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FINANCIAL AND ECONOMIC EVALUATION OF AGRICULTURAL INSURANCE MARKET IN UKRAINE

Purpose. *The purpose of the article is to diagnose the financial and economic conditions of the agricultural insurance market in the context of transformational changes, which allows identifying the dependences of variables among the indicators of insurance in Ukraine.*

Methodology / approach. *The final goal of diagnosis is to build models that describe the variables and allow assessing the impact of some insurance indicators on the number of insurance contracts, which allows conducting regression of projected and observed values among insurance indicators during 2005–2019. The direct selection was also applied, which allowed starting without variables in this model by checking the addition of each variable with the use of the selected criterion of conformity of the model; as well as the repeatedness of this process until the best state of the model.*

Results. *The modelling results allowed us to determine that among the insurance indicators in the agricultural insurance market, the dependent variable is the indicator of the number of insurance contracts. As a result of the regression, it was stated that for the dependent variable the USD / UAH exchange rate and the subsidy, mln UAH, have a significant impact on the number of insurance contracts. Less importance had the area, thousand hectares, and the remaining variables did not determine such an impact. The obtained regression value of the predicted and observed value stated an adequate model, as the slope of the regression line is 45°.*

Originality / scientific novelty. *The novelty is improvement of the diagnostic algorithm for assessing trends in the agricultural insurance market in terms of transformational changes, taking into account the regression which made it possible to establish the dependences of variables among insurance indicators; validity of the use of direct selection with repeatedness of which the best possible state of the model is achieved.*

Practical value / implications. *The comparison of the studied insurance indicators in the agricultural insurance market allowed determining the relationship between variables with the separation of their weight, which affect insurance contracts, which confirms the adequacy of the application of diagnostics which will be used during the evaluation of insurance contracts at enterprises of the agricultural insurance market.*

Key words: *insurance contracts, agricultural insurance market, crops, regression analysis, forecasting.*

Introduction and review of literature. The dynamic development of insurance in agriculture is an important and necessary condition for successful development of

the agricultural sector in Ukraine for which, as it is known, significant risks associated with both weather conditions and other equally dangerous force majeure situations that lead to losses among agricultural producers is characterized. Given the significant climate changes in Ukraine, which has caused, for example, significant droughts on farms in southern Ukraine, it is important to make changes and amendments to the Law of Ukraine "On the peculiarities of insurance of agricultural products with state support", which in many government officials' opinion has to ensure wider access of farms to insurance. It is important in this direction to use the international experience of insurance in agriculture, in particular, the practice of paying insurance premiums by farms, which in the future may partially compensate losses caused by adverse climatic conditions.

Analyzing the numerous scientific achievements of agricultural scientists in scientific periodicals, it is necessary to distinguish those related to the study of the role and importance of agricultural insurance. Thus, Chinese scientists [1], studying the impact of the Covid-19 pandemic in 2020 on the development of farms, concluded that the development of vegetable growing is impossible without the introduction of insurance at the stage of "cultivation-sale". Researchers conducted a survey in 46 agricultural cooperatives in Shanghai, which specialize in cultivation and sale of agricultural products, including vegetables.

According to the results of the survey, the researchers concluded that the pandemic had the most negative impact on sales of goods, and traditional farmers suffered the most, because they were not able to sell their products via the Internet. Considering the factor of unprofitability of small farms, scientists propose to introduce market risk insurance to reduce their losses [1]. Researchers [2], analyzing the relationship between food security on the basis of statistics in the world, production in the agricultural sector and the risks that constantly exist in agriculture, summarize that insurance in the agricultural sector stabilizes income in farms, assists in the increases of inflow of investment in the industry, which assists in the increases of competitiveness of agricultural production. Scientists emphasize that insurance in the agricultural sector of developing countries is an important factor that allows a faster transition from the natural way of farming to the stable development of agricultural production. An important role is played by the growing awareness of farmers about the importance of insurance as a factor of reducing risks for agricultural producers and a significant increase in investment in the industry [2]. Researchers [3; 4] provided an economic assessment of the expected benefits of voluntary state insurance for farms growing corn in China. In a household survey, researchers found that among 365 households engaged in agricultural production, only 60 % make rational decisions and are not at risk. Scientists state that only obtaining of additional education, including new knowledge about unforeseen risks, will allow increasing farmers' incomes by 55 % from growing crops [3].

U.S. researchers [5] consider that the review of agricultural insurance research conducted by them will help insurance companies create new insurance products for the agricultural sector and government, and also will help governments in many

countries make rational decisions about their provision [5]. Researchers [6], had analyzed the problem of risk insurance in agriculture due to the influence of climatic conditions on the cultivation of products, made a reasonable conclusion that for women farmers this type of insurance is important. This type of insurance, according to the scientists, gives a sense of social security for women farmers, because they are more vulnerable, unlike men, to various unforeseen situations associated with adverse weather conditions [6].

Harvest insurance against weather risks is supported by American scientists [7], who believe that this type of insurance should be introduced in countries with low incomes. Despite its advantages, scientists suggest the obvious thesis that this type of insurance will be much more expensive than traditional types of insurance in agriculture [7]. Vietnamese researchers claim that the Vietnamese government has achieved positive results in the formation of the primary system of regulation of the agricultural insurance market, which has helped reduce farm losses from natural disasters. At the same time, scientists argue that an effective state policy on insurance of profitable farm households has not yet been formed at the national level. According to them, this requires the development and implementation of a comprehensive action plan to stimulate farms to insure their own agricultural products [8; 9].

It is worth paying attention to the problems of insurance in agriculture by Chinese scientists [10], who devoted their study to the development of agricultural insurance in Pakistan, aiming to study the level of readiness of farmers to pay insurance premiums. According to the survey, only 30 % of farmers intended to pay insurance premiums in the future, and their responses largely depended on the types and sizes of farms, as well as their solvency. According to the Chinese researchers, it is advisable to introduce a mechanism of state subsidies for insurance of farms, which will allow to avoid difficulties of overcoming losses from various cataclysms in the future [10].

The continuation of this study of Chinese agricultural scientists is an empirical study by a team of Chinese, Vietnamese and Pakistani scientists [11] during which a questioning was conducted on the insurance of four hundred households in Pakistan and a probit regression model was applied. The researchers emphasize that the revealed results are aimed at raising farmers' awareness of various types of agricultural insurance, as well as helping to establish cooperation and collaboration between insurance companies, the government of the state and farms to insure farms against floods, which often cause great damage to local population and destroy all future crops [11; 12].

Researchers [13], studying the farm insurance market in Vietnam, came to the conclusion that farmers treat with distrust to insurance products suggested for them [13]. Makaudze [14], the scientist from the University of the Western Cape, studying the development of agricultural insurance in South Africa, notes that a pilot project implemented at the government level for insuring the agricultural sector against extraordinary droughts did not bring the expected benefits to agriculture. The

researcher carefully analyzes the development and implementation of mechanisms for insurance against extreme weather conditions in agricultural sector of the taking into account the experience of other countries that have demonstrated successful results in this area [14]. Chinese and Kenyan scientists [15; 16], studying the development of insurance in agriculture in Kenya, argue that the use of index insurance in the agro-industrial complex has a positive impact on the agricultural sector in particular and food security in general [15].

Investigating the relationship between Chinese farmers concerning joining cooperatives and paying insurance premiums, scientist [17; 18] emphasizes that there is a relationship between these two indicators, and as the conclusion he summarizes, that most Chinese farmers who decide to join cooperatives pay insurance premiums at the same time, and an inverse relationship exists, because those farmers who carry out their economic activities independently are not ready to pay insurance premiums.

The opinion of a group of Chinese researchers is correct and interesting interesting from a practical point of view. In the article on the extraordinary impact of meteorological catastrophes on grain growing, using the method of quantile regression, they established the following regularity: in case of the drought increase by one percent, the level of grain losses will increase by fifteen percent, which will threaten China's food security. Summarizing their own research, scientists emphasize the need for changes in agricultural policy, in particular, the introduction and application of innovative tools designed to reduce risks in the agricultural sector [19; 20].

The conclusion of the Chinese researchers on the increase of meteorological catastrophes in the world is well-grounded, so it is reflected in the researches of other scientists. For example, the well-known environmental scientists from the University of Oregon in the United States [21] with a group of fellow researchers from Australia and Africa published an article in the “BioScience” Biology journal “Warning of the world scientists about the extreme situation in climate”, in which they speak about a sharp increase of extreme climate conditions in the world [21].

Very important for implementation of agricultural insurance in Ukraine is the introduction of subsidies by the state, and the experience of Indonesia can be useful for use. Thus, Indonesian researchers of agricultural insurance [22] indicate that the Indonesian government subsidizes about 80 % of insurance costs in the agricultural sector, which allows farmers to pay insurance premiums of only 20 %. Despite the high level of state subsidies in the country, researchers draw attention to the fact that the state has not yet fully covered the target audience of farms. As the results of the study showed, about 82 % of farms insure land resources because they understand that the risks of loss are minimal, which allows them to attract more resources for agricultural production [22].

Having reviewed the research of agricultural insurance problems by foreign scientists, which will have scientific and applied significance, we think it necessary to consider the scientific achievements of Ukrainian scientists on the development of the agricultural insurance market in Ukraine [23; 24]. Thus, Y. Nesterchuk [23] believe

that it is quite real for the Ukrainian insurance system to form a model of public and private partnership, which will contribute to stable income for both agricultural producers and insurance companies.

Domestic scientists [25; 26] propose making the transition from multi-risk insurance to index insurance in Ukraine, which will be able to neutralize the losses of farmers in Ukraine.

Having carried out a critical review, we fully share the opinion of the leading foreign and domestic scientists and believe that the introduction of state subsidies in Ukraine is extremely necessary in modern conditions [27]. This will make it possible to increase the efficiency of agricultural production in the near future and stimulate the formation and development of small and medium-sized farms [28]. The experience of the development of the agricultural insurance market in EU countries is interesting. They use comprehensive agricultural risk insurance in agricultural activities, which, in addition to crop insurance, also provides insurance against weather events. As for the highly developed EU countries, in these countries, given the significant level of state support for farms, multi-risk insurance is carried out, which allows farmers to avoid significant losses during agricultural activities [29].

The purpose of the article is to diagnose the financial and economic conditions of the agricultural insurance market in terms of transformational changes, which allows identifying the dependences of variables among the indicators of insurance in Ukraine.

The novelty is the improvement of an algorithm of the conducting diagnostics to assessing trends in the agricultural insurance market, taking into account the regression through direct selection and repeatedness of this process until the moment of the best possible presentation of the model.

Methodology. In order to perform empirical analysis and quantitive assessment of current situation in agriculture assurance sector, such indicators of agricultural insurance sector of Ukraine were used: Number of contracts; Area, thousands of hectares; Insurance sum, mln UAH; Premium sum, mln UAH; Subsidy, mln UAH; Level of payment, %; Average premium rate, %; USD/UAH exchange rate; Insurance sum, mln USD; Premium sum, mln USD; The amount of the award, mln UAH. All data have been collected from official statistical sources.

The theoretical and methodological basis of this study is based on traditional and specific cognitive methods of studying phenomena and processes. Therefore, in the course of the research an abstract and logical analysis was used – for the theoretical generalization and substantiation of the directions and results of the research; system and structural analysis – for the study and systematization of methodological approaches to the assessment of consolidated indicators of crop insurance; structuring – for determining the factors influencing the number of insurance contracts; economic analysis – for substantiating the main directions and identification of the features of functioning of the agricultural insurance market; regression analysis – for identifying the dependencies of variables and for assessing the impact of some insurance indicators on the number of insurance contracts; variation methods – for

establishing variable components when constructing the final regression statistics; graphic method – for visual representation and schematic representation of theoretical and practical results of the research; statistical analysis − for determining the trends in the agricultural insurance market that cause a motivating or demotivating effect on its activities; method of modeling theory – for evaluating the models with the purpose of regression of the predicted and observed values.

To identify the dependence of quantity of insurance contracts and other indicators of insurance in agricultural sphere authors decided to use stepwise regression analysis.

Stepwise regression is a method of fitting regression models in which the choice of predictive variables is carried out by an automatic procedure [30–33]. In each step of the regression simulation, each subsequent variable included in the model is considered for addition or subtraction from a set of independent variables based on a certain criterion, in particular it can be a sequential calculation of F-tests or t-tests and adjusted R^2.

We used one of the main approaches to stepwise regression analysis – forward selection. This regression analysis procedure begins without variables, with stepwise addition of each variable with simultaneous testing of the regression model based on the selected match and adequacy criterion, and repeating this process until the addition of each subsequent variable improves the statistical significance of the selected criteria [34].

The main hypothesis of research is that the number of agricultural insurance contracts as an indicator of the dynamics of development of this insurance sector depends on a limited set of variables that represent economic processes in agricultural insurance.

Results and discussion. Tendencies of the market of agricultural insurance indicate that the decade since 2005 has continued its decline [35; 36]. However, since 2016, there has been some improvement as it is indicated in the data in Table 1.

In particular in the last researched period the tendency of increasing the volume of compiled insurance contracts has continuined: an increase compared to 2005, amounted 5.16 %. The volume of obtained insurance premiums in UAH decreased, in 2019 it increased by 169.5 mln UAH. However, the volume of insurance premiums in dollar terms decreased slightly (6.9 mln USD, which is 2.5 % less than in 2005), which is explained by the devaluation of the UAH.

The total insurance sum (or the volume of total insurance obligations) in 2019, compared to 2014, increased, in particular from 3055 to 6950 billion UAH. Data of Table 1 demonstrate that during the study period the number of contracts increased by 47 units, which is 5.16 % more than at the beginning of the study period. The value of the area index also has a clear tendency to increase, as at the beginning of the study period this value was 390 thousand hectares, and at the end of the study period it was 661 thousand hectares, which was 271 thousand more, or 69.5 % (Fig. 1).

Table 1

Summary indicators of crop insurance in Ukraine in 2005–2019

Indexes / years	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Absolute change, +/-	Relative change, %
Number of contracts	910	1330	4397	1637	1980	1217	2710	1936	1722	1392	1062	793	957	1207	957	47	105.2
Area, thousands of hectares	390	670	2360	1171	510	553	786	727	869	732	689	700	661	974	661	271	169.5
Insurance sum, mln UAH	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	3055	3969	6240	5933	6675	6950	-	-
Premium sum, mln UAH	12.8	28.5	116.7	155.4	42	72.1	136.3	130.4	135.4	72.8	77.7	157	204.3	208.8	178.7	165.9	1396.1
Subsidy, mln UAH	5.8	12.5	47.8	72.8	0	0	0	0.086	0	0	0	0	0	0	0	-5.8	0.0
USD / UAH exchange rate	5.05	5.05	5.05	5.22	8	7.91	7.98	7.99	7.99	12.95	22.91	26.02	26.54	28.27	25.80	20.75	510.9
Insurance sum, mln USD	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	235.9	173.3	239.8	223.5	236.1	269.4	-	-
Premium sum, mln USD	2.5	5.6	23.1	29.8	5.3	9.1	17.1	16.3	16.9	5.6	3.4	6.0	7.7	7.4	6.9	4.4	276.0

Source: made by the author's based on enterprise statistical reporting.

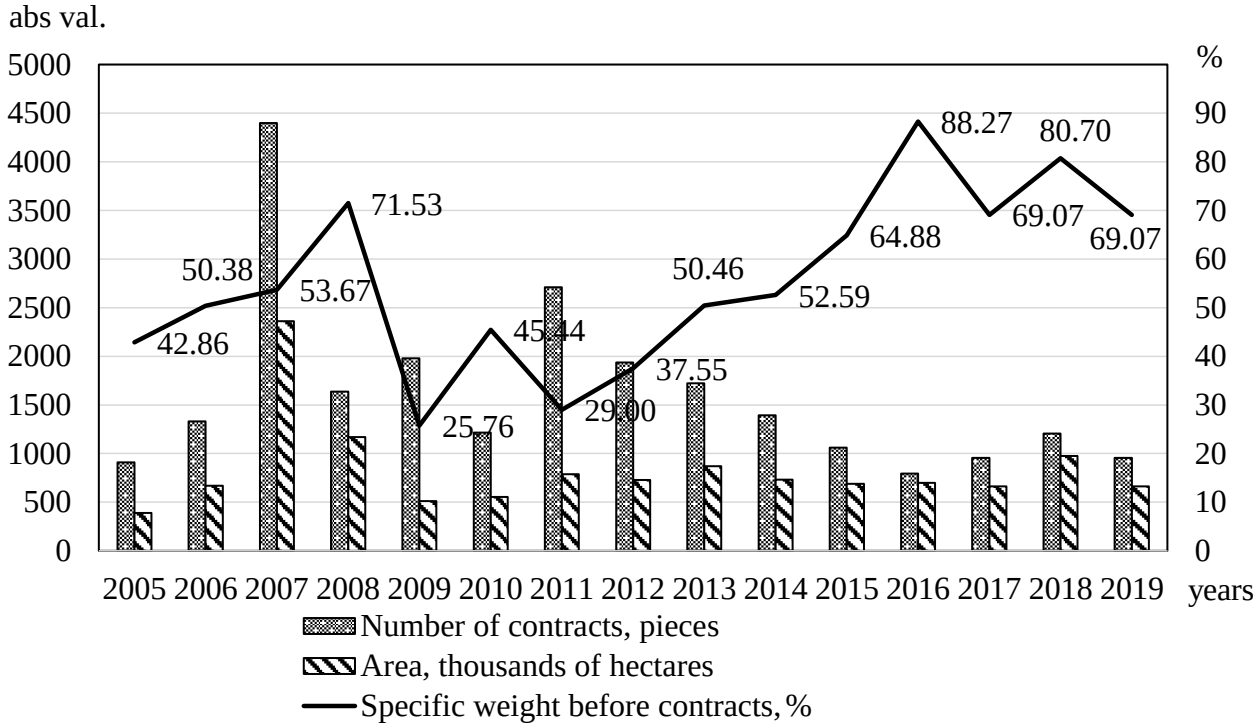

Fig. 1. The specific weight of areas before the concluded contracts for the period of 2005–2019, %

Source: made by the author's based on enterprise statistical reporting.

In 2019, the level of the insured area of agricultural crops increased significantly. Thus, there was a significant increase in the amount of insurance for winter wheat, as well as winter oilseed rape and sunflower, and to a lesser extent – spring wheat and sugar beet. Prior to that, it should be noted that in 2019, as part of the integration year, 17 types of crops were insured. Compared to 2017, the number of insured crops remained constant, but there were minor changes in the structure of insured crops, there were no agreements on insurance of soybeans, sorghum, buckwheat, beans and spring rye, however such crops as winter peas, winter garlic, oats, vineyards and roses were added. The amount of the insurance sum, the level of payments and the insurance sum have taken place since 2014, so it is not possible to determine the tendency of their change over the entire period of the study.

At the same time, the amount of insurance premiums increased by 4.4 mln UAH, or by as much as 176 % (Fig. 2). But the amount of subsidies has the opposite tendncy, as at the end of the study period it decreased by 5.80 mln UAH.

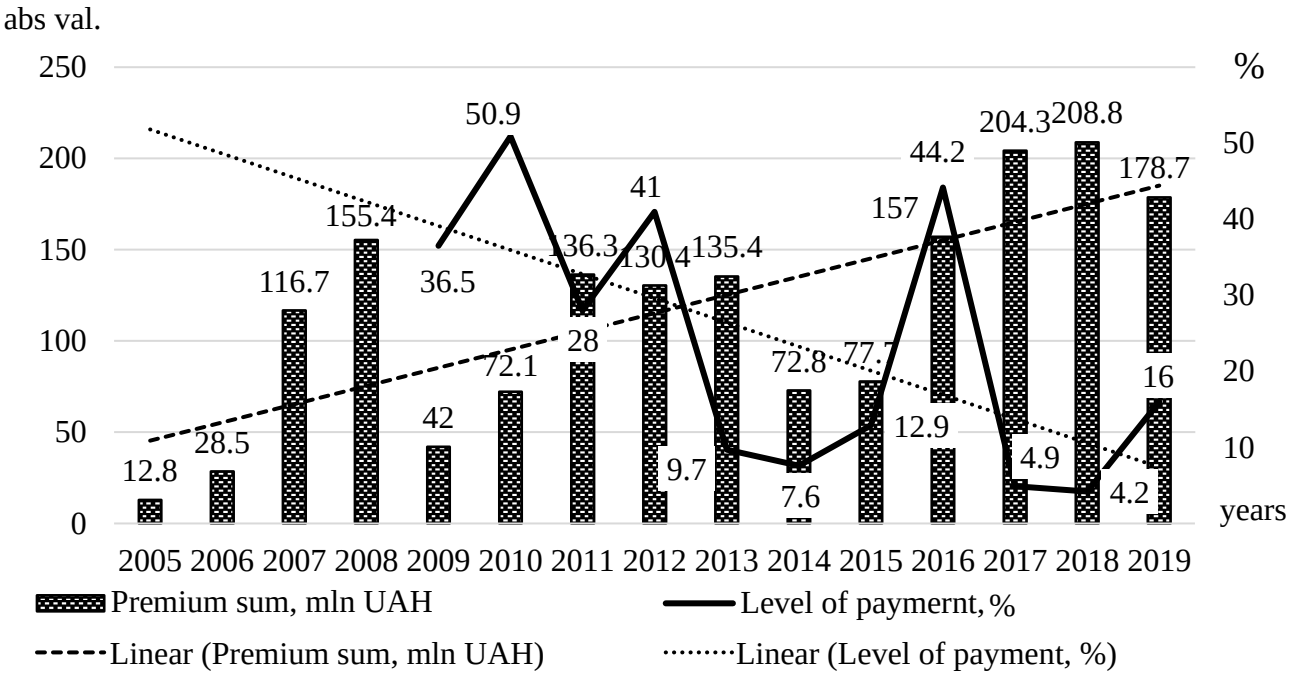

Fig. 2. Dynamics of change in the amount of insurance premiums and the level of payments for the period of 2005–2019

Source: made by the author's based on enterprise statistical reporting.

As for the size of the premium, its average rate decreased by 0.3 %, or in relative terms by 7.89 % (Fig. 3).

Paying attention to the fact that the USD / UAH exchange rate increased by 20.75 UAH or 410.9 % (Fig. 4), the premium amount in USD mln increased by 4.4 mln USD or by 176 %.

It should be noted that the leaders in the field of agricultural insurance are such insurance companies as "Ingo Ukraine", "Universalna", "Asuka", "PZU", "AXA" (AXA until 2019) and others.

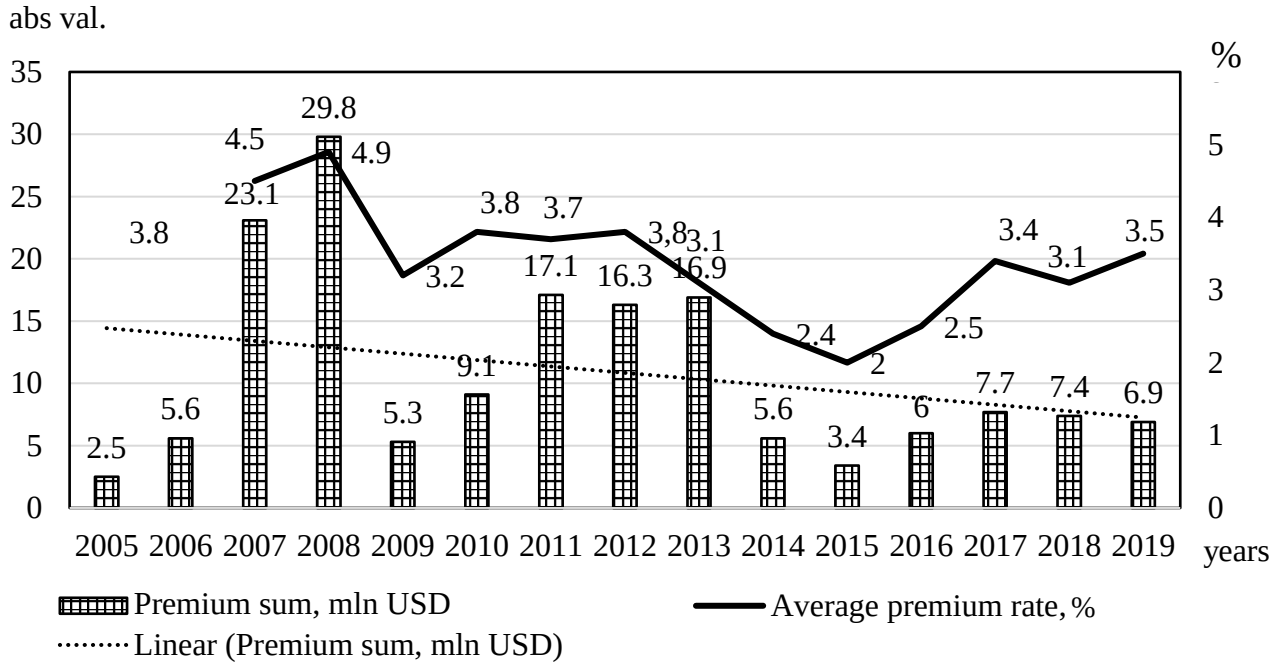

Fig. 3. Dynamics of change in the size of premiums for the period of 2005–2019

Source: made by the authors based on enterprise statistical reporting.

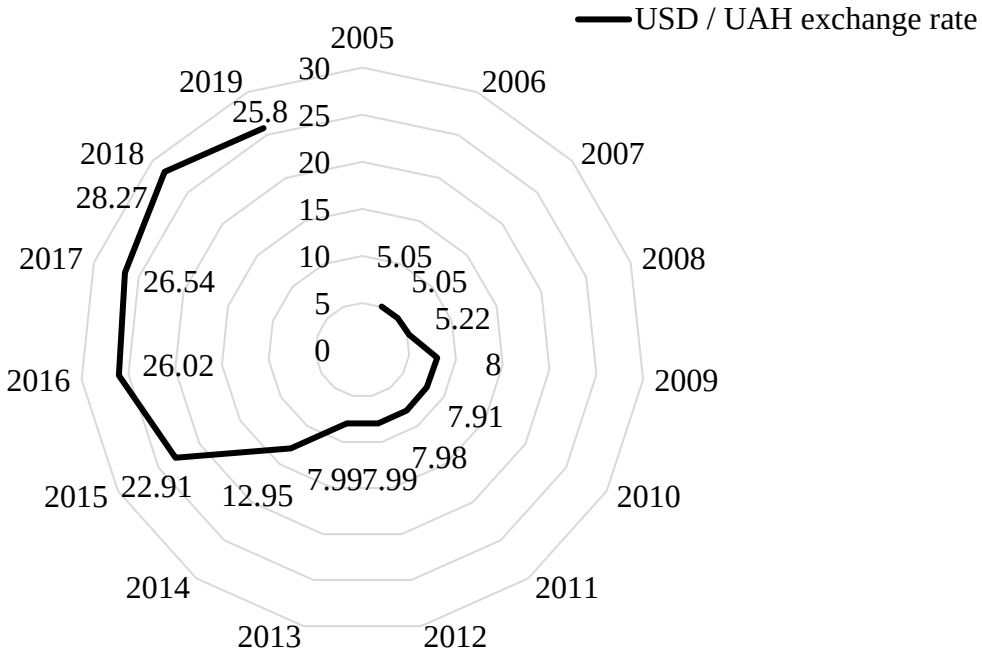

Fig. 4. Dynamics of change in the USD / UAH exchange rate for the period of 2005–2019

Source: made by the authors based on statistical reporting.

These analytical data are characterized by heterogeneous dynamics of their change. Such a tendency affirms the influence of not only subjective but also objective factors, in particular, social, economic, regulatory and political. We performed regression analysis for identification of variables dependences and in order to evaluate influence of some insurance indicators (Table 2) on quantity of insurance

contracts (*y* – dependent variable).

Table 2

Variables for regression analysis

Quantity of insurance contracts	*Y*
Area, thousand hectares	x1
The amount of the award, mln UAH	x2
Subsidy, mln UAH	x3
The level of payments, %	x4
The average premium rate, %	x5
Exchange rate USD/UAH	x6
The amount of the award, mln USD	x7

Source: made by the authors based on enterprise statistical reporting.

The main aim of constructing the model was to identify the dependence of quantity of insurance contracts and other indicators of insurance in agricultural sphere. The main hypothesis that we confirm using regression analysis is that the number of agricultural insurance contracts as an indicator of the dynamics of development of this insurance sector depends on a limited set of variables that represent economic processes in agricultural insurance.

Table 3 and 4 illustrate the results of performed analysis and indicates model accuracy. As it can be seen from Table 3 the main influence on quantity of insurance contracts have exchange rate USD/UAH and subsidy, mln UAH. Less important for the value of the variable – *Y* is area, thousand hectares. Other variables didn't determine this variable, value *x7* was not included into model due to high p-value (0.3271).

Table 3

Regression summary for dependent variable (y)

Indicators	b*	Std. Err. of b*	b	Std. Err. of b	t (9)	p-value
Intercept	-	-	608.03	320.57	1.89	0.0908
x1	0.96	0.16	1.89	0.31	5.97	0.0002
x6	-0.43	0.12	-45.65	13.32	-3.42	0.0075
x3	-0.52	0.17	-22.23	7.94	-2.79	0.0207
x7	0.19	0.18	22.64	21.85	1.03	0.3271

Source: made by the authors based on their own calculations.

Table 4

Regression summary statistics

Statistic	Value
Multiple R	0.94
Multiple R^2	0.88
Adjusted R^2	0.83
F(4.9)	17.92
p	0.0002
Std. Err. of Estimate	377.765

Source: made by the authors based on their own calculations.

Regression summary statistics presented in Table 4 shows that the correlation between actual and predicted values of the dependent variable *y* is significant (0.94) and the model's accuracy in explaining the dependent variable (determination) is also good (0.88).

Normality of the residuals (Fig. 5–6) means that our assumption is valid and model inference (confidence intervals, model predictions) should also be valid.

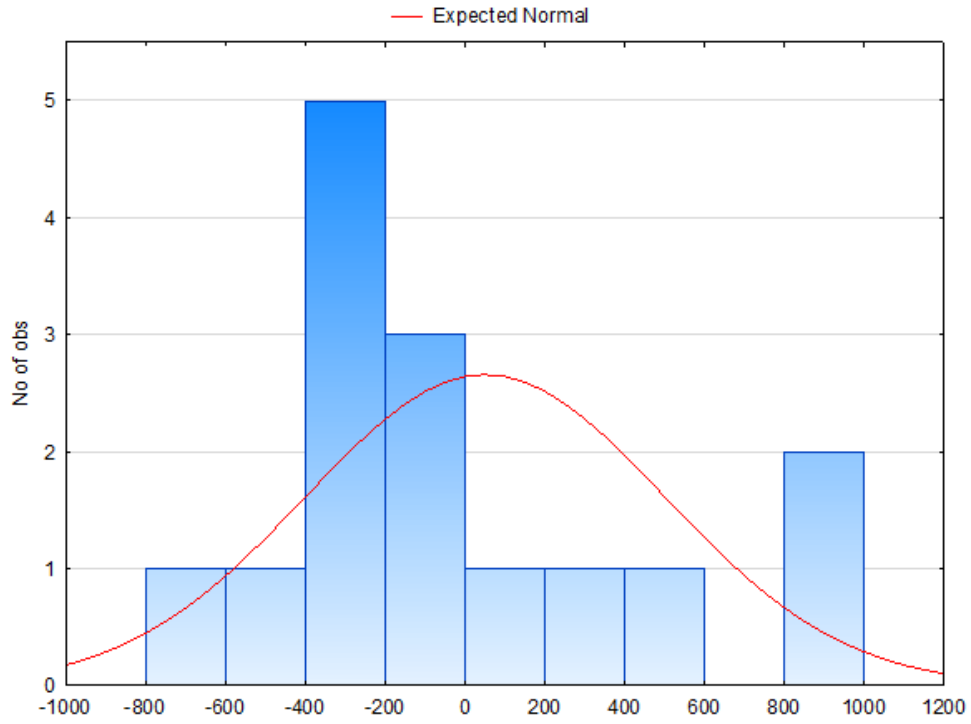

Fig. 5. Distribution of raw residuals

Source: made by the authors based on their own calculations.

A common and simple approach to evaluate models is to regress predicted vs. observed (Fig. 7).

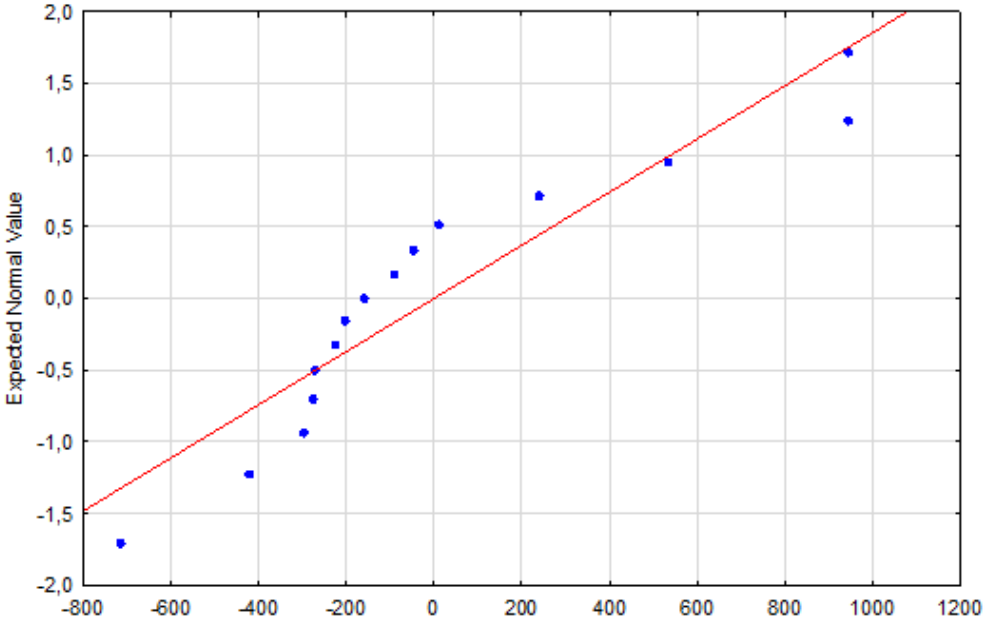

Fig. 6. Normal probability plot of residuals

Source: made by the authors based on their own calculations.

As it seen on Fig. 7 our model is quite good (regression line slope is 45 degree).

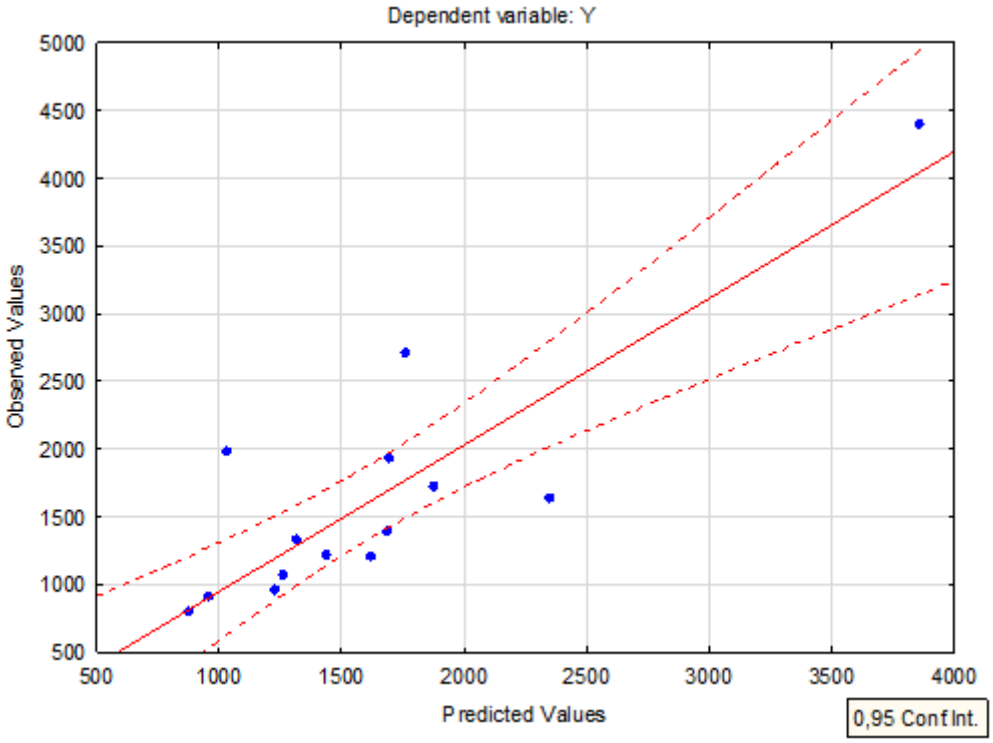

Fig. 7. Predicted vs. observed values

Source: made by the authors based on their own calculations.

The simulation shows that the number of insurance contracts has elasticity from the areas insured at the level – 0.96, elasticity from subsidies at the level -0.43, and from the exchange rate of the US dollar at the level -0.52. Therefore, it can be concluded that further increase in the volume of agricultural insurance in Ukraine will depend on the level of state subsidies for agro-industry and monetary policy in the country.

Conclusions. In the 2019 underwriting year, the growth trend of the crop insurance market continued, it was resumed in 2016. This is evidenced by the behavior of most market indicators, in particular: in the 2019 underwriting year, the volume of collected insurance premiums increased slightly (by 13.82 % in UAH); the total amount of insurance liabilities (sum insured) and collected premiums increased by 11.38 % and 2.34 % against the background of the general market growth trend; the average premium rate in 2019 changed hardly compared to the previous year, decreased by only 0.4 % and amounted to 3.5 %, including 3.7 % for the overwintering period and 3.1 % for the spring-summer period; the overall level of payments in 2019 comprised 16.9 % and which was slightly higher than in 2017.

In order to identify the dependences of variables and to assess the impact of some insurance indicators, a regression analysis was performed for further modeling. With this taking into account a direct selection was applied, which made it possible to start without variables in this model by checking the addition of each variable using the selected criterion of conformity of the model; as well as the recurrence of this process until the best state of the model.

Therefore, the regression result for the dependent variable *Y* certifies that the

main impact on the number of insurance contracts have the rate of USD / UAH and subsidy, mln UAH. Less important for the value of the variable – *Y* is the area, thousand hectares, and other variables did not define this variable. The obtained regression value of the predicted and observed values demonstrates an adequate model, as the slope of the regression line is 45°.

Prospects for further research are that the comparison of the studied insurance indicators in the agricultural insurance market allows determining the relationship between variables with the separation of their weight, which affect insurance contracts and confirm the adequacy of the conducting diagnostics which will be used during the evaluation of insurance contracts at enterprises of the agricultural insurance market.

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