Factors influencing farmers' decisions on drought index insurance in Poland

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Monika Kaczała[1], Dorota Wiśniewska[2]

Summary

The main aim of this study is to identify factors determining the acceptance of index drought crop insurance and ex-ante demand for it in Poland. Since 2014 subsidizing of index insurance has been allowed by CAP in Europe, but there is still a substantial lack of surveys concerning the introduction of this instrument in developed countries. Statistical analysis, logit models (binomial and ordinal) and sample selection model were applied for analysing the representative poll taken in March 2012 from 500 respondents with the use of the CATI methodology. The results indicate that the opinions about insurance in general and crop insurance in particular have a stronger impact on the acceptance of the index product than the characteristics of a farmer, farms and income. The level of product acceptance significantly determines the farmer's willingness to buy it. The experiences connected with drought do not influence the opinion about drought index insurance product but have an impact on purchase of insurance. The latter is significantly determined by the amount of indemnity received in the past. The monthly income level is not a significant factor affecting the purchasing decision. The findings are relevant especially for post-communist countries, where the farmers' trust in any institution and especially in insurance is relatively very low and the misunderstanding of index crop insurance is highly probable for historically established fullness of compensation.

1. Introduction

Index-based insurance has quite a few undeniable advantages. Underwriting and administrative costs are lower due to the fact that individual farms do not have to be inspected. Also, there is no need for loss adjustment because it is enough to measure the index and morale hazard is lower than with traditional insurance products. As index-based insurance

[1] Department of Insurance, Poznan University of Economics, Poland
[2] Department of Econometrics, Poznan University of Economics, Poland

minimizes the cost of insurance, it may cover otherwise uninsurable occurrences.

The main problem connected with the use of index-based insurance is the "basis risk", which denotes the discrepancy between product basis and the genuine risk parameters that a particular entity is to be protected from (Golden, Mulong, Yang 2007; Barnett and Mahul 2007). If there is no compensation despite the loss occurrence, the readiness to buy such a product obviously falls. Index-based insurance has been used in agriculture since 20th century and now is basically introduced as micro insurance in developing countries, both in plant and animal production (Collier, Skees and Barnett 2009). However, it also was or has been present in some European countries, like Spain, France, Austria (Diaz-Caneja et al. 2009) and Ukraine (World Bank 2011). In spite of the experiences there is a substantial problem with scaling up the index pilot programs due to lack of full insight into what drives the take-up.

Demand for index insurance has been researched especially in the context of developing countries (Patt, et al. 2009, Clarke 2011; McIntosh, Sarris and Papadopoulos 2014, Cole, Stein, Tobacman 2014) . However, almost no research has been conducted so far to determine farmers' acceptance and willingness to buy index insurance in the Eastern and Central Europe, especially in the post-communist countries.

In the former communist countries expectations for agricultural insurance are historically established. Since fullness of compensation in the area of agriculture was in fact a common practice in communist times, farmers still expect the compensation to fully cover the loss (e.g., paid compensation for hail-damaged corn should correspond to the values for which the seed could be sold by the farmer). In the 90's of the last century insurers in Eastern and Central Europe have begun to use limitation to prevent increased claims. Also, they gave up covering certain risks (especially drought, flood, or frost with respect to plants and fruit trees) and raised their premiums significantly. Consequently, there was a serious decrease in the number of traditional insurance contracts, which has not been restored until today. There is a question, if index insurance may, at least in part, fulfill the market need. At present, this question is getting more important, as the new Common Agricultural Policy has allowed for the support of agricultural index insurance.

The purpose of this research is to investigate the factors affecting the acceptance and willingness to buy drought index insurance in Poland.

Poland as an example of a Central European post-communist country has been selected for this study, because it is one of the main suppliers of area and people in the EU agriculture (it accounts for over 10% of the EU arable land and over 25 percent of the EU agricultural population (Statistical Yearbook of Agriculture 2013)). Only ca. 30 per cent of farms in

Poland are using subsidized crop agriculture insurance despite its obligatoriness (Rojewski 2014). Other subsidized instruments allowed by CAP, i.e. mutual funds and income stabilization funds have never been in use in Poland yet.

The primary reason for the choice of drought as a subject of this study is that it is one of the most important sources of risk for Polish farmers (Kaczała, Wiśniewska 2014). As a matter of fact, in some regions of Poland where the soil quality is poor, drought is expected to occur every two years. Therefore, insurance companies will not offer any drought insurance at all or the premium is too high for the farmers to accept.

2. Review of the literature

The debate about demand for agriculture index product on the micro-level is mainly concentrated on economic factors. Within the utility theory, farmers' maximal willingness to pay and the relative attractiveness of index insurance in comparison to other coping mechanisms are investigated (for example Clarke 2011). Demand for rainfall index insurance is significantly price-sensitive (Cole et.al. 2013, McIntosh, Sarris and Papadopoulos 2014) although some authors point that impact of the household income level is small (Patt et al. 2009). Additionally, liquidity constraints could significantly reduce the demand (Gine 2015, Patt et al. 2009, McIntosh, Sarris and Papadopoulos 2014) and their adjustment to the farmers' needs could increase the take-up by 34% (Andhra Pradesh' case Gine 2015). The use of chemical fertilizers or subsidy vouchers seems to be another important factors affecting take-up of index insurance (McIntosh, Sarris and Papadopoulos 2014).

Some researches give the evidence that the process of decision making about buying index insurance is not only rational, but it is also influenced by non-economic factors. Trust is one of the determinants, where trust in the organization involved in the insurance program, trust in insurance product and trust in one's own ability to make the right choice is distinguished. The first category, also referred to as trust in the so called third party (Patt et al. 2009, Cole et.al. 2013, Gine 2015) can enhance take-up by 11% (Andhra Pradesh' case Gine 2015). Trust in the institution involved in the agriculture index program is increased when a farmer is a member of the institution and when he has been its former customer. (Patt et al. 2009). Trust in insurance seller rises due to the endorsement from the familiar institution (Cole et.al. 2013). The trust in product, i.e. that the product is genuine and the farmer will receive a payment if the payment terms are fulfilled[3] can substantially improve take-up

[3] The latter requirement is known in the literature as one of the principles of insurance, i.e. the principle of realness (Handschke 2001).

decisions (Cai 2009, Patt et al. 2009, Cai 2013, Cole et.al 2013). In this context claim and payment experiences (farmer's own and of the closest community) (Cai 2009, Cai 2013, Cole et.al 2013, Cole, Stein, Tobacman 2014) is crucial. The role of knowledge about the product is quite ambiguous – some authors point out that it has no effect on demand (Gine 2015), but some conclude that better understanding of the product makes farmers more likely to buy it (Patt et al. 2009, Cole et.al 2013). A well-informed farmer should be able to make the right choice about the product and avoid misunderstanding payment terms; this should enhance the trust in product and the trust in their own ability to make the right decision (Patt et al. 2009). Furthermore, the better the household is educated, the more likely the farmer is to buy the index product (Gine, Townsend and Vickery 2007). Trust is a kind of equivalent of household financial literacy and low education level (Cole et.al 2013). Financial illiteracy could be reduced by appropriate materials and it could result in increasing take-up of insurance, especially when farmers' social contacts similarly gain access to this kind of materials (Giné; Karlan and Ngatia 2013). Last but not least, limited attention or salience could also decrease the demand for index insurance (Cole et.al 2013).

Most of the available research findings in the field of agriculture index insurance are concerned about index insurance for poor people (small holder farmers), who are "*the hardest target for this kind of product"* (Gine 2015). However, the identified factors affecting demand are also common for other types of index insurance, especially health insurance (for example McCord 2001, Schneider 2005, Natalier and Willis 2008). It has to be pointed out that most of the above mentioned studies analyzed ex-post demand, whereas we concentrate on the ex-ante acceptance and demand for an index product.

3. The aim, data and method of the empirical study

The main aim of this study is to identify the factors that can explain the degree of acceptance of the insurance product (index-based crop insurance for drought) and that can explain the degree of ex-ante willingness to buy the product. The strength of their possible dependence on the identified factors is of great interest to the authors: we want to check if it is possible to construct a high-quality model that enables to classify the farmers into groups according to the degree of acceptance of the product or according to the degree of willingness to purchase it. We want to construct a model that would describe the process of decision making. The practical significance of such a classification tool is really vital and certainly motivating.

The primary data was gathered on the basis of a survey conducted in March 2012 by

means of CATI method, with the use of the structured questionnaire schedule, on a group of 500 Polish individual farmers who cultivate plants and whose farms are located on the drought-prone area[4]. The representative sample was selected on the basis of the farm location and size.

The drought index product has been set up on the basis of the Climatic Water Balance (CWB) [5] indications, thus meeting the following requirements:

Threshold = CWB reaches the defined value, which causes damage exceeding 50%, of the 10 year average yield for a given crop in a province (1)

Claim payment per 1 ha = 10 year average price for 1 t of a given crop in a province*claim payment rate (2)

$$\textit{Claim payment rate} = \begin{cases} 1 \text{ for wheat} \\ 10 \text{ for sugar beets} \\ 0.75 \text{ for rapeseed} \end{cases} \quad (3)$$

The payout would be made just after the announcement that CBW reaches the threshold. The moment of premium's payment was not specified.

The study consisted of two main stages. First, some statistical tests were conducted to determine the relevant factors which have an impact on farmers' opinion about the product and which can influence their willingness to buy the product. The three groups of factors were considered:

a) objective and rather permanent traits of the farmers and farm; financial data:
   - sex, age (in intervals), educational background,
   - farm size, production purpose (for their own use or to the market), dominant soil quality class, the use of additional, non-farming sources of income (the share of

[4] Drought-prone area included selected communities from nine voivodeships, where crop drought conditions (according to the reports of the Institute of Soil Science and Plant Cultivation - State Research Institute (IUNG-PIB)) had been indicated in the last 5 years before the survey date, i.e. from: Łódź Voivodeship (V.), Greater Poland V., Masovian V., Kuyavian-Pomeranian V., West Pomeranian V., Lubusz V., Lower Silesian V., Podlachian V. and Świętokrzyskie V.

[5] The Climatic Water Balance (CWB) index is the main drought-monitoring tool in Poland, additionally including soil's water retention qualities. The CWB index meets the requirements of index-based insurance systems because it defines the potential yield losses against the average conditions. CWB expresses the difference between precipitation and potential evapotranspiration.
CWB = P - ETP
Where:
CWB - Climatic Water Balance
P - precipitation in a given period
ETP - Penman evapotranspiration in a given period

agricultural income in total income), dominant production (plant, pork, milk production, lack of specialization), types of crops, farmer's monthly income ,

- province where the farm is located – limited to drought area,

b) experiences related to drought and opinions about the sensitivity of farm income to risk:
   - the frequency of droughts in the previous 10 years,
   - evaluation of the influence that drought had on the farm's income from crops (in the scale of 1 to 4, where 1 denotes lack of influence on the income, and 4 denotes a very big influence),
   - the degree of crop loss which does not jeopardise the farm operations,
   - the degree of crop loss leading to bankruptcy;

c) the farmer's experiences connected with crop insurance and the subjective opinions of the respondents about insurance companies and insurance products (in general): the respondent was to indicate the level of his acceptance toward some statements in the scale of 1 to 5, where 1 denotes disagreement and 5 denotes agreement).

Most of the variables are qualitative ones or are stated on the scale intervals. To verify if the opinion depends on those variables, a number of contingency tables were produced and the Pearson's chi-square test of independence was conducted. In the case of quantitative variables (such as frequency of droughts or the share of agricultural income in total income) the classical ANOVA and nonparametric Wilcoxon–Mann–Whitney (WMW) or Kruskal-Wallis (KW) tests have been applied[6]. These tests allow us to verify if the mean value of quantitative variable is equal or different in distinguished groups of individuals. The latter one is more appropriate because the variables are not normally distributed.

All tests are performed in Statistica 10PL.

As some of the considered features had quite a few variants, a problem appeared with regard to the appropriate number sample size in each cell of the contingency table. Therefore, the ordered responses have been categorized into three or two classes. What is more, such a categorization was helpful in some cases (it made the interpretation of the results easier) but in one case it was even necessary – this case occurred during the construction of discrete variable model that was to be implemented. The possible variants of explained variables are presented in **table 1.**

[6] For more details see: [Aczel 2009]

Table 1. Explained variables in the research and their possible variants

Opinion that should be explained and forecasted	Multivariate variables PRODUCT_ACCEPT and BUY_DECISION	Categorized variables PRODUCT_ACCEPT_CAT and BUY_DECISION_CAT
The degree of acceptance of the new concept for index-based crop insurance for drought at a specified price for this insurance In short: the degree of acceptance of the product	1- Definitely do not like it 2 - I do not like it 3 - I quite like it 4 - I like it 5 - I like it very much 6 - I like it extremely	0 - I don't like it (if it is set to 1 or 2) 1 - I like it (if it takes variants from 3 to 6)
The degree of willingness to buy the insurance-product (index-based crop insurance for drought) In short: willingness to buy	0- Definitely will not buy it 1- Probably will not buy it 2 - I am not sure if I will buy or not 3 - Probably will buy it 4 - Definitely will buy it	0 - Will not buy (if it takes variants 0 or 1) 1 - I am not sure 2 - Will buy (if it takes variants 3 or 4)

Source: own study based on the questionnaires.

The second stage of research is an estimation of some models which would describe the explanatory variables. First two kinds of discrete variable models are constructed:

- binomial logit model for the level of product acceptance, categorized into two classes (see table 1),
- ordinal logit model for the willingness to buy, categorized into 3 classes (see table 1).

At this stage we want to check if the existence of statistically significant dependence enables the correct classification of the farmers into distinguished groups. This stage is necessary to estimate how strong features of farmers and their opinions determine the values of explained variables.

As it is natural and quite obvious that a good opinion about the product is the necessary condition to buy (unless it is obligatory), we decided to analyze more carefully why people who like the product are not always very much willing to buy (and sometimes are even unwilling to purchase it). To give model explanation of such behavior, we decided to restrict the sample to farmers who have positive opinions and identify the significant factors that have an impact on purchasing decision. In this case, we should take it into account that the determinants of the level of acceptance may indirectly influence the willingness to buy and that (what is even more important) the random disturbances that have an impact on the "selection variable" (PRODUCT_ACCEPT_CAT) and the random disturbances that affect the variable that we want to explain (BUY_DECISION taking the values on the scale from 0 to 4)

may be correlated. For that reason we decided to implement the sample selection model (heckit) to describe the process of purchase-decision making. The heckit-model consists of two equations: the first one is the model for selection variable and it is usually a probit (also in this case). The second is a type of Tobit model (used for censored variables[7]) which has an additional explanatory variable based on residuals from the model for selection variable. This additional variable will be, as usual, named lambda and its parameter reflects the strength of correlation between residuals of both equations of the heckit model.

All models[8] are estimated with maximum likelihood method in Gretl.

4. The determinants of the opinion about index-based insurance product and the willingness to buy the products in the light of statistical tests

The carried out independence tests enable us to verify if the distribution of ordered responses is not dependent on the values of different features of the respondent. To interpret the results the overall empirical distribution of responses must be known. It is presented in **table 2.**

Table 2. The empirical distribution of the multivariate and categorized responses to the questions about the index-based insurance product

	Possibile responses	Number of respondents	Percentage of respondents	
Level of acceptance of the product	1- Definitely I do not like it	97	19%	43%
	2 - I do not like it	119	24%	
	3 - I quite like it	141	28%	57%
	4 - I like it	120	24%	
	5 - I like it very much	18	4%	
	6 - I like it extremely	5	1%	
Level of willingness to purchase the product	1- Definitely will not buy it	87	17%	41%
	2 - Probably will not buy it	119	24%	
	3 - I am not sure if I will buy it or not	226	45%	45%
	4 - Probably will buy it	56	11%	14%
	5 - Definitely will buy it	12	2%	

Source: own calculations based on the questionnaires responses

As we can see most respondents (57%) quite like or even extremely like the new index-based insurance. What is really surprising, the good opinion about the product is not reflected

[7] Although censored variable in Tobit is usually continuous , we decided to implement this method because PURCHASE_DECISION can take on values on the scale from 0 to 4 and can be seen as quasi- continuous.
[8] For more details see [Cameron and Trivedi 2005; Wooldridge 2009; Gruszczyński 2012]

in the willingness to buy. The share of undecided respondents is quite big: 45%. Of course, farmers who don't like the offered product present in almost all cases a decided attitude: they would not (or rather not) buy it. The opinion about the product is (with no doubt) the strongest determinant of purchasing decision. However, it would make sense to find more relevant factors. The results of statistical test concerning the significance of rather objective farm's and farmers' features and financial data are presented in the **table 3.**

Table 3. The relevance of features of the farm or a farmer - the p-values of statistical test

Feature of the farmer or the farm	PRODUCT_ACCEPT CATEGORIZED	BUY_DECISION CATEGORIZED
Sex of the farmer	0.360	**0.039**
Age of the farmer	0.455	**0.096**
Educational background	**0.011**	0.608
The size (areal) of the farm	0.438	**0.100**
Purpose of the production	0.200	0.282
Dominant soil quality class	**0.060**	**0.026**
Dominant production	0.568	0.332
Province where farm is located	**0.006**	0.160
Monthly income of a farmer	0.263	0.557
Share of agricultural income (ANOVA)	0.510	0.159
Share of agricultural income (WMW or KW test)	0.530	0.162
Permanent vs. seasonal additional source of income	0.860	0.208

Source: own calculations based on the questionnaires responses

The above results show that only in few cases the zero-hypothesis about the lack of independence could be rejected. For that reason the 10% (not 5% as usual) significance level was accepted. Consequently, we have to be aware that statistically significant relations are probably not very strong.

Analyzing the results regarding the opinion about the product, we can notice that the most significant determinant of the level of acceptance of the index-based insurance product is the farm localization. A good opinion about the product was most often declared (by more than 80% of respondents) in Lower Silesian and Podlachian Voivodeships. Unfortunately, the number of observations in relevant part of contingency table was too small and those voivodeships (together with Świętokrzyskie Voivodeship) had to be excluded before calculation of Chi-square statistics. The lowest level of acceptance could be observed in Łódź, Greater Poland, and Świętokrzyskie Voivodeships, where only 50% of respondents declared a good opinion.

The level of education is the second significant determinant. A good opinion about the

product was offered by 63% of respondents with secondary or higher education level, 56% of respondents with lower secondary education and only 48.26% of those with vocational education.

The good opinion was expressed by 54% of farmers with domination of III and IV soil quality class and 57% of individuals with domination of V and VI class of soil; a much higher share of good opinions is observed when the I and II class of soil is dominant, but due to small number of observations this variant must be excluded from statistical inference.

Although the list of significant (but for sure not strong) determinants of opinion is closed, we decide to pay some attention to some more results. A good opinion about the product was declared by 62% with market-dedicated production and 52% of those who produce mainly for their own use. We can also observe that a good opinion is declared a little bit more often by the people with the highest monthly income than by the individuals with lower income. Although these results are consistent with intuition we can't forget about their statistical insignificance. We also indicate that only 302 out of 500 respondents disclosed their monthly income and this variable could not be used in econometric modeling which will be taken up later.

Analyzing the results regarding farmers' willingness to purchase the product, we can notice that the significant factors are: dominant soil quality class, sex and age of respondent and the size (areal) of the farm. P-values are quite low (but not low enough to infer statistical dependencies) in the case of a province (again) and the share of agricultural income in total income. . In particular:

- The owners of bigger farms are more likely to purchase the product (the willingness to buy is declared by 21% of farmers owning more than 20 ha and by only 10.7% of farmers owning less than 7 ha);
- The willingness to buy is declared as the least likely by the farmers with III-IV class of soil (47.4% of farmers state that they will not buy while 13% state that they are willing to buy), the percentage of farmers who are not willing to buy is lower in the case of the farmers with the worse class of soil V-VI (35.6%), but at the same time most of them (52%) remains hesitant.
- The reason for statistical significance of sex is that women are more hesitant than men. This regularity is not useful in identification of farmers who are more likely to buy a product;
- The willingness to purchase is declared by 18% people up to 40 years of age and 12% people who are over 60.

- Farmers who are hesitant declare that agricultural income represents 73% of total incomes. The mean shares of agricultural income are the same (67%) in groups of respondents who are willing and who are not willing to buy. This clearly shows that the source of income does not allow us to identify the potential buyers;
- The test results show that the size of the monthly income is not a significant determinant of purchasing decision, which is both very important and surprising.

To finish this stage of statistical research, we have to add that in both cases (PRODUCT_ACCEPT and BUY_DECISION) the type of crops that grow on the farm do not affect the distribution of responses (the results are not presented in a table).

In the next step, the significance of experiences related to drought and the significance of opinion about the vulnerability of the farm to the loss in crops is verified. The results are collected in table 4.

Table 4. The relevance of drought-experiences and opinions about impact of perils- the p-values of statistical test

Experiences and opinions	PRODUCT_ACCEPT CATEGORIZED	BUY_DECISION CATEGORIZED
Is draught dangerous? (0-1)	0.545	**0.084**
The impact of drought on income (3 classes)	0.276	**0.004**
The frequency of drought (ANOVA)	0.290	**0.001**
The frequency of drought (WMW/KW test)	0.510	**0.000**
The accepted degree of crop loss	0.544	0.904
The unbearable degree of crop loss	0.520	0.642

Source: own calculations based on the questionnaires responses

The findings are in line with expectations: the experiences connected with drought don't influence the opinion about index-based insurance product but have an impact on purchase of insurance cover. The results let us suspect that assessment of drought's impact on income and the assessment of the degree of crop loss dangerous for farm's operations is difficult for the farmer. This inability may explain the statistical insignificance of those factors.

Although (in general) the people who often experience drought declare their readiness to buy more frequently, the entities which are most frequently hit by drought are still often hesitant in terms of the purchase. Quite similarly, people for whom drought is not dangerous, significantly more often (almost 50% of them) say that they will not buy the product; but again the half of units that assess drought as a dangerous peril remains undecided in terms of the product purchase. These regularities are an interesting puzzle for insurance companies.

The results obtained in the next stage of research (see table 5) give us a plausible solution to this puzzle.

Table 5. The relevance of experiences and opinions about insurance cover - the p-values of statistical test

Experiences and opinions about insurance		PRODUCT_ACCEPT CATEGORIZED	BUY_DECISION CATEGORIZED
The level of acceptance rated in the scale from 1 to 5	Insurance makes me feel confident about my own future and my family's (INSUR_SECURITY)	0.014	0.001
	I am worried about problems with indemnity payment (INSUR_PROBLEMS)	0.035	0.067
	Insurance companies offer policies which cover all types of perils (INSUR_COVER_ALL)	0.048	0.004
	Every farmer should buy crop insurance (INSUR_SHOULD)	0.119	0.029
	Crop insurance guarantees a high indemnity INSUR_HIGH_INDEMNITY	0.000	0.086
	Crop insurance is too expensive for me (INSUR_EXPENSIVE)	0.006	0.170
Did you have any crop-insurance last year?		0.279	0.016
Did you have drought-insurance last year?		0.007	0.196
Was a loss in crops financed by insurance in last 10 years?		0.887	0.001
How many times were losses in crops financed by insurance in last 10 years (? (ANOVA) INSUR_FINAN_LOSS_FREQ		0.380	0.000
How many times were losses in crops financed by insurance in last 10 years? (WMW or KW) INSUR_FINAN_LOSS_FREQ		0.910	0.000

Source: own calculations based on the questionnaires responses

The results presented in table 5 show very clearly that earlier opinions about the insurance affect the distribution of responses to the question about new insurance product. In general, if we expect the earlier opinion to act as a stimulant, it is stimulating indeed. And on the other hand, if the earlier opinion is expected to be a destimulant, it causes lower acceptance of the new product and it lowers the willingness to buy it.. As regards the impact of the opinion about insurance on the investigated phenomena (level of acceptance and willingness to buy), it is most significant if the respondent thinks that crop insurance (generally) guarantees a high indemnity and if he/she thinks that crop insurance is (generally)

too expensive. Only the conviction that farmers should buy crop insurance is irrelevant for opinion about the product. However, this belief is a significant determinant for the willingness to buy the product: people are more likely to buy crop insurance if they think that such behavior is desirable. This result becomes even more interesting if we notice that the matter of cost (as we can see) is not significant. We should, at this moment, point that the monthly income is not a relevant variable either. This also confirms the previous research results (Patt et al. 2009).

The most relevant for the willingness to buy are the past experiences in indemnity payments, which is consistent with results of previous studies (Cai 2009, Cai 2013, Cole et.al 2013, Cole, Stein, Tobacman 2014). The significance of beliefs that insurance makes people feel safe and that the offer of insurance companies is full indicates the importance of trust in the insurance companies and the product itself. That supports the conclusions from earlier studies (Patt et al. 2009, Cole et.al. 2013, Gine 2015, Cai 2009, Cai 2013). Also, this conclusion is of great practical importance, because the farmers' trust in insurance companies in Poland is only 27% (Social Diagnosis 2013). And finally we can notice that, people who had crop insurance in the last year are more open to new offers. However, if they have got drought-insurance, the decision about a purchase of the new type of drought-insurance is not predictable (maybe because they are satisfied or not satisfied with the previous one).

5. The discrete variable models in classification of individuals according to the level of product-acceptance or willingness to purchase the product

As the level of acceptance of the product can be categorized into two classes (see table), we want to construct a model for binomial variable Y (short for PRODUCT_ACCEPT_CAT) which equals 1 if a respondent accepts the product and 0 if otherwise. The most popular are logit and probit models that usually produce a very similar effect as regards correctness of classification. They both enable us to calculate the conditional probability P_i (assuming the specified vector of explanatory variables: $\mathbf{x}_i$) that $Y_i=1$: it depends on linear combination of explanatory variables: $\mathbf{x}_i^T \cdot \boldsymbol{\beta}$ and vector of parameters ($\boldsymbol{\beta}$) must be estimated.

In order to estimate the probability that a respondent likes the product, a logit model was constructed. This model has been chosen because those parameters can be easily interpreted in terms of the log-odds ratio – the estimated logit model is usually written as follows[9]:

[9] For more details see: [Cameron, Trivedi 2005: 463-477; Wooldridge: 529-539; Gruszczyński 2012: 71-108]

$$\ln(\frac{P_i}{1-P_1}) \hat{=} \mathbf{x}_i^T \cdot \hat{\boldsymbol{\beta}}.$$

As the respondents were described using mainly qualitative traits they were introduced into the model by means of a series of 0-1 variables. If a variable (e.g. educational background) could be counted in *m*-variants, *m*-1 binary variables were introduced into the model. Also, *i*-binary variable equalled 1 if the *i*-variant of a feature occurred and 0 if the i1 opposite occurred. Hence, one of the trait's variants was treated as a base. To assess which group of traits (objective ones or opinions about insurance) leads to more correct classifications, first the set of potential explanatory variables was limited to those specific for a particular group (Model 1 and Model 2) and finally all potential variables were introduced (Model 3). The step-backward elimination of insignificant variables was carried out. The maximum likelihood estimates of parameters and other characteristics of the models are presented in table 6. The classification matrices obtained for cut-off point fixed on 0.5 ($\hat{Y}_i = 1$ if $\hat{P}_i > 0.5$)) and for optimal Cramer's cut-off point (equal 0.568 in this case) are presented in table 7.

As we can observe, the results confirm the findings from an earlier correlation analysis. Among significant variables are the variables connected with educational background, class of soil, farm's location and the opinions about insurance. It should be emphasized that previous experience and opinions are even more significant than the objective features of a farmer and farms: the information criteria for Model 2 are lower than for Model 1. The superiority of these insurance-related determinants is confirmed by the ratio of accurate classification: model 2 lets us correctly classify 64% of respondents according to their opinion about the product, while model 1 less: 61%. This is, with no doubt, a very interesting result.

The choice between Model 2 and Model 3 is not so obvious: only less restrictive AIC (Akaike Information Criterion) gives us the reason to augment the set of explanatory variables. In this case we should notice that the joint set of explanatory variables becomes the tool for more accurate classification of people declaring bad opinion (the hit ratio increases from 44.9% (model 2) to 52.3% (model 3)) and the total hit ratio increases to 66.4%. As the groups are not balanced, the implementation of Cramer's optimal cut-off point improves the accuracy of classification to a less numerous group, but (as usual) at the expense of the other group. In this case, we can correctly classify both 64.4% of respondents declaring a bad opinion and 64.4% of respondents declaring a good opinion about the product. Although the obtained hit ratio is higher than the minimum hit ratio obtained as a result of random

Table 6. Estimates of logit model for PRODUCT_ACCEPT_CAT, obtained for different sets of explanatory variables

	Variable	Parameters	p-value	Marginal effect
MODEL 1 ONLY FEATURES OF THE FARM AND FARMER INCLUDED	Const	0.4006	0.0514	NA
	SEC&HIGHER_EDUC	0.6163	0.0011	0.1494
	SOIL_CLASS_III_IV	-0.4104	0.0347	-0.0999
	LOWER_SILESIAN_V	1.3820	0.0337	0.2740
	PODLACHIAN_V	1.2604	0.0546	-0.1511
	GREATER_POLAND_V	-0.6119	0.0104	-0.1405
	ŁÓDŹ_V	-0.5699	0.0148	0.2560
	SBIC = 692.366 AIC = 662.864 CHI-SQR(6)=35.004 [0.000]			
MODEL 2 ONLY INSURANCE FACTORS INCLUDED	Const	-0.1361	0.8130	NA
	HAD_DROUGHT_INSUR	0.6720	0.0308	0.1527
	INSUR_SECURITY	0.2153	0.0170	0.0501
	INSUR_HIGH_INDEMN	0.2442	0.0089	0.0579
	INSUR_EXPENSIVE	-0.2557	0.0125	-0.0671
	SBIC = 680.7814 AIC = 659.7084 CHI-SQR(4)=34.100 [0.000]			
MODEL 3 ALL POSSIBLE DETERMINANTS INCLUDED	Const	-1.3825	0.0014	NA
	SEC&HIGHER_EDUC	0.6847	0.0005	0.1652
	SOIL_CLASS_III_IV	-0.4219	0.0360	-0.1024
	LOWER_SILESIAN_V	1.4216	0.0339	0.2772
	PODLACHIAN_V	1.5135	0.0241	0.2889
	GREATER_POLAND_V	-0.6770	0.0066	-0.1668
	ŁÓDŹ_V	-0.5120	0.0334	-0.1260
	HAD_DROUGHT_INSUR	0.8004	0.0125	0.1800
	INSUR_SECURITY	0.2833	0.0031	0.0690
	INSUR_HIGH_INDEMN	0.2623	0.0067	0.0639
	SBIC = 680.9655 AIC = 638.8194 CHI-SQR(9)=65.05 [0.000]			

Source: own calculations

Table 7. Classification matrices based on logit models of PRODUCT_ACCEPT_CAT

	MODEL 1			MODEL 2			MODEL 3		
Real opinion	CUT-OFF POINT FIXED ON 0.5								
	bad	good	Hit ratios	bad	good	Hit ratios	bad	good	Hit ratios
bad	120	96	56%	97	119	44.9%	113	103	52.3%
good	99	185	65%	60	224	78.9%	65	219	77.1%
Real opinion	Overall hit ratio:		**61%**	Overall hit ratio:		**64.2%**	Overall hit ratio:		**66.4%**
	CRAMER'S OPTIMAL CUT-OFF POINT FIXED ON 0.568								
bad	127	89	59%	145	71	67.1%	139	77	64.4%
good	110	174	61%	122	162	57.0%	101	183	64.4%
	Overall hit ratio:		**60%**	Overall hit ratio:		**61.4%**	Overall hit ratio:		**64.4%**

Source: own calculations

classification (56.8% - due to maximum chance criterion), the obtained results suggest that the impact of the unincluded factors is very big. We can't rule it out that they are purely accidental but we can't rule it out, either, that unsatisfactory quality of the model results from the respondents' clumsy or thoughtless answers.

As the willingness to purchase the product was categorized into 3 groups we decided to construct the ordinal logit model (OLM) as the classification-tool. Naturally, all variables that significantly influence the distribution of responses, according to the results of statistical analysis, have been introduced as the potential explanatory variables of the model. Additionally, we decided to introduce the variable PRODUCT_ACCEPT, to reflect the significance of the opinion about the product for the decision about its purchase. Like before, the step-backward procedure of elimination of insignificant variables was carried out. The estimated parameters and other characteristics of two models (with and without PRODUCT_ACCEPT) are presented in table 8. The classification matrixes are given in table 9.

The results are again consistent with results of the earlier statistical analysis. As regards OLM1, the statistically significant parameters are the ones that reflect the influence of drought frequency (higher frequency of drought increases the willingness to buy the product) and the level of agreement with opinion that farmers should insure their crops (it is a stimulant too). Of course, the level of product acceptance is of a great significance. We can see that omission of this variable results in the quality deterioration of the model. The variable PRODUCT_ACCEPT must be replaced by some other variables which affect the opinion about the product. It is replaced by merely overall opinions about insurance (i.e. the strongest determinants of opinion, as it has been shown) and additionally the class of soil and localization (but the latter does not play such a role as we could observe in Model 1 or Model 2). What is more, we may expect older people to be less willing to buy the new product. And finally, we should emphasize again that the financial issues (costs, income) are of no significance.

As he opinion about the product could not be perfectly described by the model, an attempt to replace it by other variables failed. The information criteria show clearly that OLM1 is a simpler and more sophisticated model of willingness to buy. It is reflected in quality of classifications. The OLM1 model enables to correctly classify 62% of individuals into one of three distinguished groups, while the total hit ratio for OLM2 equals only 52% and additionally, people who would definitely not buy the product are very poorly identified (only 39% of them).

Table 8. The Results for Ordinal Logit Model explaining the willingness to purchase the index-based insurance product

	Explanatory variables	Parameters	P-values
OLM1 with PRODUCT_ACCEPT	CUT POINT 1	3.8433	0.0000
	CUT POINT 2	6.7364	0.0000
	BIG_FARM	0.4129	0.0949
	LUBUSZ_V	-0.9009	0.0435
	LOWER_SILESIAN_V	1.3362	0.0057
	ŁÓDŹ_V	0.6069	0.0059
	PODLACHIAN_V	-0.9960	0.0574
	DROUGHT_FREQUENCY	0.0966	0.0271
	INSUR_FINAN_LOSS_FREQ	0.1144	0.0870
	INSUR_SHOULD	0.2468	0.0111
	PRODUCT_ACCEPT	1.0285	0.0000
	SBIC = 882.107 AIC = 835.75 CHI-SQR(9)=244.9 [0.00]		
OLM2 without PRODUCT_ACCEPT	CUT POINT 1	1.7551	0.0002
	CUT POINT 2	4.1403	0.0000
	AGE_60+	-0.4798	0.0659
	SOIL_CLASS_III_IV	-0.4468	0.0127
	LOWER_SILESIAN_V	1.3507	0.0028
	DROUGHT_FREQUENCY	0.0832	0.0449
	INSUR_FINAN_LOSS_FREQ	0.1361	0.0364
	INSUR_SECURITY	0.1892	0.0385
	INSUR_COVER_ALL	0.1588	0.0478
	INSUR_SHOULD	0.2423	0.0120
	SBIC = 1005.6 AIC = 963.4 CHI-SQR(8)=115.3 [0.00]		

Source: own calculations

Table 9. Classification matrices based on OLMs for BUY_DECISION_CAT

	Classifications based on OLM1			Hit ratios	
Real class	I will not buy	I don't know	I will buy	Classic	Modified
I will not buy	**136**	69	1	**66%**	**66%**
I don't know	46	**175**	5	**77%**	**82%**
I will buy	6	51	**11**	**16%**	
			TOTAL HIT RATIO:	**64%**	**76%**
	Classifications based on OLM2			Hit ratios	
Real class	I will not buy	I don't know	I will buy	Classic	Modified
I will not buy	**81**	125	0	**39%**	**39%**
I don't know	49	**177**	0	**78%**	**80%**
I will buy	11	55	**2**	**3%**	
			TOTAL HIT RATIO:	**52%**	**63%**

Source: own calculations

When we assess the quality of the OLM1 model, we should take it into account that a lot of respondents are hesitant. In this situation we should check if the model enables us to separate those who wouldn't buy (one group) from whose who still can be potential buyers of insurance policy (i.e. those who will buy or who don't know what they will do – the second joint group). For that purpose, the hit ratios were calculated in appropriately modified way. It turns out that 74% of individuals are correctly classified.

For sure, the identification of factors that make people hesitant would be of a great practical importance.

6. The sample selection model in explaining the respondents' behavior concerning the product acceptance and its purchase

Although it is expected that a good opinion about insurance product is the necessary condition to buy it, it seems that it is an insufficient condition: out of 284 respondents, who accept the product:

- only 21.1% declare that would definitely or rather buy the product,
- up to 56.3% declare that they don't know what they would do,
- 22.3% declare that they would rather or definitely not buy the product.

To give a model explanation of such a phenomenon, we decided to restrict the sample to farmers who have a positive opinion and identify the significant factors that have an impact on their purchasing-decision. The BUY_DECISION (not categorized) played the role of a dependent variable. As the random factors that affect the opinion about the product and the random factors that affect the willingness to buy may be correlated, the sample selection model (heckit model) was applied. The heckit model consists of two connected (via residuals) submodels[10]. The first one is the probit model for PRODUCT_ACCEPT_CAT – the selection-variable. The set of explaining variables in probit model is the same as in Model 3 (all objective features of farms and farmers and their opinions concerning the insurance that turned out to be significant – see table 6 for details). The set of potential explaining variables in the second one – the dependent variable model – consists of all the above mentioned variables and additionally covers all factors that significantly affect the distribution of responses to the question about willingness to purchase (due to statistical analysis results). However, some parameters in the second equation appeared to be statistically insignificant –

[10] For more details see Cameron and Trivedi 2005; Wooldridge 2009; Gruszczyński 2012.

the appropriate variables were rejected according to step-backward procedure. The estimated parameters of the final form of the heckit model are presented in table 10 (as HECKIT 1).

Table 10. The parameters and characteristics of heckit models for the willingness to buy in selected sample

	HECKIT 1		HECKIT 2	
Explanatory variables	Parameters	P-values	Parameters	P-values
Tobit for BUY_DECISION				
Const	1.0129	0.0002	0.4919	0.1125
INSUR_FINAN_LOSS_FREQ	0.1248	0.0000	0.1297	0.0000
AGE_60+	-0.3472	0.0151	-0.3586	0.0105
INSUR_SHOULD	0.0914	0.0674	0.1057	0.0246
INSUR_SECURITY	0.1022	0.0410	insignificant	
LOWER_SILESIAN_V	0.3852	0.0074	0.4783	0.0232
PRODUCT_ACCEPT	not introduced		0.24642	0.0002
Lambda	0.2801	0.1032	0.2086	0.201
Selection sample equation (probit)				
Const	-0.8616	0.0010	-0.7987	0.0026
HAD_DROUGHT_INSUR	0.5073	0.0066	0.5099	0.0068
SEC&HIGHER_EDUC	0.4146	0.0005	0.4198	0.0004
SOIL_CLASS_III_IV	-0.2460	0.0420	-0.2577	0.0332
LOWER_SILESIAN_V	0.9268	0.0192	0.9253	0.0192
GREATER_POLAND_V	-0.3944	0.0080	-0.4073	0.0063
ŁÓDŹ_V	-0.3303	0.0230	-0.3348	0.0231
PODLACHIAN_V	0.9099	0.0016	0.9446	0.0121
INSUR_SECURITY	0.1699	0.0033	0.1547	0.0091
INSUR_HIGH_INDEMN	0.1687	0.0033	0.1679	0.0037
Aditional characteristics	BSIC=1310.73. SIGMA=0.791 RHO=0.35		BSIC=1301.22 SIGMA=0.766 RHO=0.27	

Source: own calculations

As we are aware that respondents in the selected sample are not homogenous with regard to the level of acceptance of the product (they could "quite like/like/ like very much or extremely like the product) we decided to check if the uncategorized variable PRODUCT_ACCEPT (see table 1) is also relevant (as expected). Therefore we present estimations obtained after augmentation of the set of explanatory variables with that particular variable – the final model (obtaining only statistically significant variables) is presented as HECKIT2 in Table 10.

Analysis of the results allows us to make the following observation: people who

accept the product are more willing to buy if:

- the losses in crops were frequently financed from indemnity paid by insurance company (in the last 10 years)[11].
- they are less than 60 years old,
- they highly agree with the opinion that farmers should insure their crops,
- they highly agree with the opinion that insurance makes people feel confident about their own future and their families',
- the farm is located in Lower Silesian Voievodship.

The last two variables are the only ones out of the variables included in the selection variable model which are significant in both equations. However, the level of agreement with opinion that insurance makes people feel confident is insignificant in the HECKIT2 - it is simply replaced by the level of acceptance of the product which, after all, is influenced by overall opinions about insurance. What is more, the HECKIT2 is more sophisticated: it minimizes the Schwarc (Bayesioan) information criterion (SBIC) and reduces the impact of random factors: estimated sigma indicates that the true value of the dependent variable (level of willingness to buy) may differ from the expected value by 0.766. Finally, we should point out that the random factors which influence the level of product acceptance are not correlated with the random factors which influence the level of willingness to purchase it: the specific component of heckit model (lambda) is not statistically significant, especially in HECKIT2.

To sum it up, the previous opinions about insurance turn out to be (once again) significant factors affecting willingness to buy the insurance product.

7. **Conclusions**

The purpose of this study was to investigate the factors affecting acceptance and willingness to buy drought index insurance in Poland. There are dozen or more studies of index product demand in developing countries (researched mostly ex-post) but, to our best knowledge, the present article describes the first attempt to investigate the ex-ante acceptance and demand in apost-communist country. The statistical analysis and construction of logit models and sample selection model enable us to explain the respondents' behavior concerning the product acceptance and its purchase. The opinions about insurance in general and crop insurance in particular have more influence on the acceptance of the index product than the characteristics

[11] The interesting result is that this variable can be replaced with the variable indicating that the farm is big. The previous research showed that in big farms indemnity is more often used as a source of loss financing [Kaczała, Wiśniewska 2014]

of a farmer, farms and income. The level of product acceptance significantly determine the farmer's willingness to buy it. The experiences connected with drought do not influence the opinion about drought index insurance product but have an impact on purchase of insurance. The latest is significantly determined by the amount of indemnity received in the past. The monthly income level is not a significant factor affecting the purchasing decision.

The results confirm that the non-economic factors substantially determine acceptance and ex-ante demand for index product and it is not only the case of developing countries and small holder farmers, but also quite well established insurance markets with differentiated farm sizes. As the CAP for 2014-2020 allows for subsidizing agriculture index insurance, we can expect a growing interest in using such contracts in Europe, which makes our findings especially useful at present. The findings are relevant especially for post-communist countries, where the farmers' trust in any institution and especially in insurance is relatively low. What is more, the trust and understanding of index product is a big challenge, not because of financial illiteracy but for the historically established full compensation in agriculture contracts. Last but not least – our study focuses on ex-ante demand which could be different from the ex-post demand, although the key drivers for the uptake, as we have presented, are very similar.

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