Method of calculation of critical values of financial indicators for developing food security strategy

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Abstract. On the basis of decision making theory (minimax and maximin approaches) the authors propose a technique with the results of calculations of the critical values of effectiveness indicators of agricultural producers in the Republic of Tatarstan for 2013-2015. There is justified necessity of monitoring the effectiveness of the state support and the direction of its improvement.

1. Introduction
In the context of food security, with the input of retaliatory sanctions and with respect of a significant population growth, point of the agriculture increase can provide state support using direct and indirect instruments of influence. Undoubtedly, the most important direct support measures are undertaken both by the federal and regional budgets by laws and resource support. The indirect ones, as a rule, include coordination and stimulation of food producers. In scientific publications, usually researchers consider quantitative and qualitative methods of economic evaluation of the effectiveness of the state support of agricultural producers. Further, this paper presents comparative characteristics of the existing Russian and international practice methods for assessing the costs of agriculture support.

2. Theory
Currently, in the world practice there are two main approaches to the assessment of state support for agriculture: the methodology used by the World Trade Organization (WTO), and the methodology used by the Organization of Economic Cooperation and Development (OECD). A significant difference in the methods is in calculated indicators and the ultimate goal.

Assessing the level of state support for the agricultural sector in the OECD method implies the calculation of the index PSE (Producer Support Estimate) [7]. In contrast to the index AMS, the value of PSE is the sum of funds directed to farmers through the tools of government support measures of transfers from consumers and taxpayers. The share of these transfers in the total income of the rural economy is characterized by percentage indicator PSE (PSE,%).

The method of estimating the efficiency of the subsidies using is developed by the All-Russian Scientific Research Institute of Economy, Labour and Management in Agriculture (VNIETUSKH), which leads to assessing the total direct (federal and regional) support for agricultural enterprises. The data in this method are the materials of the land evaluating works, accounting data (financial) statements. The financial result of support is based on commodity indices / gross output per ruble of
production costs of the product and the total volume of support (thus, the assessment is focused on a single use of one’s own and budgetary sources).

$$FRS = \frac{GO(CO) \cdot VS}{P \cos tGO(\cos tCO)}$$

where FRS- financial result of support; 
GO - gross output, 
CO - commodity output; 
PcostGO- production costs of gross output; 
PcostCO - production costs and sale of commodity products; 
VS- volume of support. 

Proceeding from the above-mentioned formula, the effectiveness of support is calculated as follows:

$$EFRS = \frac{FRS}{VS}.$$ 

The paper presents various approaches to assessing the level and effectiveness of state support that have their advantages and disadvantages. Currently, scientific studies and publications submit methods are based on economic and mathematical models and methods. At the same time, it should be noted that there is no single methodology, the calculations do not take into consideration statistical information and they are not mathematically proven. Branches of agriculture are characterized by both quantitative and qualitative parameters, reducing them into a single system seems quite a complex issue. In the calculating parameters of efficiency assessment methodology, it is necessary to include the values of earnings and profitability of sub-sectors.

3. Methods
For the economic analysis, the indicators that reflect the status of the entity and lead to the conclusions are often used. However, for the analysis of economic indicators, critical data are necessary. The calculation of the critical values is an urgent and important task of any analysis. The following method is proposed for the calculation of critical values using the example of the economic indicators of the agricultural sector as the net profit from the crop per 1 ha of arable land, productivity and return on sales.

So, for each indicator, there are two critical values: top and bottom. The interval between the upper and lower critical values of economic indicators corresponds to the normal conditions of functioning of the enterprises of the region [8]. With the example of the diagrams of distribution of earnings per hectare of arable land for various crops to crop production branch in the Republic of Tatarstan presented in Figure 1, quite a large spread of these indicators of individual farmers can be seen. Therefore, to analyze the critical values, the greatly deviating values of indicators should be discarded. Based on Pareto optimality rule, the sample values of the indicators is carried out in such a way that it got values of about 80% of all farmers producing one type of product for which indicator the calculation is made[9, 10]. The calculations of the minimum, maximum, medium values and the total values in the Republic of Tatarstan for 2013-2015 are presented in Tables 1 and 2.

| Table 1. Calculation of the critical effectiveness values of agricultural producers in the Republic of Tatarstan for 2013-2015 |
|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|
| Index | Net income from the crop per 1 ha of arable land, thous.roubles | Profitability on sales, % |
| cereals, including maize | sugar beet | potatoes | rape | cereals, including maize | sugar beet | potatoes | rape |
| lower bound | -0.60 | -3.23 | -7.85 | 2.31 | -16% | -20% | -65% | -26% |
| upper bound | 1.67 | 15.24 | 7.20 | 5.93 | 25% | 37% | 28% | 42% |
Table 2. Calculation of the critical effectiveness values of agricultural producers in the Republic of Tatarstan for 2013-2015

| Index                  | Productivity, kg/ha | Profitability of sales of livestock,% |
|------------------------|---------------------|--------------------------------------|
|                        | cereals, including maize | sugar beet | potato es | rape | milk | meat of cattle | pork | poultry | eggs |
| lower bound            | 20.04               | 134.2      | 35.00     | 2.35 | -21% | -65%         | -67% | -42%    | -6%  |
| upper bound            | 28.99               | 394.48     | 133.50    | 18.82 | 25%  | 15%          | 13%  | 24%     | 29%  |

The calculated value of the critical indicators is a tool for the analysis of the current economic situation of agricultural enterprises of the Republic of Tatarstan.

Figure 1. Distribution of the index profitability on 1 hectare of sown area for various crops in 2011-2012, thousand rubles/ha

The theory of decision-making is used to calculate the critical values of economic indexes. Currently designed quantitative methods of decision-making (such as maximizing of expected utility, minimax theory, maximum likelihood methods, game theory, the analysis of "cost-effectiveness" and others) help to choose the best from a variety of possible solutions only in terms of one particular type of uncertainty or with complete certainty. Most of the existing methods to facilitate quantitative research within the specific tasks of decision-making are based on very simplified models of reality and overly stringent restrictions, which reduces the value of the results of research and often leads to bad decisions.

In the economy, the apparatus of mathematical analysis engaged in definition of extrema of functions is proved to be insufficient. There was a need to study the best way so-called minimax and maximin solutions. Minimax and maximin approaches aim to refuse to deal with uncertainty of
"weight method". From the entire field of admissible values minimax methods select two, at which the effect of successively takes the maximum or minimum value.

Maximin criterion involves getting the maximum guaranteed result under the worst conditions [11]. When choice is made according to these conditions, the guaranteed result is selected in the worst conditions, that is the least critical economic indicator \( a_{it} \) for the industry for one period. The highest value of all \( a_{ij} \) (‘maximin’) is selected to get maximal guaranteed effect in the worst conditions:

\[
\alpha = \max_{t} \alpha_{t} = \max_{t} \min_{i} a_{it}
\]

where \( \alpha \) – lower border of the critical economic indicator;
\( a_{it} \) – value of the economic indicator, of i enterprise in year t;
\( i \) – number of the enterprise;
\( t \) – calendar year.

Minimax criteria for implementing a strategy of selecting the worst result of the best, that is suited to determining the best values with caution. Consequently, this criterion is optimal for determining the boundaries of the upper critical economic indexes of effectiveness of producers. Using minimax criterion, the upper critical value is defined as the minimum of the maximum values of the industry for 2013-2015.

\[
\beta = \min_{t} a_{i} = \min_{t} \max_{i} a_{it}
\]

where \( \beta \) – upper border of the critical economic indicator;
\( a_{it} \) – value of the economic indicator of i enterprise and for year t.

Economic, social - political, climatic factors having a direct effect on the efficiency of the agricultural producers can lead to a situation where the calculated critical limits may lose economic sense [12, 13]. For example, as a result of the severe drought in 2010, 2012, earnings per 1 ha of cultivated area for potatoes and rape are such that 80% of producers have a loss in 2011, 2013 according to that type of crop which is reflected in the critical values that have to be optimal, unbiased and have economic justification.

4. Results
From our point of view, despite the overall situation in the region, the critical values of the earnings per 1 hectare of arable land must not be less than zero, as loss-making activities may not be indicative of the efficiency of production. Consequently, the algorithm for determining upper and lower borders for such crops should be adjusted so that the lower critical value of the index (\( \alpha \)) is not less than zero. The same algorithm should be applied to all the calculated indices in order the critical indicators make adequate evidence of the efficacy of industrial activity. Thus, the critical values of sales profitability, productivity and profitability of agricultural land can be used to analyze the efficiency of all agricultural enterprises of Tatarstan and are listed in Table 1 for 2013 and in Table 2 for 2014.

5. Conclusion
The current state of the global economy and policy requires increased attention to the problems of food security. Decision-making support of the forms of state support for agricultural producers, the recipient, the type and the amount of the subsidy are an urgent task. The overview of modern methods of evaluation of public support for agriculture shows that the calculations involve generalized indicators of the average price, sales volume and the amount of subsidies.

However, this approach does not assess how state support influences to agricultural producers, whether the improving of its financial indicators, productivity, and stability of activity. Also, the international methods do not take into consideration how government subsidies affect the regional market as a whole, as the most well-known negative consequence is a sample of state support is the
monopolization of the market [14], reduction of incentives for natural competition and, consequently, reduction of incentives for the modernization of the industry.

Alternative methods of assessment of state support for the agricultural sector suggest the use of various financial and non-financial indicators; however, they reflect only one aspect of this phenomenon. Therefore, the main goal is the creation of a comprehensive mathematical model of evaluating the effectiveness of agricultural subsidies, which would include both quantitative and qualitative indicators of the impact of government support for producers, buyers [15] and transactions between them.

The problem of accounting in the complex state model of agricultural producers is usually solved by using the calculation of financial and economic indicators: profitability, liquidity, financial stability, performance. However, the further transformation of these indicators requires the use of their critical values. The review of the literature on this issue has shown the lack of international and regional standards and recommendations, as well as reasonable methods of calculating them.

In this study, there is proposed the method of calculating the critical values of financial and economic indicators based on minimax and maximin approach. This method involves a statistical analysis of the financial ratios of all the manufacturers of the sector in a few most typical years (climatic factors: the length of growing season, rainfall, air temperature, etc.).

By dropping out strongly trending indicators, there is a maximum strategy to calculate the lower critical value, and the minimax strategy for the calculation of the upper critical value. That is, the best (and worst) values of financial index in each of the agricultural producers in a few years were selected, and then the worst (and best) of all the agricultural producers in the sample were chosen.

The proposed methodology is universal and allows calculating the critical values for all financial and economic indicators of the industry. Among the shortcomings, one should note the need for a statistical database of all enterprises in the industry over a long period of time and the need for detailed statistical analysis.

However, through the use of sound critical values of the efficiency of the producers, one can achieve precise and accurate results in models for calculating the efficiency of the state support that is the basis for making the right decisions on the government encourage the development of agriculture and improve the food security of the country.

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