tons. We selected the following indicators-factors from the data set provided by Rosstat and introduced the following designations:  $x_1$  - consumption of bakery products per capita per year, kg/person;  $x_2$  - average consumer prices for bakery products made from premium flour, rubles/kg;  $x_3$  - indices of average consumer prices for bakery products made of premium flour in % to the previous year;  $x_4$  - average consumer prices for premium wheat flour, rubles/kg;  $x_5$  - indices of average consumer prices for wheat flour of the highest grade in % to the previous year;  $x_6$  - the gross harvest of wheat (winter and spring), thousand tons;  $x_7$  - the level of use of the average annual production capacity of organizations for

the production of bakery products,%;  $x_8$  - coefficient of depreciation of fixed assets of bakery enterprises,%;  $x_9$ - the level of profitability of the production of bakery products,%.

Indicators  $x_1 - x_3$  reflect the state of the market situation (demand for bakery products, prices for final products, and their dynamics). Indicators  $x_4-x_6$  reflect the impact of economic ties between producers of raw materials and final products. Indicators  $x_7-x_9$  characterize the state of the means of production and the economic efficiency of production in the industry. At the first stage of statistical analysis, the pairwise correlation coefficients were calculated for the selection of factors in the regression model. We did not use statistically insignificant factors in further analysis (that is, those indicators for which the values of the correlation coefficients are below the critical values with 11 observations and the probability of calculations is 95%). The critical value of the correlation coefficient is 0.553.

Correlation analysis showed that in the period from 2008 to 2018, the dynamics of the volume of production of bakery products in large enterprises at the macroeconomic level was determined by the average per capita consumption of bakery products ( $x_1$ ), prices for bakery products ( $x_2$ ), prices of flour ( $x_4$ ), the gross harvest of wheat ( $x_6$ ), the degree of depreciation of fixed assets at bakery enterprises ( $x_8$ ). At the same time, the connection with the factor  $x_1$  is direct (which is obvious: the decrease in demand led to a decrease in production volumes), and with the rest of the listed factors, the relationship is inverse. The high level of prices for final products and for flour are constraining factors for bakery producers. Along with this, the high wear rate of equipment (factor  $x_8$ ), which did not decrease during 2008-2018, also contributed to the reduction in the production of bakery products. Note that the relationship with the factors  $x_2$ ,  $x_4$ , and  $x_8$  is the closest, that is, these are the most significant factors in the dynamics of the volume of production of bakery products in Russia.

The values of the paired correlation coefficients make it possible to analyze the relationship between factorial signs, considering one of them as consequence, and the second one as a cause. In particular, the dynamics of the level of profitability of bakery production ( $x_9$ ) at the macroeconomic level in the period from 2008 to 2018, none of the indicators presented had a statistically significant effect. At the final stage of the regression analysis, while taking into account the established statistically significant relationships, and after excluding statistically insignificant variables from the regression model, we obtained the following equation:

$$\tilde{y} = 14904.49 - 182.7x_8 \quad (R^2 = 0.78) \quad (1)$$

(-5.992)\*

Note: \*observed value of Student's t-test for the regression coefficient.

After excluding the statistically insignificant factors from the model, a paired linear regression model (1) was calculated for the Russian Federation. The technical condition of the fixed assets of organizations ( $x_8$ ) is one of the most significant factors in the volume of production of bakery products in large organizations at the macroeconomic level. 78% of the variation in the effective indicator is due to the variation in the depreciation rate of fixed assets of bakery enterprises (the coefficient of determination ( $R^2$ ) is 0.78).

#### **4. Purpose of the Study**

The goal of the study is to find economic factors that determined the change in the volume of production of bakery products in Russia in the period from 2008 to 2018. Significant changes began to take place in the structure of bread production after 2008. The market share of the large producers began to decline. To achieve the goal, the authors performed the following tasks. First, the authors substantiated the system of factor indicators associated with the indicator of the volume of production of bakery products. They then identified the factors most closely related to the performance indicator using correlation coefficients. At the next step, the parameters of the regression equation were substantiated. At the last stage, the authors drew conclusions and developed proposals for the development of bakery production in Russia.

#### **5. Research Methods**

In the study, the authors applied the methods of analysis of dynamics and structure. The parabolic model of the trend of the "bread production" indicator was obtained by the method of analytical alignment of the time series. The structure of bread production by regions of Russia is presented. To measure interrelated indicators, the authors used correlation coefficients. The authors also performed a regression analysis. Calculations were performed by using the "Statistica" software. Official publications of Rosstat are a source of information for the statistical analysis.

#### **6. Findings**

The information available in the state statistics of Russia allowed us to select 8 factor indicators, information on which was known for each year of the period under review. In the period from 2008 to 2018, 5 statistically significant factors ( $x_1$ ,  $x_2$ ,  $x_4$ ,  $x_6$ ,  $x_8$ ) that determine the change in the volume of production of bakery products, were identified. However, when constructing a regression model, when the requirements for estimates of the connection indicators are more stringent, the number of statistically significant factors decreased. At the macroeconomic level, only one factor can be considered as the one that determines the dynamics of the volume of production of bakery products ( $x_8$ ).

The conducted statistical analysis confirmed the need to develop integration between producers of bakery products and producers and processors of grain. It is the large bakery enterprises with agricultural enterprises and flour mills at their command that can build effective chains "from field to counter". This can reduce material costs within such a system. Due to large volumes of products, large enterprises can reduce risks associated with the start of production of non-traditional bread varieties. Some Russian economists are developing similar economic models of cooperation in the grain product cluster (or agro-industrial cluster). For example, the use of a mezzanine financing mechanism within the cluster will optimize internal relations and protect against external threats associated with the problem of dependence on imports of certain types of raw materials, equipment, etc. (Bondarenko et al., 2016). Farmers that produce small quantities of grains are also interested in cooperating with bread producers. Russian farmers can apply Western European experience in building networks between farmers themselves and large agricultural enterprises, as well as grain processors that produce flour, cereals, and bread (Golovina et al., 2019). It should be added that the Russian Government is also interested in the development of national

bakery production. This fact is confirmed by the state programs adopted by the Government of the Russian Federation. According to the Government's plans, the share of citizens who have access to domestic food products that contribute to the possibility of eliminating the deficit of micro nutrients and macro nutrients, will increase to 50% by 2023 and up 60% by 2025. In order to fully achieve the planned indicators, it is necessary to modernize the equipment at bakery enterprises and to assist in the development of economic ties between producers of raw materials and those that produce final products.

## 7. Conclusion

The authors of the article analyzed the indicators of the production of bakery products in Russia over the 11 years (from 2008 to 2018), basing their analysis on the data of Rosstat. The rates of production of bakery products in large organizations are declining, albeit it is increasing in small businesses. At the same time, the available Rosstat database does not take into account many phenomena in the bakery market (for example, the volume of production of bakery products performed by restaurants or by the population itself, etc.), and analytical agencies are, to a greater extent, guided by expert assessments, which do not cover the entire set of bakery manufacturers. Nevertheless, the statistical analysis made it possible to identify 5 most significant factors that had influenced the change in the volume of production of bakery products by large enterprises (average per capita consumption of bakery products (x1), prices for bakery products (x2), prices for flour (x4), the gross yield of wheat (x6), the degree of depreciation of fixed assets at bakery enterprises (x8). At the same time, the factor x8 had the greatest influence on the dynamics of the effective indicator. According to the authors of the article, bakery enterprises in Russia can increase their effectiveness by developing ties within the cluster of the market, which includes the producers of grain, flour, and bread. This is likely to increase the production of therapeutic and prophylactic and functional products that are healthy food.

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