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Integral assessment of innovation potential farms

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Abstract. Integral estimation of innovative potential of agricultural enterprises based on factor analysis is defined in the article. Determination of weights for the factor loadings is based on the use of factor analysis for constructing general indicators. The proposed system includes a balanced list of metrics that can objectively determine the components of the innovation capacity of enterprises.

Key words: innovative capacity, factor analysis, integral index, index

INTRODUCTION

Development of scientific areas and effectiveness of research activities depend primarily on the availability and use of scientific and technical potential, the degree of implementation of the production of research results, the intensity of innovation processes.

The concept of scientific and technological potential is used to describe the ability of the system to create new products in general, while innovative capacity reflects the possibility of using existing innovations both inside and outside the system. An important thing in the definition of scientific and technical potential is the proportion of its relationship with the scientific and technical potential.

Making the distinction between the concepts of scientific-technical and innovation capabilities, we should note their specific relationship. Firstly, scientific and technical sector in all circumstances has a significant degree of innovation, as it creates new products. The degree of innovativeness is determined by how the products of this sector are to potential consumers. Secondly, scientific and technical sector of the economy is the consumer of the much innovations generated inside and outside the macroeconomic system, which also increases the degree of innovativeness. Thirdly, scientific and technical sector is one of the foundations of innovation in any industrial and economic system regardless of its complexity. Therefore, scientific and technical sector is important parameter of innovative potential of any industrial-economic sector, which leads to the possibility of its effective development and functioning.

Theoretical and methodological basis of innovative potential of Ukraine are fully represented in such works e.g. [3,4,6,11,12]; practical problem solving innovation potential of Ukraine is reflected in such works e.g. [5,7,8,18]; statistical modeling of social and economic indicators researches e.g. [2,13,14,16,17].

The purpose of the article is to determine the integrated assessment of innovation potential of farms using factor analysis.

Nearly thirty years ago, the Japanese government published a "White Paper" which tried to give comparative integrated evaluation of innovation capacity of five leading industrial countries - the U.S., Japan, Germany, Britain and France - for two periods of time - the second half of the 60s and second half of 70-ies. Eight indicators were selected: 1) the number of scientists and engineers engaged in research and development, 2) national spending on science, and 3) the number of patents registered in the country, and 4) the number of patents registered abroad, 5) the amount (in value) technology of trade, 6) the volume of exports of high technology products, 7) the amount of added value in processing industry, 8) the volume of technology exports [1]

Simulation integral index (index) that characterizes one or more aspects of social and economic phenomena is based on the methodology of obtaining a summary indicator that represents (contains data) simultaneously several different properties of the object being studied. Typically, the task of building of integral indicator stems from the need to obtain some conditional meter (or method of measurement) of such property of an object that can not be measured directly. That is, it is a latent variable that can not be directly quantifiable (for it does not exist objectively due to the scale) [13]

Summarizing global and Ukrainian experience of integral index calculations, we find out that the methodology of its construction is to obtain some special kind of individual criteria, so the integral index the total aggregate latent characteristic of one or more properties of the object, which in turn are determined by a set (range) of seperate individual criteria (features) that sum variables that can be identified and measured *x1, x2, ..., xn.*

The relevance of designing of integrated parameter for different social and economic phenomena and processes are explained that their properties are usually characterized by a large set of features (t> 2), so in practice when ordering these items together often there is a need to aggregate all futures of set's in a one cumulative assessment Gj. This assessment is geometrically interpreted as a point in multidimensional space, the coordinates of which indicate the scale or position of the j-th unit. Algebraic value of features for attributes for the j-th unit vector set are represented by Xj = | x1, x2, ..., xm |, and their aggregation means the transformation of vector in to scalar.

Aggregation of futures is based on the so-called theory of "additive value," according to which the value of the whole equal, to the sum of values of its components. This approach, for example was, implemented in our rankings based on expert estimations presented by ranks or scores. If signs of sets X have different units, the additive aggregation needs to bring them to one basis, that is to pre-standardization. Vector of initial values of features Xj = | x1, x2, ..., xm | is replaced by the vector of standardized values Zj = | z1, z2, ..., zm |.

Determination of weights according to the factor loadings based on the use of factor analysis for constructing general indicators and logic of use of universal methodological support to solve complex problems. The basic idea of determination of the weights is to identify determining the contribution of each factor to the total variance (for all factors, including latent), which is 100%. The algorithm involves three consecutive steps:

1) calculation of the product of the load factor $|f|_i$ and the share of the total variance, which it explains q_i:

$$q_i = |f|_{ik} \, d_k, \tag{1}$$

2) calculation of sum of derived products of all factors:

$$\sum_i q_i,$$

3) calculation of the contribution of each factor to the specified sum that is actually the weight of the ith factor in the overall model:

$$W_i = \frac{q_i}{\sum_i q_i} \tag{2}$$

Formation of the initial set of individual criteria of the properties of integrated parameter is done expertly, although it is often carried out by methods of multivariate statistical analysis, namely the method of principal components. However, regardless to the method or scheme of structuring of statistical indicators, a number of authors, and in particular S.A.Ayvazyan, insist on to take into consideration the following requirements [2]:

– Representation, according to which in this list all key indicators of studies category should be presented,
– Information accessibility, according to which those figures and some individual criteria that will be used in the future, should be available to their statistical registration and should be included into the list of official statistics (or calculated based on the values of the last ones),
– Information accuracy, according to which used statistic data and criteria should adequately reflect the position or particular aspect of the integral indicator.

For integrated assessment of innovation potential legs define the indexes of such factors as the number of employees who do research, the volume of scientific and scientific and technical activities, the amount of scientific and technical works, the number of scientific organizations of international cooperation, the number of firms that introduced innovations; number of enterprises that have implemented innovative products abroad). Table 1 shows the index values of these parameters.

Table 1. Index values

Year	i_1 (indexes of number of employees who do scientific and technical work)	i_2 (indexes of scientific and scientific and technical works)	i_3 (indexes of scientific and technical work)	i_4 (indexes of number of scientific organizations of international cooperation)	i_5 (indexes of number of enterprises that introduced innovations)	i_6 (indexes of companies that have implemented innovative products abroad)
2001	1	1	1	1	1	1
2002	0,932	1,058	1,111	1,033	1,010	1,021
2003	0,953	1,150	1,093	1,039	1,008	1,018
2004	0,931	1,051	1,028	1,298	1,009	1,139
2005	0,909	1,243	1,287	1,318	0,751	1,296
2006	0,911	1,105	1,054	1,284	0,967	1,377
2007	0,845	0,968	0,872	1,274	0,702	1,257
2008	0,894	0,941	0,975	1,365	0,896	1,435
2009	0,817	1,028	0,978	1,498	0,795	1,307
2010	0,795	0,987	1,011	1,782	0,777	1,304

Table 2. Factorial load

	Components			
	1	2	q_i	The values of weights W_i
i1	-0,937890	0,132241	52,47905	0,221130609
i2	-0,483245	-0,842676	23,65777	0,09968659
i3	-0,475014	-0,845495	23,73693	0,10002013
i4	0,887641	-0,230307	49,6674	0,209283159
i5	-0,786894	0,334024	44,03019	0,185529692
i6	0,781890	-0,278227	43,75018	0,18434982
		$\sum_i q_i$	237,3215	
The share of the variance explained by component,%, dk	55,9543834637612	28,0745888010538		1

We determine the value of weights for the factor loadings (f_{ik}) using the method of principal components of factor analysis (Table 2).

The method of principal components allows to determine the initial linear combination of factor features that provide maximum cumulative variance $\sum_k d_k$.

$d_к$ – Percent of total variance signs - symptoms (index), that explained by the relevant principal components ;

f_{ik} – Factorial load (coefficient of pair correlation between the i-th indicator (index) and k-th main component).

The value of factor loadings (f_{ik}) indices are shown in table 3.

Table 3. The matrix of coefficients of (factor loadings) components

Index	*Component*	
	1	2
i_1	-0,937890*	0,132241
i_2	-0,483245	-0,842676*
i_3	-0,475014	-0,845495*
i_4	0,887641*	-0,230307
i_5	-0,786894*	0,334024
i_6	0,781890*	-0,278227

Note - this sign marks indices that define a particular component, that is they have the greatest influence on it.

The value of these indicators - the first part of the calculation of weights, namely - $|f|_{ik}$, the second component - $d_к$ - are obtained from table 4.

Cumulative part of variance explained by derived components is 84%. That is, these components account for 84% of baseline (cumulative part of variance should be higher than 75%), the value of the eigenvalues of component meet the condition $\lambda_к \geq 1$ these components contain high load factor ($|f|_{ik} \geq 0,7$), that explains the possibility of obtained principal components use in order to determine weights integral index.

So multiplying, we obtain the product of the factor loadings of each component and the percentage of the total variance, which it explains (table 5) that allows to determine the weight indexes.

Hence, the integral indicator will be the following:

$$I = 0,221 i_1 + 0,099 i_2 + 0,1 i_3 + +0,209 i_4 + 0,185 i_5 + 0,184 i_6. \quad (2)$$

Estimated value of the integral index for 2001 - 2010 is shown below (Table7).

CONCLUSIONS

The value of integrated assessment ranges from 0 to 1. Based on the above calculations, we can conclude that during the period studied (2001 - 2010) integrated assessment of innovation potential characterizes the constant increase of innovation, except 2007, when the value of the

Table 4. Full explanatory variance

Component	The part of the variance by explained component,% ($d_к$)	Cumulative part of variance explained by components,%	The value of the eigenvalues of components $\lambda_к$
1	55,9544	55,9544	3,357263
2	28,0746	84,029	1,684475

Table 5. Calculation of the index weights

Index	**Coefficient** q_i	**The values of weights** W_i
i_1	52,47905	0,221130609
i_2	23,65777	0,09968659
i_3	23,73693	0,10002013
i_4	49,6674	0,209283159
i_5	44,03019	0,185529692
i_6	43,75018	0,18434982
Sum	237,3215	

Table 6. Integral indices

Year	I1	i2	i3	i4	i5	i6	Ind
	0,221131	0,099687	0,10002	0,209283	0,18553	0,18435	
2001	0,221131	0,099687	0,10002	0,209283	0,18553	0,18435	1
2002	0,206094	0,105468	0,111122	0,21619	0,187385	0,188221	1,01448
2003	0,210737	0,11464	0,109322	0,217445	0,187014	0,187668	1,026826
2004	0,205873	0,104771	0,102821	0,27165	0,187199	0,209974	1,082287
2005	0,201008	0,12391	0,128726	0,275835	0,139333	0,238917	1,107729
2006	0,20145	0,110154	0,105421	0,26872	0,179407	0,25385	1,119001
2007	0,186855	0,096497	0,087218	0,266627	0,130242	0,231728	0,999166
2008	0,197691	0,093805	0,09752	0,285672	0,166235	0,264542	1,105464
2009	0,180664	0,102478	0,09782	0,313506	0,147496	0,240945	1,082909
2010	0,175799	0,098391	0,10112	0,372943	0,144157	0,240392	1,132801

Table 7. Calculated values of the integral index

Year	I
2001	1
2002	1,01448
2003	1,026826
2004	1,082287
2005	1,107729
2006	1,119001
2007	0,999166
2008	1,105464
2009	1,082909
2010	1,132801

integral index is less than 1. Despite the fact that nowadays motivating mechanisms for attracting intellectual resources with integrated parameter values are less used we see that in 2010 there are was essential dynamics of the innovation capacity of enterprises.

Therefore, we proposed the technique which is based on the use of indicators for integrated assessment of innovative capacity on the basis of factor analysis. The proposed system includes a balanced list of indicators that can objectively determine the components of the innovation capacity of enterprises, establish the dynamics and the relationship of individual and general trends in the development of innovative agricultural enterprises.

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