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Economic and Mathematical Modelling of Food Exports' Turnover in Russia on a Mid-Term Horizon

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Abstract:

On the basis of economic and mathematical modeling, the author suggests a forecast for the values of Russia's food exports until 2020, which empirically proves the growth of export amounts and could be characterized by the good quality of multiple regression econometric models.

Keywords: *Forecasting of macroeconomic phenomena, food exports, economic and mathematical modelling, econometric models.*

JEL Classification Codes: *F17, F14, F47.*

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1. Introduction

Economic-mathematical modeling, methods and models of macroeconomic calculations are the tools of forecasting and analytical estimations that are successfully applied in the practice of state and regional management, as well as in the modeling of results of the impact of political decisions within the framework of integration associations (EU, EEU).

The commonly applied management methods in *agrarian sector* include a number of economic and mathematical approaches and econometric models including the ones forming the structure of production and distribution of resources.

Objectives of modeling the market structure at the *national level of management* come to consideration of problems and variation approaches to trade policy that affect macroeconomic indicators like fiscal position, economic climate for consumers and producers (Fock *et al*., 2000).

Complication of market economy phenomena stimulates economists to apply dynamic economic and mathematical models. Based on the study of the "supply-demand" ratio for agricultural products, we suggest a simulation model that estimates forecast scenarios of the domestic agricultural market on the basis of changes in parameters within specified intervals that can be both market variations and targets for its regulation, promoting a multi-scenario for the market situation development forecasting (Fetyukhina, 2011).

The formation of a *supranational level of management* within the Customs Union and the EEU was reflected in numerous studies devoted to the problems of modeling the development of agricultural sector and the verification of integrative agricultural policy.

Modeling of agricultural policy's scenario forecasts and international trade activity of the three largest countries of the EEU (Belarus, Kazakhstan and Russia) provided the methodology for improving the subsidization of agricultural producers. This problem is in focus of political discussion of Eurasian integration, reflecting different approaches of governments to the objective of state support for operators of foreign trade in agricultural products (Svetlov, 2016).

The efficiency of integration processes within the framework of the Customs Union is presented in studies on the example of combining agrarian markets' task. Siptits (2010) presented a four-criteria system of dynamic models and a methodology for assessing the effectiveness of integrated markets, developed for the food market within the Russian Federation: a reduction in retail prices for products obtained as a result of processing for the end user; increase in producers' income; increase in investments in the industry-producer; increase in budget revenues.

Numerous studies on modeling the Russian grain market are presented in the economic literature. The strategies of the grain market participants are formulated on the basis of the simulation experiment. It is stated that creating proper conditions is important for the technologies of cultivating grain crops, as well as creating the market infrastructure and conditions for attracting investments in agricultural sector of economy (Svetlova, 2012).

2. Export potential of the grain sub-industry in the context of Russia's membership in the WTO

Russia's accession to the WTO seems to be a significant event for the formation of a system of national interests of industries and large production facilities. Medvedev (2012) aimed the Russia's Government at the policy of attention and support of the domestic producers: "*The challenge is to make the most of the benefits of joining the WTO and minimize the risks for industries that are most sensitive to processes .... We are joining the WTO in order to use wisely our competitive advantages on external and domestic markets... We must do our best to support our producers*".

As an established export-oriented sub-industry of domestic agriculture, we should consider grain production and export, broadly integrating the production and export of grain crops, and in a narrow sense - the production and export of dominant exports of goods i.e. wheat and meslin, according to the FEACN of the CU[2].

Sectoral analysis of the dynamics of the foreign trade balance of Russia's main food products in physical terms for 2000-2017 has revealed the explicit leading groups of food products for domestic exports: wheat and meslin, barley, sunflower oil, flour. The export has been the most important factor in the development of the grain market in recent years. At the same time, exporters face a number of infrastructural restrictions. For example, the lack of transshipment facilities in the Far East severely restricts access to the Asia-Pacific markets. Moreover, they face the strengthening of administrative and technical barriers not only in importing countries, but also from national supervisory authorities, a high level of transaction costs resulting from the underdevelopment of competitive environment in the field of exporting companies' services.

The concept of Russian grain market development for the medium term (CRGMD, 2017) presented by Russian Grain Union experts, highlights the following factors restricting the growth of grain production:

- the increasing lag in the growth of traditional consumption patterns from the growth of grain production;
- disproportion of directions and mechanisms of budgetary support and the technological breakthrough objectives;

[2]*FEACN of the CU is a commodity nomenclature of Customs Union's foreign economic activity. It was introduced on January 1, 2012 "Wheat and meslin" identified as group 1001.*

- poor dynamics of innovative development including the introduction of biotechnology achievements, the Internet of Things and the development of new technologies adapted to the conditions of global climate change;
- lack of long-term programs to stimulate the marketing and consumption of grain and grain products;
- infrastructural restrictions including the deficit and territorial infrastructure of facilities' allocation for grain storage and mixed fodders production, high costs for rail transportation;
- persisting administrative and technical barriers.

Studies indicate that the regional infrastructure of foreign trade is a "bottleneck" for realizing the potential of Russia as the world's leading grain exporter. The shortage of grain storage facilities, transportation equipment, ship loading facilities, the customs procedures' time and inconsistencies in state export control lead to unjustified time and resource expenditures of exporters, monopolization of the market through ousting producers from the market.

3. Forecasting the food exports of Russia in the mid-term horizons

The problem of assessing the basic trends, dynamics and investment attractiveness of foreign economic operations in the food sector is connected with macro- and micro-forecasting and process management on the basis of patterns. The modern forecasting tool provides not only identification of trends and development of appropriate strategies for a narrow segment or certain food product, but also assesses possible changes and the results of established patterns.

Statement of the research problem. Macroeconomic phenomena forecasting on a time series data is usually conducted through the methods of economic and mathematical modeling. The mid-term forecast of exports' amounts of the group "food products and agricultural raw materials for production"[3] in Russia will be carried out on the basis of regression analysis providing, on the one hand, the resolution of the time series data design and its forecasting problem. On the other hand, it acts as an adequate and justified tool.

Factor attributes of regression model's design include a regressand and a number of regressors. For the developed model, "the export of food products and agricultural raw materials in the Russian Federation, $ million." is assigned to regressand *Y*. Relying on the production function's methodological approach that provides for the dependence of exports on the factors of production (the relationship between the explanatory and explaining variables) and is subjected to the one of known functions. The latter is assigned to the most common Cobb-Douglas function:

[3]*According to FEACN of EEU, sections 1-4, groups 1-24.*

$$Y = \beta_0 X_1^{\beta_1} ... X_k^{\beta_k} u, \quad (1)$$

where $X_1,...,X_k$ – factors, β_j – unknown parameters, j=1, …, k, u – random error value.

As regressors (explanatory variables) X_1, X_2, ... X_9, indicators characterizing the state of the agro-industrial sphere of the national economy were chosen as follows:

X_1 –fixed assets' investments in agriculture, billion rubles;
X_2 – sown areas of agricultural crops, thousand hectares;
X_3 – agricultural production output, billion rubles;
X_4 – yield of cereals and leguminous crops, centners per hectare;
X_5 – average annual number of employed in agriculture, thousand people;
X_6 – production of livestock products (cattle and poultry for slaughter), thousand tons;
X_7 – livestock of animals (cattle), thousand units;
X_8 – livestock of animals (pigs), thousand units;
X_9 – gross harvest of cereals and leguminous crops, thousand tons.

The sample scope corresponds to the period from 2000 to 2017. The data were obtained from official statistics' compilation "Agriculture, hunting, forestry in Russia", "Russian Statistical Yearbook", operational bulletins of Rosstat and information presented on the official website of the Federal State Statistics Service (GKS, 2018). Exports information is available in the database of the Federal Customs Service (FCS, 2018).

We proceed from the model (1) to its linear analog by taking the logarithm of both sides of equation (1). Inclusion of the full set of explanatory variables in our case is not correct, since it will lead to a significant decrease in the degrees of freedom of the model (the aggregate contains only 18 observations). We use the method of incremental inclusion / exclusion of variables with a 10% significance level. As a result, we obtain a regression equation with the wave variables as logarithms of the original variables (values of coefficients' standard errors are in parentheses here and below):

$$\tilde{Y} = \underset{(18,53)}{66,37} - \underset{(2,97)}{6,25}\tilde{X}_2 + \underset{(1,56)}{3,37}\tilde{X}_5 - \underset{(1,54)}{5,87}\tilde{X}_7 + \underset{(0,84)}{3,24}\tilde{X}_8 + \underset{(0,37)}{0,73}\tilde{X}_9, \; R^2_{corr} = 0,95, \quad (2)$$

where X_2 – sown areas of agricultural crops, X_5 – average annual number of employed in agriculture, X_7 – livestock of animals (cattle), X_8 – livestock of animals (pigs), X_9 – gross harvest of cereals and leguminous crops.

In equation (2), factors X_7, X_8 are significant at 1% level, other factors are significant at 10% level. The residuals of the model have zero assembly average, are linearly

independent and normally distributed at 1% significance level (Kolmogorov-Smirnov statistics $D = 0.21$). The average value of VIF specifying multicollinearity does not exceed 10, indicating the absence of multicollineariny of variables. Notable that model (2) has the least value of information criterion (Akaike-Schwartz). Therefore, it eminently explains the variation of the regressand.

The coefficients of model (2) could be interpreted as the factorial expression of exports' elasticity. Thus, an increase in acreage by 1% of its average value leads to a decrease in exports of food products by 6.25% of its average. Negative elasticity is a consequence of the non-linear decrease in the crop area for the review period along with a significant increase in food exports. An increase by 1% of the average number of employed in agriculture leads to an increase in exports by 3.37%. The increase in the number of cattle by 1% reduces exports by 5.87%, the increase by 1% in the number of pigs leads to an increase in exports by 3.24%. Finally, an increase in the gross harvest of grain and leguminous crops by 1% leads to an increase in exports by 0.73%.

When modeling time series, we should consider that their levels are essentially time-dependent, that is, the time series of the source data are often nonstationary. If the regression of nonstationary series of the resulting indicator is based on explanatory variable, a case of so-called false regression is possible if the resulting series of residuals is also nonstationary. In this situation, the values of the coefficient of regression determination are high, and the Durbin-Watson statistics is low. Testing the residuals of regression (2) for stationarity (unit root) using the Dickey-Fuller statistics revealed that the time series of the residues is stationary. This implies that the time series of the export of food products, the acreage of agricultural crops, the average annual number of employed in agriculture, the livestock of cattle and pigs, the gross harvest of cereals and leguminous crops are cointegrated. In other words, they are in a long-term dynamic equilibrium, as their trends and random fluctuations coincide. In fact, the coefficients of the model (2) involve a cointegrating vector.

We use model (2) for forecasting future exports' amounts. We construct trend models for each of the factors in the form of polynomials of degree no higher than the third:

$$\underset{(5013,01)}{X_2} = \underset{(5013,01)}{107955,2} - \underset{(1311,71)}{6015,29}t + \underset{(104,09)}{350,16}t^2 - \underset{(2,55)}{6,06}t^3, \tag{3}$$

$$\underset{(173,67)}{X_5} = \underset{(173,67)}{9440,46} - \underset{(12,01)}{188,63}t, \tag{4}$$

$$\underset{(2449,39)}{X_7} = \underset{(2449,39)}{39266,28} - \underset{(640,9)}{2792,18}t + \underset{(50,86)}{137,86}t^2 - \underset{(1,24)}{2,44}t^3, \tag{5}$$

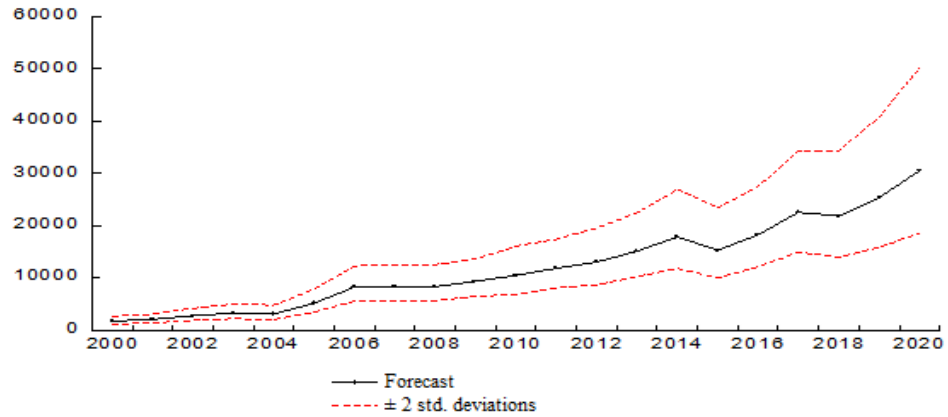
$$\underset{(1501,39)}{X_8} = \underset{(1501,39)}{19823,41} - \underset{(243,23)}{919,74}t + \underset{(8,88)}{49,08}t^2, \tag{6}$$

$$\underset{(9833,28)}{X_9} = \underset{(9833,28)}{54942,73} + \underset{(679,91)}{2552,39}t, \tag{7}$$

all coefficients are significant at the 5% level.

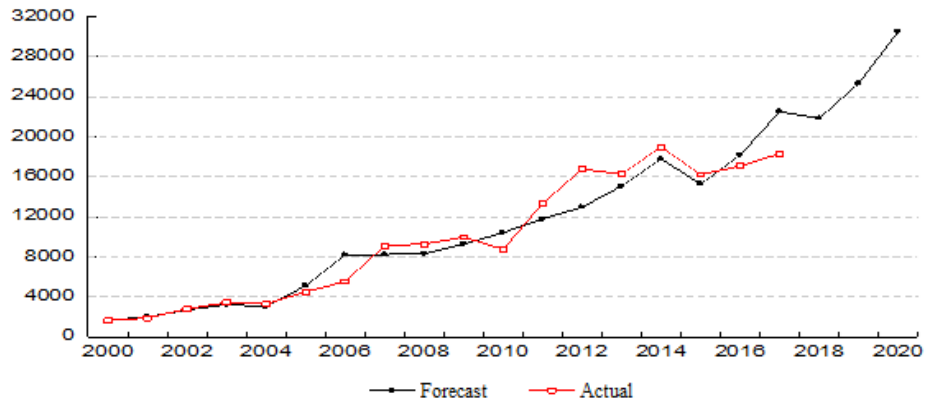
Then, according to (3) - (7), the 3-year forecasting (2018-2020) of the factors was carried out. Figure 1 presents a retrospective (according to available data and models (2)) and export projection, as well as the gap from the doubled standard deviation of the forecast values, which, as expected, becomes deeper at the end of the period.

Figure 1. *Forecast value of exports of food products and agricultural raw materials of the Russian Federation, million USD*



The dynamics of the initial time series of exports and forecasts is shown in Figure 2. Except for peak values, the time series are sufficiently close. The average absolute error of the retrospective forecast was 12.0%. The Theil index is 0.07, which implies a good forecast quality based on historical data.

Figure 2. *Actual series of exports and forecasting values of food products and agricultural raw materials of the Russian Federation, million USD*



The result of designing multiple regression predictive models are represented as follows: by projected values of explanatory factors; by projected values of the dependent variable *Y*, obtained on the basis of the multiple regression equation (2) and by the predictive values of the explanatory factors.

Thus, the amounts of food and agricultural raw materials' exports of the Russian Federation in 2018-2020 will be amounted to 21,842, 25,333 and 30,506 million USD, respectively.

The practical conclusion based on the results of the objective stated is the stability and positivity of the forecast indicators could become the basis of investment decisions, since the food industry is the investment attractive one.

4. Conclusion

To sum up:

1. Russia's accession to the WTO raises new requirements for the effectiveness of state regulation and support for national food exports on the assumption that wise land utilization, application of advanced technologies, increased yield and product quality, as well as its balanced volume considering priority objectives of reproduction and restoration of land resources should be assigned as the criteria indicators for providing the state support.

2. To take advantage of WTO membership, it is important to implement national foreign economic interest in the agricultural field via production incentives to increase the supplies to regional markets, expand and diversify export amounts; acquisition of foreign exchange income and its increase in the trade and foreign exchange balance of Russia; assistance in eliminating fluctuations in domestic demand and food products' prices, obtaining theoretical knowledge and practical experience of foreign trade activities.

3. The production of grain, mainly wheat, appears as one of the key non-resource export sectors of Russia. In this context, the grain cluster of the national economy moved Russia to the fore on the world market of grain and grain products.

4. A good-quality forecast characterized by the use of econometric models of multiple regression is made for the values of food exports until 2020, empirically proving the growth of export amounts. The medium-term forecast of Russia's food exports is a significant basis for making investment decisions.

References:

CRGMD. 2017. The concept of the Russian grain market development in the medium term (draft). Russian Grain Union. M. 16 p.

FCS. 2018. Federal Customs Service. Foreign trade statistics 2000-2017. Available online: http://www.customs.ru/index.php?option=com_content& view = article&id=13858 & Itemid = 2095.

Fetyukhina, O.N. 2011. Economic-mathematical modeling of development of the agro-food market of Russia. TERRA ECONOMICUS, Vol IX, issue 3, part 2, 52-55.

Fock, A., Weingarten, P., Wahl, O., Prokopiev, M. 2000. Russia's bilateral agricultural trade: First results of a partial equilibrium analysis. Russia's Agro-food sector: Towards truly functioning markets. Kluwer Acad. Publ., 271-197.

GKS. 2018. Federal state statistics service of the Russian Federation. Available online: http://www.gks.ru/.

Medvedev, D.A. 2012. Medvedev held a meeting with representatives of the expert community on economic development in the context of accession to the WTO. Available online: http://open.gov.ru/events/1558/.

Siptits, S.O. 2010. Theoretical and methodological aspects of assessing the efficiency of functioning of integrated food markets. Nikonovskie chtenia, 6-9.

Svetlov, N.M. 2016. Methodology for agro-food policy in the context of Eurasian integration. Bulletin of the TSAA, Vol. III, 94-114.

Svetlova, G.N. 2012. Methodology of modeling the national grain market. Vestnik of Kostroma State University, issue 6, 213-217.