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RELATION BETWEEN SELECTED WEATHER FACTORS AND INSURANCE INDEMNITY IN UKRAINIAN AGRICULTURE

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ABSTRACT

The present paper is devoted to examining if weather variables have a significant impact on the level of indemnity in examined agriculture insurances, i.e. insurance of winter crops. The authors will determine whether indicators as excessive rainfall and extreme temperatures (especially frost) contribute to crucial increase of insurance indemnity. According to currently existing theories, weather changes have vital consequences both for farmers and for insurers as they take over the risk. The goal of the present paper is to analyse strength and direction of correlation between weather variables and insurance indemnity in case of winter plants to state whether these influence amounts of money paid to farmers for their crops' losses.

Keywords: insurance indemnity, weather variables, agriculture
JEL codes: G22, Q14

INTRODUCTION

It has been acknowledged that climate change is one of the greatest ongoing risks to our society (World Economic Forum, 2017). The problem of climate change and its influence has recently moved from the ecological areas of study to economics. The unpredictable character of the climate makes the business of agriculture more risky and costly. That is why the variety of weather conditions and the circumstances under which the insurer will compensate the insured from year to year has become more extensive. The research question is if critically changing weather conditions always cause the increase of insurance indemnity. The case of Ukrainian agricultural insurance is the subject of our research.

THEORETICAL BACKGROUND

At present, agricultural insurance is developing towards the minimization of the asymmetry of information concerning agricultural risks and towards a more effective estimation of insurance losses. Agricultural insurance losses have a direct connection with natural disasters and climate change. Due to this, different theoretical approaches are being explored that attempt to explain the relationship between weather changes and agricultural insurance. Most papers discuss insurance indemnities in the context of the implementation and development of index insurance. Different types of indexes are used in agricultural insurance: weather index, commodity price index, vegetation index, area yield index, etc. The main advantages of index

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insurance are the objectiveness and non-sensitive to moral hazard and adverse selection instead of traditional insurance. The mechanism of index insurance provides the dependence of insurance indemnities on critical weather indices. The idea of index insurance is based on the concept of providing financial protection to the cultivator against losses due to adverse weather incidents, such as rain deficit and excess rainfall, frost, heat, relative humidity, etc. In practice, the weather indices may include: the total seasonal rainfall indices, weighted rainfall indices, multiple phase weather indices, consecutive dry days indices, excess/untimely rainfall indices, low temperature or frost indices, high temperature indices, weather indices for pests and diseases (World Bank, 2011).

We would like to point out that weather index insurance has become more popular in some countries such as India, USA, Canada, Uruguay, Mexico, Ukraine, Malawi, or Brazil. This type of agricultural insurance is widespread in developing countries as it produces optimal insurance coverage with minimal asymmetry of information (due to clear meteorological indicators). That being the case, we tried to de monstrate the relationship between selected weather parameters and insurance indemnity in the case of winter crops. It has been said that weather factors determine the risk of crop losses, but what about the relationship between weather parameters and insurance indemnities? Different aspects of this question have been discussed by various researchers (Table 1).

Some questions concerning weather insurance indices were researched, such as the underwriting of agricultural risks under the conditions of a changing climate and fluctuating insurance prices (Che Mohd Imran, 2012), the influence of climate change on crop insurance premium rates (Tack, 2013). It has been demonstrated by research that:

– there is a close relationship between lowering the chemical input of farmers from one side and the moral hazard of agricultural insurance on the other side (Smith, 1996);
– there is only a tenuous relationship between insurance indemnities in agriculture and natural disaster losses in China due to the 'saving' policy of insurance companies; this was the main reason for the weak development of agricultural insurance in China up until 2007 (Wang, 2011);
– the opportunities and challenges of using techniques like satellite imagery, weather stations, drones (Krishna, 2017);
– in 2017 weather factors caused 58% of the total losses in Ukrainian agriculture (International Finance Corporation, 2017).

The demand for agricultural insurance is characterized by a range of indicators such as the number of insurance contracts, the territory which was insured, the insurance sum, premiums and level of indemnity payments. It may be observed from Table 2 that the total number of contracts declined from 2011 to 2017. Most of these contracts concern insurance

Table 1. Selected articles about the relationship between weather indicators and insurance indemnity

Source	Title	Conclusions
Willams et al. (1997)	An Expected-Indemnity Approach to the Measurement of Moral Hazard in Crop Insurance	'moral hazard affects multiple peril crop insurance indemnities in poor production years but that no significant moral hazard occurs in years when growing conditions are favorable'
Raju et al. (2016)	Transforming Weather Index-Based Crop Insurance in India: Protecting Small Farmers from Distress.	high correlation between rainfall deficit (drought) and insurance indemnities
Maestro, Bielza and Garrido (2106)	Hydrological drought index insurance for irrigation districts in Spain	unitary indemnity estimation does not completely offset economic losses that might affect ligneous crops in case of drought, especially when drought affects production in subsequent years
Clarke (2016)	The theory of rational demand for index insurance	the risk that the farmer experiences a loss and receives no insurance indemnity because it is not a loss that is reflected in the index

Source: own elaboration.

Table 2. Selected indicators concerning agricultural insurance in Ukraine in 2010–2017

Specification	2010	2011	2012	2013	2014	2015	2016	2017
Insurance contracts	1 217	2 710	1 936	1 722	1 392	1 062	793	957
Insured yields (thous. ha)	553	786	727	869	732	689	700	661
Insurance sum (UAH million)	n.d.	n.d.	n.d.	n.d.	3 055	3 969	6 240	5 933
Insurance premiums (UAH million)	72.1	136.3	130.4	135.4	72.8	77.7	157.0	204.3
Subsidy (UAH million)	0	0	0.086	0	0	0	0	0
Level of indemnity payments (%)	3.8	50.9	28.0	9.7	7.6	12.9	44.2	4.9

Source: International (2018).

against frost damage during the dormant period of plant growth and early springtime frost (according to data 2017).

On the other hand, the absolute indicators of insurance premiums and sums have ceased to increase. This may be explained by changes in Ukrainian currency exchange rates and prices in the world market for some types of grain.

MATERIALS AND METHODS

The research includes 3 different aspects: weather conditions, agriculture and insurance. The scope of our research involves Ukraine as one of the leaders in world agriculture (wheat production 26,700 thousand tonnes, maize – 28,418 thousand tonnes in 2017) (OECD, 2018a). Ukrainian share in world wheat production equals 3.58% and in world maize production about 2.78% (OECD, 2018b).

Firstly, we discuss the extent of the weather changes in 2017 and during the period 2007–2017. For this discussion we use some weather indices (maximum temperature, minimum temperature and average rainfall) with weekly values in the period from 1 December 2016 till 30 April 2017. The study of weather changes in selected Ukrainian districts was based on the data of the Speedwell Weather System. Secondly, we explore the subject of insured areas and the types of insured crops. For this analysis we used the reports of the Ukrainian Ministry of Agriculture and other government and international institutions. The third aspect is an analysis of the insurance indemnity in selected districts of Ukraine that avoided the highest insurance indemnities per insured hectare in 2017.

RESULTS AND DISCUSSION

Within the scope of the research, twelve Ukrainian districts were examined. The variables, that were taken into consideration were the area insured in hectares, the number of insurance contracts, premiums in UAH, the insurance premium per unit area insured, and the insurance indemnity in UAH. Because different districts have different areas to be insured, it was necessary to include a new indicator – indemnity in UAH per hectare insured, to allow a fair comparison to be made. This indicator was then juxtaposed with data concerning weather variables. The results are presented in Table 3. The correlation between indemnity per hectare and selected weather variables was not very significant (absolute value below 0.25), only in the case of the minimum temperature recorded it was at a level of –0.44, showing that lower temperatures (frost) cause an increase in the indemnity per hectare.

Four districts with a higher indemnity per hectare insured were examined: Cherkasy, Khmelnytskyi, Zaporizhia and Ternopil. Correlation coefficients between indemnity per hectare insured and weather variables: rain, maximum, and minimum temperature were as follows: 0.78, 0.63, –0.37. An increase in rain intensity and in maximum temperatures leads to a higher indemnity per hectare insured.

The data presented above for the regions shows that the standard deviation calculated for the year 2017 for all the examined variables differs from the one calculated for the last ten years. These discrepancies, however, are at various levels – the most significant variations may be observed in the case of rain intensity, the least significant ones occurred in the case of

Table 3. Summary statistics for weather variables

District	Insurance premiums for area insured	Indemnity/ /area insured	Rain		Maximum temperature		Minimum temperature	
			standard deviation – 2017	standard deviation – last 10 years	standard deviation – 2017	standard devia-tion – last 10 years	standard deviation – 2017	standard devia-tion – last 10 years
Zaporizhia	265	48.47	7.20	1.60	7.40	6.62	6.26	4.54
Khmelnytskyi	207	41.15	3.49	1.28	8.02	6.66	6.09	4.66
Cherkasy	422	85.00	6.99	2.03	7.50	6.79	6.06	4.69
Ternopil	201	23.24	2.73	0.99	2.73	6.51	6.13	4.80
Vinnytsia	536	8.46	6.73	1.42	7.42	6.70	6.95	4.75
Dnipropetrovsk	269	1.11	10.35	2.28	7.17	6.84	6.61	4.63
Donetsk	118	4.80	6.72	1.42	6.39	6.51	6.26	4.77
Zhytomyr	312	13.46	6.02	1.47	7.42	6.59	6.64	4.48
Ivano-Frankivsk	231	3.02	2.96	1.13	7.69	6.02	6.37	4.76
Lviv	479	4.42	4.16	1.89	7.32	5.95	6.00	4.28
Kharkiv	88	0.90	6.96	1.69	6.97	7.05	7.40	5.20
Chernivtsi	403	6.56	4.04	2.10	8.00	6.52	6.16	4.85

Source: own calculations based on: Speedwell Weather on-line database, International Finance Corporation (2018).

minimum temperature. To examine these differences, the coefficient of variation was calculated. The percentage results are presented below (Table 4).

Although data regarding temperature were originally expressed in degrees Celsius, they were converted to kelvins, to enable the calculation of coefficients

Table 4. Coefficients of variation

District	Indemnity/area	Rain (%)	Maximum temperature (%)	Minimum temperature (%)
Zaporizhia	48.47	128.27	2.61	2.35
Khmelnytskyi	41.15	83.13	2.85	2.28
Cherkasy	85.00	145.78	2.65	2.27
Ternopil	23.24	94.70	0.99	2.30
Vinnytsia	8.46	98.13	2.63	2.60
Dnipropetrovsk	1.11	163.66	2.54	2.48
Donetsk	4.80	114.44	2.27	2.34
Zhytomyr	13.46	91.73	2.62	2.48
Ivano-Frankivsk	3.02	83.57	2.69	2.40
Lviv	4.42	73.37	2.58	2.26
Kharkiv	0.90	111.84	2.48	2.78
Chernivtsi	6.56	112.01	2.81	2.30

Source: own calculations based on: Speedwell Weather on-line database, International Finance Corporation (2018).

of variation (that must only be calculated using a ratio scale). The degree of variation with temperature was low, oscillating between 2 and 3%. It is interesting to note that a clear link between variations in rainfall and indemnity per hectare insured may not always be observed. For example, the district of Dnipropetrovsk has a very high coefficient of variation while at the same time having a very low indemnity per hectare insured. In contrast, the district of Khmelnytskyi has a low coefficient of variation (in relative terms, in this set) but it has the third highest indemnity per hectare insured.

CONCLUSIONS

Our work has led us to conclude that:

– based on an analysis of twelve districts, we found that the correlation between indemnity per hectare and selected weather variables (minimum and maximum temperature, rainfall) was not very significant (absolute value below 0.25), only in the case of the minimum temperature it was found to be at a level of –0.44, showing that lower temperatures (frost) cause an increase in indemnity per hectare;
– in the case of the analysis of four districts with higher indemnities per hectare we found that an increase in rain intensity and in maximum temperatures lead to a higher indemnity per hectare insured;
– the clear link between the variation in rainfall and indemnity per hectare insured may not always be observed: the districts with the highest level of variation in rainfall had the lowest indemnity per hectare in 2017 as was the case with Dnipropetrovsk. At the same time, it is necessary to acknowledge that variations in the maximum and minimum temperature did not affect the insurance indemnity. And vice versa, there is evidently a relationship between the insurance indemnity and the amount of rain in the Cherkasy district.

Taken together, these results suggest that rainfall and maximum and minimum temperatures are not the main factors that may have an effect on the high insurance indemnity for the insurance of winter plants.

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