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«Entropy approach to the evaluation of the integration processes in agro-industrial complex»

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Problem statement

Considering the integration processes in agro-industrial complex (agribusiness), we are talking about vertical and horizontal integration. At the same time, attention is paid to the creation of mechanisms applicable to the introduction of innovation. In essence, it is a question of development of system recommendations with involvement of theoretical achievements and data of the analytical studies based on the network analysis and the concept of entropy. The creation of integrated structures in the conditions of agricultural production has become one of the effective ways to build supply chains, improve the market stability of enterprises and strengthen the competitive position of agricultural producers in the domestic market. Thus, the intensity of the integration process in the agro-industrial complex depends largely on the availability of innovative resources, among which information should be highlighted.

The objectives of integration are fixed in the form of systems of planned activities to develop the potential and capabilities of agricultural enterprises. Considering at the same time modern researches of integration processes, much attention is paid to studying of influence of network structures on development of information, expansion of knowledge and transformation of the latter into new developments and technological processes.
Solution methods

Considering the state of the network structure, the value of $x$ relating to two random distributions is subject to analysis. For example, the first distribution – the planned values of indicators of realization of integration processes in agro-industrial complex, the second – the actual values of the results obtained on the basis of results of a successful integration project on a similar network. Comparing both distributions with each other, it is impossible to say unambiguously whether the probability distributions of $q_i(x)$ events coincide with the probabilities of $p_i(x)$. The probability distribution $q_i(x)$ of the planned indicators is subject to verification and serves as an approximation of the distribution $p_i(x)$.

The result of the approximation reflects the magnitude of loss (unaccounted for amount) of information in the transition from the desired (expected) distribution $p_i(x)$ to the planned $q_i(x)$ (which is due to the ability to manage the integration process). The measure of information considered in this case is called cross-entropy. For two distributions, cross-entropy is determined as follows:

$$H_p (q) = -\sum_{i=1}^{n} p_i(x) \log_2 q_i(x)$$
Solution methods

If we consider equally probable realizations as the occurrence of a single event from the whole set of \( k \) events in the system, the probability of occurrence of a single event is \( p = 1/k \). Since all probabilities are equal, it is possible to speak about the equality of all \( x \) values of the expected distribution \( p_i(x) \). Distributions of this kind are characteristic of a stationary flow of events. Then the cross-entropy is determined as:

\[
H(q) = -\frac{1}{k} \sum_{i=1}^{n} \log_2 q_i(x)
\]

There is a difference between entropy and cross-entropy, which is called Kullback-Leibler divergence – the discrepancy between the distribution of \( q \) and \( p \):

\[
D_p(q) = H_p(q) - H(p).
\]

The divergence of the Kullback-Leibler has the form:

\[
D_p(q) = \sum_{i=1}^{n} p_i(x) \log_2 \frac{p_i(x)}{q_i(x)}
\]

It should be borne in mind that the functional (7) is not a metric in the space of distributions, since it doesn’t satisfy the axiom of symmetry: \( D_p(q) \neq D_q(p) \).
Conclusions

Having considered the main directions in the study of network analysis, it was found that the entropy approach to the assessment of integration processes takes a leading position, since it accumulates a number of developed theories. The entropy measure of information – a universal tool for measuring the state of the network structure to develop rational solutions. The determination of the amount of entropy and its application in the analysis process allows to identify opportunities (importance) of the network elements in supporting the integration processes of the agro-industrial complex.

The divergence of Kullback-Leibler, which is the distance (the degree of distinctiveness) between two distributions of a random variable, acquires an important significance here. The presence and capabilities of the entropy interpretations presented in the paper can be considered justified. Its application in solving problems of assessing the structural content of networks and probabilistic behavior of individuals is an integral part of the implementation of a comprehensive solution to the integration processes in the agro-industrial complex.
Contacts

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