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CLUSTER FORMATION OF INVESTMENT ATTRACTIVE AGRARIAN REGIONS OF THE COUNTRY USING NEURAL NETWORKS

The article analyzes the investment attractiveness of the domestic agricultural sector, determines the structure of sources of investment, heterogeneity of directions and attraction conditions. It is pointed out that during the period of 2012-2016 the total amount of money allocated by the state in the agricultural sector decreased by 83% and in 2016 is 16,5% in comparison with 2012. It is noted that the negative dynamics of public funding was partially covered with growth of capital investments from own funds of agricultural enterprises. Using regression analysis, it is proved that the studied phenomena are closely linked, namely: increase in gross regional product of the cluster is due to the growth of factor characteristics. The analytical platform Deductor Studio Academic 5.2 is used for the neural processing of statistical information. Inequalities in the distribution of investment capital among clusters of agricultural enterprises are specified. It is noted that investment policy requires improvement towards the creation of favorable conditions for attracting capital to the development of the agricultural sector and the organizational and economic mechanism requires development to facilitate the proportional allocation of investments.

Keywords: investment attractiveness, agricultural sector, clusters, neural networks, self-organizing map.

Formulation of the problem. Today, Ukraine's economy has signs of transformational nature, providing movement from one qualitative state to another one by deep systemic changes. These changes require additional financial resources. Given the peculiarities of functioning enterprises of the agricultural sector financial and time ensuring of effective investments of the production process becomes important. Investments are an integral part of any economic system. Studying their structure, heterogeneity of ways and attraction conditions will identify existing problems of funding and find sources of financing this imbalance. The main goal of this phase of the development of the domestic agricultural sector is the reorientation from raw material agricultural production to the highly developed commodity one. This will increase socio-economic indicators of the development of a country and population and improve the ecological state of the environment. However, aggressive market environment, due to competition, inflation, disparity of prices and other factors destabilizing activity of agrarian entities, does not contribute to a particular purpose. Determination of investment attractive agrarian regions will substantiate benefits of these clusters, indicate prospects of their development and give proposals to increase the volume of investments in other areas of the country. At the same time, application of artificial neural networks able to process large data quickly and accurately, achieves a new quality of results. For agricultural enterprises the use of this technology in the process of decision-making is the key to obtaining economic benefits.

Analysis of recent studies and publications. National and foreign scholars have made significant theoretical and methodological contributions to the study of investment attractiveness and development of measures for its improvement. They are Blanc I. [1], Dorokhov V., Pyndur M. [2], Haidutsky A. [3], Yermakov O. [4], Pogrischuk B. [5] and

others. Attention of mentioned above scientists concerns mostly theoretical developments. Meanwhile, Kohonen T. [6], Nedosekyn A. [7], Beshelev S., Gurvich F. [8], Shykyn E., Chkhartyshvili A. [9], Matviychuk A. [10], Velykoivanenko G., Mamonova K. [11] and others worked on the development and improvement of methodological tools, including the use of neural networks in conducting economic research of the investment process.

Given the results of scientific works of scholars we will study the investment situation in the agricultural sector and define investment attractive regions of the country.

According to OECD experts, 47 leading countries in the production of agricultural products, providing 80% of total value added in the sector, use various mechanisms to support producers, including subsidies that malform data on production and trade, the so called measures of "yellow basket". The level of this aid in these countries is on average 1/6 of gross farm receipts, including 15% in 2011 and 17% in 2012 [12].

The level of aid to farmers in China and the EU countries (according to Producer Support Estimate) was 19%, in the USA, Russia, and Kazakhstan was 12%, in Ukraine it was 3% in the period of 2012-2014 (-9% in 1995-1997). Thus, national farmers are in unequal financial conditions in the absence of a clearly formulated public policy aimed at protecting a producer and creating favorable conditions of the sector.

The research goal is to analyze sources of investment capital for agricultural enterprises and determine investment attractive agrarian regions using stochastic neural networks.

Presentation of main results and their justification. Today, agro-industrial complex accounts for about 14% of total GDP of the country and export of products is over 40% of the total volume [13]. The branch is developing dynamically. Thus, for the period of 2007-2014 production of agricultural products increased by 47% and by 87% in agricultural enterprises. Falling volumes in 2014-2015 can be explained not only by the financial crisis in the country but also by the loss of cultivated areas of the Autonomous Republic of Crimea and the occupied territories. This is estimated by experts at 4% of GDP [14].

The investment activity in Ukraine is under conditions of deficiency of financial resources and destructive financial policies. Analyzing the dynamics of flow of capital in the agricultural sector from the state budget of Ukraine we note that during the period 2012-2016 the total amount of allocated funds decreased by 83% and in 2016 is 16,5% of 2012 [15-19].

The peculiarity of the current financial and economic support for the agricultural sector is that it is carried out mainly through a complex of programs aimed at increasing the production efficiency and profitability of agricultural commodity producers. However, due to the lack of funds of State Budget of Ukraine, this support came to the producer through favorable tax policies that are indirect subsidizing forms of the sector. So, in 2014 agricultural enterprises received funds from the budget subsidies (176,5 million UAH). Due to the special regime of VAT payment 8,3403 billion UAH was received, the percentage is 2% to 98% [20]. However, in December 2015 changes to the Tax Code were adopted by the Supreme Council of Ukraine. According to them, the use of indexation coefficient of normative monetary value of the land is canceled for determining the tax base of taxpayers of the single tax of group 4 in 2016 and since January 1, 2017 the special regime of VAT payment for agricultural producers is canceled [21].

These changes can destroy the domestic agricultural sector. Losing a powerful source of financing of working capital of enterprises adversely affect the logistical support, cost of production, economic results of activities, employment and well-being of the rural population.

Studies of main sources of capital receipt into agricultural enterprises for the period of 2010-2014 have identified changes in their structure:

- capital investments grew by 1,6 times or by UAH 364 per 1 hectare;
- foreign direct investments increased by 1,2 times or by \$7 per 1 hectare;
- state funding has decreased by 6,7 times or USD 52 per hectare;
- financing through VAT grew by 206 times or UAH 254 per hectare;
- number of people employed in agriculture decreased by 1,5 times or by 8 workers per 1 hectare;
- net profit increased by 2,5 times or by UAH 1000 per 1 hectare.

The negative dynamics of public funding was partially covered with growth of capital investments from own funds of agricultural enterprises. However, all this had social consequences, namely: reducing the number of employees and migration of the rural population.

Assessment of investment of agricultural enterprises and the region's share in gross production will help to form agricultural clusters for their investment attractiveness and to develop proposals to increase the volume of investment in other areas of the country. Factor analysis revealed 3 clusters:

- Cluster III has the highest volumes. It includes Dnipropetrovsk, Kyiv and Poltava regions: gross regional product (GRP) per 1 person is UAH 49282.3 that more than 3 times than in cluster I, similar to foreign direct investments (FDI) (USD 1546.3) and capital investments (UAH 7455.6) respectively.

- Cluster I has the lowest volumes which includes Zakarpattia, Chernivtsi and Lugansk regions. In the production of gross regional product (GRP) UAH 16600 is per 1 person, USD 276.5 for foreign direct investments (FDI) and UAH 2001.6 for capital investments, respectively.

- Other 18 regions of the country form cluster II and have the average size of GRP, FDI and capital investments for 1 person, namely UAH 27598.8, USD 411.0 and UAH 2909.9, respectively.

Conducted regression analysis allowed us to determine the closeness of the relationship between the studied phenomena ($R = 0.8656$) and confirmed that the growth of cluster GRP is due to the growth of factor features. Multifactor regression equation is as follows:

$$Y = 16297,88 + 8,72 x_1 + 2,36 x_2$$

In which Y is a gross regional product for 1 person, UAH;

x_1 are foreign direct investments for 1 person, USD;

x_2 are capital investments for 1 person, UAH.

According to the results of regression analysis, increasing FDI per \$1 and capital investments per UAH 1 shows up GDP growth by USD 8,72 and UAH 2,36.

Using traditional methods of determining heterogeneity of information bases is not always effective under conditions of limited information. So, in addition to the statistical method [7], sometimes the expert method is used which is that the function is given by one or a group of experts intuitively, given the level of their competence [8; 9]. Given that most investors now make decisions about capital investment under conditions of limited and plural information base, using the abovementioned methods can be ineffective. So, we suggest using neural networks for this purpose. They are based on the principle of "error back propagation algorithm" [10; 22].

The main advantages of this method of the research include [11]:

- they have no restrictions on the amount of incoming information, while physiological abilities of experts do not allow them to work with very large amounts of data;

– processing the input data is made solely on the basis of mathematical and logical changes which allows providing a relatively high level of objectivity of the results;

– application of tools of the theory of fuzzy logic and neural networks can significantly improve the speed and quality of information processing. The efficiency of this type of models does not depend on the presentation of input data, etc.

The neural processing of statistical information is carried out using analytical platform Deductor Studio Academic 5.2 to form clusters by the investment attractiveness of the region. This platform refers to Data Mining. This method of data processing is relatively new and includes the set of methods to reveal hidden regularities or relationships between variables in large arrays of raw information of various origins. Deductor Studio Academic 5.2 allows applying a large number of methods and data processing techniques, including clustering and self-organizing maps.

Self-organizing map (SOM) performs the task of visualization and clustering. The idea of the network was proposed by the Finnish scientist T. Kohonen [23]. This method does not require a large amount of statistical observations, known values model “output” and the involvement of expert opinions. This makes it quite convenient to configure membership functions [24].

Construction of neuro clustering based on self-organizing maps envisages two phases: 1. Construction of a neural network. 2. Network configuration.

The first phase includes process description of topology of the neural network which is characterized by the number, shape and structure of neural layers and number of neurons in each layer and connections between them. Self-organizing map is a asynchronous actual neural network of direct distribution which consists of two layers of neurons (input and output (competing)), between which there are no feedbacks [23; 25].

The second phase is a configuration of the self-organizing map in analytical platform. It comprises administering of statistical information (GRP for 1 person, UAH, FDI for 1 person, USD and capital investments for 1 person, UAH) and determination of ways of displaying the results (Fig. 1).

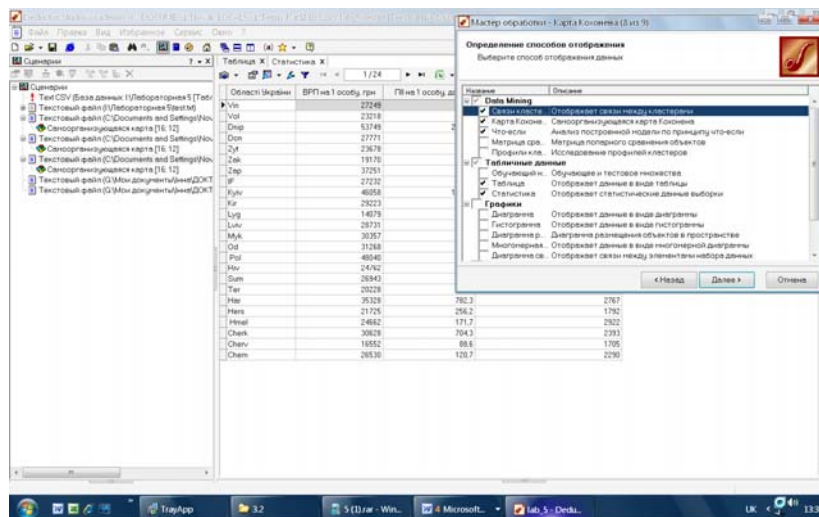


Figure 1 – Setting up ways to display results of the analysis in analytical platform Deductor Studio Academic 5.2 (author’s calculations)

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This neuro clustering identified three clusters that partially repeat the results of factor analysis. Dnipropetrovsk, Kyiv and Poltava regions (red color in self-organizing map, cluster 0 in the table) were the most investment-attractive with the highest volumes of investment and GRP production (Fig. 2-3).

Область України	БРП на 1 особу, грн	П/на 1 особу, дол.	Капітальні інвестиції на 1 особу, грн	Номер янтраї	Номер кластера
Тер	26228	84.3	2279	2	2
Ки	29223	103.9	3038	7	2
Льв	30357	241.7	3071	9	1
Ж	27232	99.0	6841	11	1
Київ	46656	1157.4	10573	15	0
Львів	24662	171.7	3925	20	2
Одеса	18552	88.6	1705	32	2
Дніпро	27249	191.5	3401	54	2
Львів	29731	874.9	3498	57	1
Він	23218	328.8	3119	83	2
Рів	48040	732.3	5889	95	0
Львів	14679	391.9	2294	86	2
Дніп	27771	828.8	2980	104	1
Зап	37951	832.9	3759	109	1
Од	31260	701	3626	122	1
Закар	19170	148.2	2006	130	2
Рів	24762	270.9	2207	133	2
Сум	28530	120.7	2290	149	2
Сум	26943	372.1	2297	167	2
Полтава	21725	254.2	1792	176	2
Дніпро	23678	386.9	2117	179	2
Черка	30628	704.3	2293	185	1
Хар	35328	782.3	2767	188	1
Дніпро	53749	2749.3	5905	191	0

Figure 2 – Showing results of neuro clustering estimated by the analytical platform Deductor Studio Academic 5.2

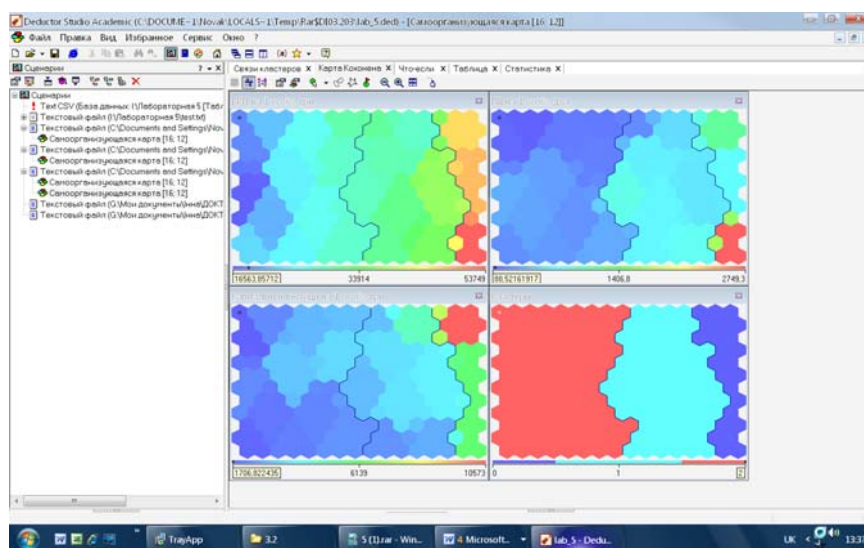


Figure 3 – Results of neuro clustering of agricultural enterprises of regions in Ukraine by investment attraction (self-organizing map) (author’s calculations)

Cluster I includes 11 regions with the lowest indicators, pointing to the low investment attractiveness: Volyn, Rivne, Kherson, Zhytomyr, Transcarpathian, Sumy, Khmelnytsky, Luhansk, Ternopil, Chernivtsi and Chernihiv.

According to the analytical platform cluster II includes 7 regions: Cherkasy, Donetsk, Zaporizhzhia, Ivano-Frankivsk, Lviv, Mykolaiv and Odesa. They are characterized by the average amount of GDP, FDI and capital investments per 1 person.

Results of the study point to inequalities in the distribution of investment capital among agricultural enterprises in the country. In fact, the greatest amount of capital and direct foreign investments were invested in Dnipropetrovsk, Kyiv and Poltava regions. As a result of it there is the highest level of production of gross regional product per capita. At the same time, other regions of the country get significantly lower investments with almost similar agronomic indicators. It points to the need to improve investment policy that will show up in the development of measures aimed at stimulating capital inflows in other areas of the country.

Conclusions. So, research results have identified changes in the dynamics of the sources of financing of agricultural enterprises in Ukraine. We note that currently the main source of capital investments is funds of enterprises that are partly gained by the special regime of VAT payment. So, cancellation of this preference since January 1, 2017 will have negative consequences for the agricultural production.

Factor, regression and neural analyzes of information processing were used in the study to determine the investment attractive clusters of agricultural regions. Three clusters were formed according to the results of the factor analysis. Data of this analysis have been clarified by neuro clustering that pointed to inequalities in the distribution of investments among regions of the country. Consequently, investment policy requires improvement towards the creation of favorable conditions for attracting capital into the development of the agricultural sector. Also, it requires the development of organizational and economic mechanism to facilitate the proportional distribution of investments. Regression analysis proved that the studied factors are closely linked. In particular, growth of volumes of capital and direct investments will increase volumes of GRP cluster.

The prospect of further research is determined as the application of artificial neural networks in the decision making process in the formation of effective strategies for investing of the agricultural sector.

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Формування кластерів інвестиційно-привабливих аграрних регіонів країни за допомогою нейронних мереж

У статті досліджено інвестиційну привабливість вітчизняного аграрного сектора, визначено структуру джерел інвестування, гетерогенність напрямів та умови залучення. Вказано, що за період 2012–2016 рр. загальний обсяг коштів, виділених державою в аграрну галузь, скоротився на 83% і становить у 2016 р. 16,5% рівня 2012 р. Зазначено, що негативна динаміка державного фінансування була частково покрита зростанням капітальних інвестицій за рахунок власних коштів сільськогосподарських підприємств. Доведено за допомогою регресійного аналізу тісну зв'язку між досліджуваними явищами, а саме: збільшення валового регіонального продукту кластера обумовлено зростанням факторних ознак. Для нейронної обробки статистичної інформації використано аналітичну платформу *Deductor Studio Academic 5.2*. Вказано на диспропорції в розподілі інвестиційного капіталу серед кластерів аграрних підприємств країни. Відзначено, що потребує вдосконалення інвестиційна політика держави в напрямі створення сприятливих умов залучення капіталу в розвиток аграрного сектору, а також вимагає розроблення організаційно-економічний механізм, що сприятиме пропорційному розподілу інвестицій.

Ключові слова: інвестиційна привабливість, аграрна галузь, кластери, нейронні мережі, самоорганізаційна карта Кохонена.

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Формирование кластеров инвестиционно-привлекательных аграрных регионов страны с помощью нейронных сетей

В статье исследовано инвестиционную привлекательность отечественного аграрного сектора, определена структура источников инвестирования, гетерогенность направлений и условия привлечения. Указано, что за период 2012-2016 гг. общий объем средств, выделенных государством в аграрную отрасль, сократился на 83% и составляет в 2016 г. 16,5% уровня 2012 г. Отмечено, что негативная динамика государственного финансирования была частично покрыта ростом капитальных инвестиций за счет собственных средств сельскохозяйственных предприятий. Доказано с помощью регрессионного анализа тесноту связи между изучаемыми явлениями, а именно: увеличение валового регионального продукта кластера обусловлено ростом факторных признаков. Для нейронной обработки статистической информации использовано аналитическую платформу *Deductor Studio Academic 5.2*. Указано на диспропорции в распределении инвестиционного капитала среди кластеров аграрных предприятий страны. Отмечено, что требует усовершенствования инвестиционная политика государства в направлении создания благоприятных условий для привлечения капитала в развитие аграрного сектора, а также необходимо разработать организационно-экономический механизм, который будет способствовать пропорциональному распределению инвестиций.

Ключевые слова: инвестиционная привлекательность, аграрная отрасль, кластеры, нейронные сети, самоорганизационная карта Кохонена.

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