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Articles

INDEX-BASED INSURANCE OF GROSS MARGIN IN AGRICULTURE – KEY CHALLENGES

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Abstract

The paper attempts at assessment of usefulness of the index-based insurance of gross margin compared to traditional production insurances. The analysis used FADN data and was limited to the example of winter wheat. The conducted simulations showed that the category of gross margin is characterized by higher variability than yields or prices, thus the costs of its insurance expressed as fair premium would be higher than the costs of traditional production insurance. However, the major problem in case of index-based insurances is still the basic risk related to the possibility that part of the insured will not receive compensation even though they incurred losses. The conducted analyses showed that the assumption of the index basing on the average drop in yields in a voivodeship would result in major percentage of errors as regards payment and refusal of payment of the compensation compared to individual insurance. Structuring of the system of index-based insurances would require collecting data – to construct indices – from areas of much smaller territorial coverage.

Keywords: risk, insurance, gross margin.

JEL codes: Q12, Q14, G22.

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Introduction

The observed climate change (Kundzewicz and Kozyra, 2011), progressive liberalisation of international trade in agricultural products (Czyżewski and Poczta-Wajda, 2011) or changes in the Common Agricultural Policy are reasons for which the conditions of pursuing the agricultural activity are characterised by increasing variability. The growing variability in the agricultural sector implies a need for intensification of the search for new risk management tools in agriculture. The most widely used tools in this regard are various types of economic insurance which, through the transfer of risk to multiple entities (against specific payment), allow to reduce the financial consequences of losses incurred. The essence of insurance is based on the principle that a group of entities at risk of specific events is much wider than a group of entities in the case of which this risk is going to materialise (Ronka-Chmielowiec, 2002). The efficient use of agricultural production insurance also involves many challenges, which makes existing insurance systems rather ineffective and requiring support with public funds. Existing experiences (both national and international) in the field of using crop insurance imply a need to seek new, more efficient insurance instruments. In this context many authors point to index-based insurance (Handschke, Kaczała and Łyskawa, 2015) or mutual funds (Majewski, Sulewski and Meuwissen, 2014). Given the complex nature of risk in agriculture, the relevance of seeking solutions, which would enable a simultaneous reduction in the effects of yield and price volatility, is increasingly highlighted. In this context, a separate and weakly recognised category is revenue and income insurance (Skees, Harwood, Somwaru and Perry, 1998), as well as gross margin insurance. Some progress in this field was made in some countries mainly in the livestock production (Bozic, Newton, Thraen and Gould, 2012). Recently, the concept of using index-based insurance of gross margin in the crop production was presented by Sinabell, Url and Heinschink (2017). Although the use of such instruments seems to be an interesting prospect, it also has some weaknesses, and a low degree of recognition of the mechanism of their functioning requires intense studies which would allow us to adapt the overall concept to the market requirements.

In the context of the outlined problems, the main objective of the study was to assess the suitability of innovative ways of insuring the agricultural production (such as index-based insurance and gross margin insurance) when compared to traditional (individual) crop insurance. The first part of the study reviewed the literature covering the issues such as: identification of basic problems in the functioning of traditional agricultural production insurance, identification of the characteristics of index-based insurance, indication of the importance of the price risk and overview of known ways to insure revenue and margins. The second part of the study shows the results of empirical analyses on the conditions of the use of gross margin insurance in the crop production. The analysis was limited to the example of winter wheat, assuming this was the most important commodity plant in the Polish agriculture.

Literature review

Basic problems of traditional agricultural production insurance

The use of insurance as an effective risk reduction tool requires meeting several conditions, including, first of all, the randomness of damage (incidental and unintended nature of events), possibility of its measurement and valuation and independence of damage and possibility of estimating the likelihood of its occurrence (sufficiently large number of objects) (Berg, 2007; Wicka et al., 2013). An important obstacle to the effective use of insurance is related to the asymmetry of information about the phenomenon of moral hazard[1] and adverse selection[2], which is of particular importance in the case of agricultural production insurance (Ramirez and Colson, 2013). A significant problem in the case of the agricultural production is also the systemic nature of risk associated with the spatial correlation of damage. Existing obstacles are a reason for which agricultural insurance systems are generally, to some extent, supported by the state (OECD, 2011). This does not eliminate all problems, but only allows to increase the attractiveness of available solutions from the point of view of the farmer and the insurer (e.g. by partially subsidising contributions, reinsurance, etc.). The insurance product, which is most commonly used in agriculture of most countries, is crop insurance against losses due to adverse weather phenomena (European Commission, 2006). The system of subsidised production insurance was also introduced in Poland by way of the Act of 7 July 2005 on crop insurance and livestock insurance (Act, 2005). Although the aforementioned regulations have been repeatedly amended, the scale of their impact, in terms of the increased stability of agricultural activity, still remains insufficient (Pawłowska-Tyszko, Gorzelak, Herda-Kopańska, Kulawik and Soliwoda, 2017).

Because of the aforementioned conditions crop insurance works properly only with regard to certain risk factors. An example could be the risk of hailstorm, where the impact of moral hazard, adverse selection and correlation of the occurrence of the phenomenon among regions is small, while the possibilities of estimating the contribution and the start level are quite large (Kang, 2007). A much more problematic situation is the risk of drought, where there is a spatial correlation of losses3 and some effects of its occurrence are difficult to be distinguished from the effects of errors in the production technology, which can be illustrated by take-all diseases (Majewski, 2001; Nieróbca and Zaliwski, 2007). Due to the dependence of production effects on maintaining the technological regime, traditional production insurance does not usually provide a possibility of insuring losses associated with the impact of pests and diseases (it is assumed that they result from technological negligence and thus are not fortuitous) (Kang, 2007). Traditional production insu-

[1] Moral hazard – thesis showing that the entity protected against risk (taking out insurance) behaves in a more risky way than it does without insurance coverage.

[2] Adverse selection – phenomenon of increased tendency to take out insurance policies by entities particularly exposed to suffering losses.

[3] Drought usually affects large areas of a country or even a continent.

ance also often does not offer a possibility of insuring specific risk factors typical for only the selected types of production (problem of limited commonness due to a small number of the insured). Insurance functioning on a basis of mutual funds is partially deprived of the aforementioned weaknesses (Cafiero, Capitanio, Cioffi and Coppola, 2007; OECD, 2009). In this case, however, an important problem remains, i.e. the systemic nature of risk in agriculture (it applies to all fund members) and barrier to cooperation between farmers (Majewski et al., 2014; Meuwissen, Asseldonk and Huirne, 2003).

Index-based insurance

Among innovative insurance solutions eliminating the problem of moral hazard, adverse selection or correlation of events, index-based insurance is increasingly mentioned, where payment of compensation does not depend on losses incurred by a particular farmer, but on exceeding the threshold value of the established index (Smith and Watts, 2009; Binswanger-Mkhize, 2012). In general, weather indicators based on e.g. the amount of rainfall in a given period, wind speed, insolation level or livestock mortality level are usually used as indices (Kaczała, 2017). In addition to many advantages, index-based insurance has also certain disadvantages associated with a necessity to acquire reliable data for developing an index, limiting the applicability only to selected types of risk or a high degree of complexity from the point of view of the farmer, which makes the scale of its use rather small, although it is the subject of numerous theoretical analyses (Handschke et al., 2015). A specific type of an index can be the area yield insurance index (Miranda, 1991; Barnett, Black, Hu and Skees, 2005). When compared to weather indices, the adoption of the yield index as a basis for payment of compensation allows us to cover e.g. all kinds of production risk (while weather indices are generally used to cover crop losses associated with only one weather factor), eliminate technical problems associated with selection of the index properly reflecting the risk or limit the risk of the absence of correlation between the yield and index (Trang, 2013). Similarly, however, as with other types of index-based insurance, an important issue remains the so-called basic risk associated with a possibility that the farmer does not receive compensation despite the occurrence of damage (and receives compensation despite the absence of any loss) (Kaczała, 2017; Kasten, 2012). This is important in the context of behavioural aspects included in the decision-making process on the use of index-based insurance. The studies by Carter, Elabed and Serfilippi (2015) indicate that farmers are characterised by a high level of sensitivity to the basic risk and perceive the costs of contributions as certain and inevitable, while they assess payment of compensation rather as a stochastic event. Recently, the issue of reduced rationality as a factor determining the possibility of using index-based insurance was also pointed out by Mußhoff, Hirschauer, Grüner and Pielsticker (2018).

Price risk

Both traditional crop insurance as well as mutual funds and index-based insurance cover most often yield fluctuations, while ignoring the price risk issue. As pointed out by Rembisz (2008), the particularly high importance of the price risk in agriculture is connected with the fact that the prices of products are affected by specific institutional conditions (related to the intervention system) and natural conditions. What is more, the agricultural producer does not determine the buying-in prices of agricultural products sold (prices received) and must adapt to them without a possibility of transferring the effects of their changes to the buyer (Rembisz, 2007). Taking into account also the production effect deferred in time (in relation to expenses incurred), it can be assumed that the risk of the fall in the prices of agricultural commodities is essential both from the point of view of the production profitability and the farm income stability (Rembisz and Stańko, 2007).

Considerations of the price risk often point to the phenomenon of the opposite direction of the price and yield changes, which is referred to as "natural hedging" (Kobus, 2014). In the case of products with low price demand flexibility, the changes in supply result in more than proportional price changes, which is referred to as the "King effect". This leads to the so-called low-yield paradox, according to which the prices and, consequently, farmers' income in the years of bad crops may be higher than in the years of good crops (Runowski, 2008). However, in the natural hedging mechanism there are many factors distorting the above-mentioned rules, as a result of which only some farmers can have real benefits of it (OECD, 2011). We can even mention here the increasing degree of linking domestic markets with global markets, which translates into the dependence of the domestic prices of agricultural products on the global market situation (Hamulczuk, 2009). We also need to stress the fact that while the negative correlation between the price changes and yield levels is quite visible at the aggregate level, this correlation can be considerably weaker at the level of individual farms (Kimura, Anton and LeThi, 2010; Kobus, 2014). For producers in many countries, a basis for hedging against the price risk are derivatives (OECD, 2009), but the Polish experience in this area is rather low (Śmiglak-Krajewska, 2008; Jerzak, 2013) and most farmers have, in practice, limited opportunities to use the forward market, inter alia, due to the too low production scale.

Revenue and margin insurance

The problems observed with regard to the possibilities of stabilising the financial situation of farms through the use of traditional hedging mechanisms are the grounds for seeking new solutions in this area. One of the possibilities is income insurance, which includes the cumulative effect of changes in the production volume and prices, which makes it particularly useful in situations where natural hedging does not work (Skees et al., 1998). Compensation, in this case, is paid in the event of a decrease in revenues due to reduced yields, price fall or both. Revenue insurance for farms was first introduced in the early 1980s (Kang, 2007). In practice,

this instrument become popular mainly in the USA, where the well-developed futures market makes it easy to estimate the expected price of products being insured (Iturrioz, 2009; Kang, 2007). A theoretical illustration of the functioning of the revenue insurance mechanism was also drawn up for many other countries, including Poland (e.g. Janowicz-Lomott, Łyskawa and Rozumek 2015). Revenue insurance programmes were used mainly in the livestock production (Bozic et al., 2012; Valvekar, Chavas, Gould and Cabrera, 2011), where the scale and extent of use of traditional insurance instruments are insignificant. Revenue insurance in the crop production was offered e.g. in Great Britain, however, probably due to the high degree of complexity, the scale of its practical use was minor (Meuwissen, Huirne and Skees, 2003).

Revenue (or income) insurance may be offered in a form of individual instruments but in this case, an important problem remains moral hazard and a need to record revenues/ income or as index-based insurance (Janowicz-Lomott et al., 2015). In economic practice, the most complex form of "revenue-income" insurance in agriculture can be gross margin insurance, which, in addition to protecting revenues, also provides the protection against changes in certain production costs. In the existing implementation attempts, insurance usually covered the costs of feed, and those instruments were addressed to farmers involved in livestock production. Here, we can mention such protection programmes as Margin Protection Program for Dairy Producers (MPP) available in the US since 2014 (Newton, Thraen, Gould and Bozic, 2014) or Livestock Gross Margin Insurance (for dairy and pig farms), also offered in the US, since 2008 (Mark, Waterbury and Small, 2007). The need to construct such tools was dictated by the increasing variability of feed prices (as a result of variability of plant product prices), due to which previously used revenue insurance was not performing its stabilisation function sufficiently any longer (Bozic et al., 2012). The subject of insurance is, in this case, the value of the expected production margin (product of the price and quantity) over the costs of feed. However, this instrument does not protect against the variability of prices of other production inputs.

A need to extend the portfolio of insurance products in agriculture by instruments allowing to insure revenues has also been noticed at the EU level, which resulted in the introduction into the Regulation of the European Parliament and of the Council (EU) No. 1305/2013 of the so-called Income Stabilisation Tool which could be created by the Member States on a basis of mutual funds under the RDP. In Poland, this instrument was not introduced, but its usefulness was considered by, e.g., Klimkowski (2016). Within the framework of the national policy, the Ministry of Agriculture and Rural Development worked on the Act on the Mutual fund in stabilising agricultural income, the objective of which was to compensate farmers for losses in income caused by various factors (Rządowe Centrum Legislacji, 2014). Considerations regarding the relevance of insuring agricultural income were also carried out by e.g. Rembisz (2011) or Klimkowski and Rembisz (2014), indicating that such instruments could be more efficient than production insurance. As indicated by Soliwoda, Kulawik and Góral (2016), income stabilisa-

tion instruments should be considered as an important component of the agricultural risk management system, which means that attempts to implement them do not rule out the search for new production insurance solutions. As stated by the above-quoted authors, the greatest experience as regards income stabilisation instruments is that of Canada, and the prerequisite for implementing such solutions is the common record of economic events (agricultural accountancy).

Recently, Sinabell et al. (2017) have presented the concept of gross margin insurance in the crop production on an example of wheat. According to the authors' knowledge, this was the first thorough attempt to analyse the gross margin insurance mechanism in the crop production. The proposed concept illustrates the index-based insurance mechanism in which the index role is played by the gross margin value. According to the general concept of index-based products, the decrease in the margin value below the accepted limit launches payment of compensation. The concept presented by the above-mentioned authors, although ideologically useful, seems to contain some inaccuracies that could impede its practical implementation in agriculture. What seems problematic here is an assumption of the absolute and equal, for all years, gross margin value as the index launching payment of compensation (which is natural for weather indices). Given that both prices, yields and costs are within certain trends, it seems reasonable to introduce a modification consisting in the application of a specific relative deviation (%) from the expected gross margin value (instead of the fixed absolute value). From the point of view of the farmer, the relevant criterion for assessing the effectiveness of the proposed mechanism will, undoubtedly, be also the basic risk mentioned in the literature (resulting from the correlation of the given index with the actual level of losses on the farm (Barnett et al., 2005). The low level of this correlation, reflecting a situation where the number of cases of incurring losses is lower than the number of compensations due will constitute a barrier discouraging farmers from participating in such a system. It seems that the systemic assessment of the concept of this type of insurance should be extended by analysis of the basic risk level. Although the gross margin insurance proposal presented by Sinabell et al. (2017) seems to be still incomplete, it can be considered possibly the first study of its kind in the economic and agricultural literature (the studies known so far applied to livestock gross margins). Analyses carried out by those authors indicate that gross margin insurance, particularly in the concept of an index-based product, may provide an interesting alternative to other forms of agricultural insurance, but the assessment of this issue requires further and deeper analyses. A synthetic specification of basic types of agricultural insurance applied on a different scale in economic practice is given in Table 1.

Table 1

Basic division of agricultural production insurance used in practice

Type of insurance	Basis for payment of compensation	Examples of use
Traditional insurance (payment of compensation based on actual losses)		
1. Against a single risk factor	Percentage range of damage caused by this factor	Various countries
2. Package insurance	Total yield losses	Various countries
Index-based insurance (payment of compensation based on the index measure)		
1. Based on the area index	Yield reduction in the given area	USA, India, Brazil
2. Based on the weather index	Exceeding the threshold level of the index (indicator)	India, Mexico, Canada, USA
3. Based on the normalised difference vegetation index (NDVI)	Exceeding the threshold level of the NDVI	Mexico, Canada, Spain
4. Based on the livestock mortality index	Exceeding the threshold level of the livestock mortality index	Mongolia
Revenue or income insurance (payment of compensation based on the product of yields and prices of agricultural crops)		
1. Crop production insurance	Production value	USA
2. Livestock production insurance	Production value	USA
3. Programmes of stabilisation / protection of farm income	Income	Canada
4. Gross margin insurance	Gross margin in the livestock production over the costs of feed	USA, Canada

Source: Iturrioz (2009); Kang (2007).

Methodology

The main objective of the study was to assess the suitability of innovative ways of insuring the agricultural production (such as index-based insurance and gross margin insurance) when compared to traditional (individual) yield insurance. To implement the main objective, the following specific objectives were used:

1. Determination of the variability of yields, prices and gross margins in the winter wheat cultivation along with designation of a trend function for each parameter.
2. Assessment of the impact of the identified variability on the wheat cultivation stability.
3. Determination of the percentage of farms which would receive compensation in the event of a loss in "traditional" and "index-based" insurance at the established franchise levels.
4. Assessment of the level of compliance of compensation payments with losses incurred (correctness of classification of farms based on the established index).
5. Determination of insurance costs (yields and margins) expressed by the fair contribution.

The value of gross margin (as well as of other variables) was determined pursuant to the FADN database (yields and prices) and variables available in the "Agrokoszty"[4] database (variable costs of wheat cultivation). Analysis was carried out on the example of winter wheat in 4 basic variants of considerations presented schematically in Table 2. The study sample included a total of 762 farms involved in 2004-2015 in the winter wheat cultivation and simultaneously keeping FADN agricultural accountancy. The basis for identifying the individual variants was the nature of insurance (individual or area-based) and the subject of insurance (i.e. traditional yield insurance vs gross margin insurance). In the considerations on gross margin, the variant of insuring its value with and without subsidies was examined. The "no subsidies" variant was considered in academic terms, as in the current conditions of the agricultural policy subsidies are, in practice, an integral part of farmers' income. Subsidies to production play an important role in stabilising revenue and income (Majewski and Wąs, 2009; Severini, Tantari and Tommaso, 2016; Wąs and Kobus, 2018), hence considering such variant in the context of the studies seems to be an interesting complement to the main issue of the analyses. The subject of insurance in each variant of the simulation was the expected value of individual parameters (yields, margins) estimated for each farm for the period of 2004-2015 based on the trend function. In the comparisons regarding the occurrence of a loss eligible for compensation, 3 levels of deviation downwards from the expected value (trend function) were considered, i.e. 10%, 20% and 30%. Schematically, this approach was illustrated on the example of the selected farm in Figure 1.

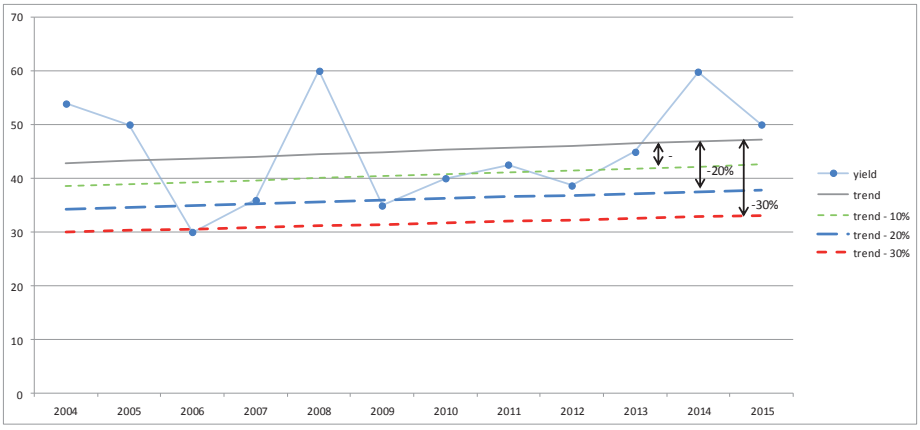

Fig. 1. Illustration of the way of estimating deviations from the expected value (trend) being a basis for payment of compensation (example for the yield).

Source: own study.

[4] The data available in the FADN database is not sufficient to determine the direct costs of each activity, therefore, analyses carried out used the data from the "Agrokoszty" database kept by the Institute of Agricultural and Food Economics – National Research Institute, linking functionally the value of this data with the wheat yield for individual FADN farms.

Table 2

Diagram of comparisons carried out in the study

Specification		Subject of insurance	
		traditional (yield)	gross margin
Character of insurance	individual	individual of yield	individual gross margins
	index-based (area, group)	index-based of yield[a]	index-based gross margins

[a] area yield insurance

Source: own study.

As regards the adopted convention of analyses, it should be stressed that only the variant of individual yield insurance reflects the existing Polish agricultural insurance solutions, while the other scenarios are academic considerations, since they have not been used in Poland so far, and the scale of their use in other countries is still minor (they can be perceived mainly as proposals resulting from the search for new, more effective insurance products). In the context of the terminology used in the study, it should be noted that the term "index-based insurance" was used in relation to area-based insurance for yields (margins), although in the literature it is mainly used in the case of weather indices. A certain simplification is also the use of the word "compensation" with respect to farms which would receive payment under the index-based insurance scheme, despite the lack of any loss (in principle, compensation relates to a situation where the insured person suffered a loss).

Results

At the first stage of the analysis, the range of variability of yields, prices and gross margin for wheat in 2004-2015 was assessed. The average value of these parameters for the analysed group of farms in each year is shown in Figure 2. The charts were supplemented by an estimate of the average coefficient of variability reflecting synthetically the variability of these parameters between the individual years of observation (coefficient calculated as the average value of the coefficients of variability from individual farms) (Table 3). It should be emphasised that the category of the coefficient of variability includes both downward and upward deviations from the expected value. From the viewpoint of the farmer, however, only downward deviations are perceived as a problem, therefore analysis is only formal. Analysing in the further part of the study the mechanism of action of index-based gross margin insurance, the reference was made only to downward deviations from the expected value. Both graphical analysis of the chart as well as a comparison of average coefficients of variability (Table 3) clearly indicate that the lowest fluctuations at the average level are characteristic of yields, significantly higher – of prices and the highest – of gross margin. The average value of the coefficient of variability

for yields was at the level of 0.19, while for prcies it was 0.27 and for gross margin 0.37 (slightly lower in the case of the trend-adjusted coefficient of variability). The highest level of the coefficient of variability in the case of gross margin is reasonable, since this margin includes both fluctuations in yields, prices and costs. The high value of the coefficient of variability in the case of margin also suggests that the phenomenon of natural hedging is rather negligible here (at least at the level of annual average values), since the decreases in yields are not neutralised by the price rise and vice versa (which translates into the high variability of gross margin with the assumed fairly stable cost level). This observation justifies a need to look for new insurance instruments, since even a significant elimination of the effects of yield fluctuations under traditional insurance does not solve the problem of unstable revenues and thus gross margins.

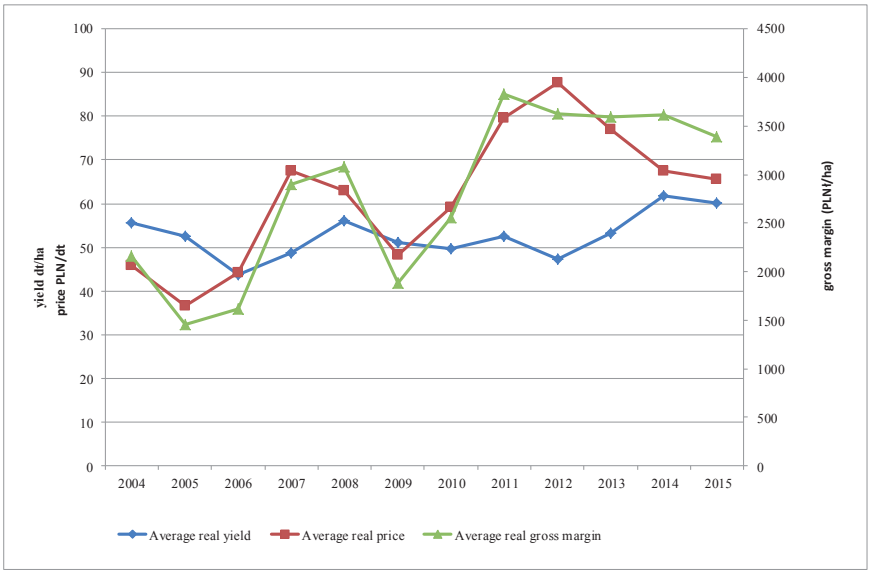

Fig. 2. Average value of yields, prices and gross margin in the cultivation of wheat in the analysed group of FADN farms (n=762).

Source: own study.

In the context of the above-mentioned average coefficient of variability, what is also worth noting is the issue of its diversification within the analysed group. The large dispersion of the coefficient of variability suggests that farms differ significantly in terms of fluctuations in the given parameter (yield, margin). The construction of a parameter-based index characterised by the large variability within the given group of farms would be characterised by a high level of basic risk. In such a situation, it would be difficult to determine the level of the index which would guarantee the smooth operation of the insurance mechanism (the prerequisite of it is a high level of correlation of the constructed index with the parameters of indi-

vidual farms e.g. the index of margin with margins of individual farms). The low level of correlation of the index with the actual levels of the given parameter could be a reason for which a large proportion of farmers would not receive compensation despite the loss, as well as a part of the group of the insured could receive compensation, despite no loss incurred. The distribution of the parameters included in analysis, as shown in Figure 3, shows that only the price is characterised by the fairly small dispersion of the coefficient of variability, which means that the construction of an index based on this parameter would be quite a simple task. The large homogeneity of the analysed group is quite evident in this case, as the prices are slightly diversified among farms and among the individual parts of the country.

Table 3

Average coefficient of variability for the parameters included in the study

Parameters included in analysis	Coefficient of variability	
	standard[a]	adjusted[b]
Yield	0.19	0.18
Price	0.27	0.22
Gross margin with subsidies	0.37	0.29
Gross margin without subsidies	0.48	0.42

[a] calculated as a quotient of the standard deviation of the sample and the average for the years 2004-2015;

[b] deviation from the trend for the given farmer by the average value of the trend function according to the formula:

$$ccv = \frac{\sqrt{\frac{1}{n-2}\sum_{t=1}^{n}(x_t - \hat{x}_{(t)})^2}}{\bar{x}}$$

where:

ccv – adjusted coefficient of variability,

x_t – value of the variable x in the year t,

$\hat{x}_{(t)}$ – estimation of the trend function for the variable x in the year t.

Source: own study.

The much greater diversification is specific to the distribution of the coefficient of variability for yields, as a result of which the range of variability cumulated in gross margin clearly exceeds the variability of other parameters (particularly for gross margin without subsidies). It follows from this observation that gross margin insurance by nature would be encumbered by greater basic risk which could be a barrier to the attempts of practical implementation of such mechanism. One way to reduce this problem which fits index-based insurance is to adjust it to the regional (local) production and market conditions, as highlighted in the literature of the subject (Barnett et al., 2005; Kaczała, 2017). The presented analysis results were carried out using the data from all Polish FADN farms involved in wheat cultivation; hence the high diversification in the coefficient of variability is a natu-

ral consequence of the methodology applied. From the above results that national data cannot, in practice constitute a basis for developing an effective index-based insurance mechanism. In this context, e.g. the approach proposed by Sinabell et al. (2017) relying on the national averages seems to be a simplification of sorts and, in practice, would require going to the level of regional data (as the authors point out, although Austria is a small country, the production conditions are very diverse). Taking into account the observations made and considerations of other authors, it can be assumed that the construction and implementation of index-based insurance requires the previous identification of the distribution of the variability of the parameters constituting the subject of insurance.

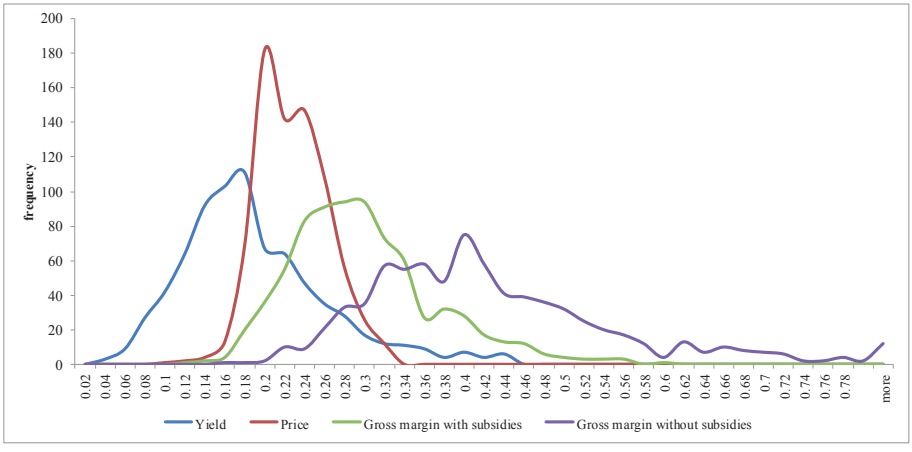

Fig. 3. Distribution of the coefficient of variability for the parameters in question.
Source: own study.

As regards the observed variability of yields, prices and margins, it is worth adding that in the years covered by the analysis, 100% of farms in the analysed group at least once experienced a fall in prices, yields (96% of farms) and gross margins by at least 10% (Table 4). The significant percentage of the survey was also affected by losses at the level of at least 30%. As regards the yield, there were 38% of farms which recorded such a loss at least once, 31% in the case of prices more than 90% in the case of margins. Table 4 also contains the information about the total percentage of events consisting in a reduction in the individual parameters by at least 10% and 30% over the entire observation period (i.e. 2004-2015). The percentage of observations consisting in a decrease by at least 10% was at the level of nearly 25% in the case of yields and about 40% for prices and margins. On the other hand, the percentage of observations consisting in a loss of at least 30% was at a relatively low level in the case of yields and prices (respectively, 4.1% and 3.3%) and at a high level for margins (15% and 23.9%). This data indicates that, although relatively small falls in yields and prices are common and are a normal risk, at the level of gross margin they are cumulated, due to which

the rate of falls in margin by more than 30% is significantly higher than the rate of such falls in the case of prices and yields assessed separately. In addition, this effect may also be reinforced by changes in the prices of production inputs and potential fluctuations in the efficiency of using incurred inputs (depending on the specific conditions of a farm).

Table 4

Percentage of farms and observations with drops in individual parameters by more than 10% and 30% in 2004-2015

Parameters included in the assessment	Number of farms with at least 1 loss		Number of observations in the entire sample	
	loss level		loss level	
	at least 10%	at least 30%	at least 10%	at least 30%
	% of farms		% of observations	
Wheat yield	95.9	37.8	24.8	4.1
Wheat price	100.0	30.8	39.5	3.3
Gross margin with subsidies	100.0	91.5	38.7	15.0
Gross margin without subsidies	100.0	99.1	41.4	23.9

Source: own study.

In order to more accurately assess the functioning of the index-based insurance mechanism, the assessment of the distributions of the coefficient of variability was supplemented by an estimate of the percentage of farmers who would not receive compensation despite suffering a loss and the percentage of farmers who would receive compensation, although the level of losses on their farm was lower than the limit level launching payment of compensation. The percentage of farms correctly and incorrectly classified in a situation where the average yield falls below and above 10% at the voivodeship level is shown in Table 5. The reference point in the simulation was the minimum decrease in the parameter (yield or margin) estimated at the farm level, at which compensation would be paid if insurance was individual (equivalent to integral franchise[5]). The simulation assumes three levels of the minimum decrease in the yield and margin at the farm level, which when exceeded triggers payment of compensation (10%, 20% and 30%). A comparison of the percentage of farms entitled to receive compensation at those levels with the percentage of farms which would receive compensation if its basis was the average yield in the voivodeship points to the degree of conformity between individual insurance and index-based (group) insurance. The index constructed on this basis can be seen as a basic risk indicator. Depending on the assumed minimum decrease at the farm

[5] Integral franchise – threshold specifying the loss value, below which compensation is not paid (e.g. integral franchise of PLN 500 means that losses below this amount do not result in payment of compensation).

level resulting in payment, the rate of erroneous assessments ranged from a few to nearly 40%. In total, the most cases of non-compliances would be for gross margin insurance (especially in the variant with subsidies), assuming a 10% threshold launching payment of compensation (individual insurance), of which the majority of non-compliances would entail the lack of payment despite a loss (the adoption of the minimum individual threshold of 10% means that many farmers would be entitled to receive compensation with a relatively small loss in the subject of insurance while the average level of losses in the voivodeship would be lower than the limit level in index-based insurance.

On the basis of the simulation, it can be concluded that the use of the average yield in the voivodeship as an index launching payment of compensation for gross margin insurance would entail a large number of erroneous classifications (high basic risk). Slightly better results would be obtained in the variant where the regional yield rate would be used to insure yield, although in this case also the total share of incorrect classifications in relation to individual insurance would cover almost 1/4 of farms (assuming that individual compensation is paid for losses at the level of 10%). In general, it can be observed that the majority of incorrect classifications would apply to a situation where the farmer does not receive compensation, although the losses exceeded the minimum level for each variant of individual insurance. It can be expected that this situation would constitute a significant factor discouraging farmers from participating in the yield and margin insurance system dependent on the average level in the voivodeship (index-based insurance). The relatively best balance, between the percentage of farms which would receive the compensation despite the lack of losses and those which would not receive compensation despite incurring a loss was observed when assuming the yield loss threshold on the farm at the level of 20% (7.1% of farms would not duly receive compensation and 8.8% would unduly receive compensation). It follows from this observation that if an integral franchise for individual insurance was set at the level of 20%, then the percentage of victims of the system from the point of view of farmers and insurance companies would be similar.

Table 5

Percentage of correctly and incorrectly classified farms in yield and margin insurance based on the voivodeship index of yields

Subject of insurance	Minimum decrease in the parameter at which is considered that the farmer suffered a loss	Decrease in the yield in the voivodeship launching payment of compensation under index-based insurance				Rate of erroneous assessments
		< 10% (no compensation)		>10% (compensation is paid)		
		Correct classification (farmer does not suffer a loss – does not receive compensation)	Incorrect classification (farmer suffers a loss – does not receive compensation)	Incorrect classification (farmer does not suffer a loss – receives compensation)	Correct classification (farmer suffers a loss – receives compensation)	
		% of farms				
Yield	10%	69.4	18.5	5.7	6.4	24.2
	20%	80.8	7.1	8.8	3.3	15.8
	30%	85.2	2.7	10.6	1.5	13.4
Gross margin	10%	57.0	30.9	4.3	7.8	35.2
	20%	67.8	20.1	6.2	5.9	26.3
	30%	76.5	11.4	8.5	3.6	19.9
Gross margin without subsidies	10%	54.6	33.3	4.0	8.2	37.3
	20%	62.1	25.8	5.2	7.0	31.0
	30%	69.5	18.4	6.7	5.5	24.3

Source: own study.

The basic risk mainly associated with the possibility of not receiving compensation despite incurring a loss may be considered one of the key factors determining the usefulness of index-based insurance. In assessing the functioning of traditional (individual) yield insurance taken out by farmers, there is usually an argument of too high insurance costs (despite co-financing for the insurance contribution) (Sulewski, 2015; Majewski, Sulewski and Wąs, 2008). Figure 3 compares the cost of insurance for yields, prices and gross margins (with and without subsidies) expressed in the so-called fair contribution[6] whose amount reflects the value of losses incurred in a given period. The reflections on price insurance, contained in this fragment, are academic and serve only to illustrate the differences between the individual parameters, since in practice such insurance is not applied (this role is played by futures contracts). The value of the fair contribution was calculated

[6] In practice, the insurance contribution paid by the insured also covers the system functioning costs, transaction costs, profits of an insurance company, etc. In a simplified manner, it can be assumed that the fair contribution reflects the "pure" cost of risk.

based on the cumulative difference between the expected value (from the trend) and the actual level of the given parameter (per 1 ha). The amount of the insurance contribution was considered assuming four levels of integral franchise[7], i.e. 0%, 10%, 20% and 30%[8] (assumed that compensation only covers losses above the agreed threshold[9]). The presented statement shows that the highest insurance cost of 1 ha of wheat, regardless of the level of franchise, would take place in the case of gross margin insurance. The greatest diversification in terms of the insurance cost for the individual parameters can be observed in the case of applying franchise at the level of 30%. It should be also noted that the application of this threshold would result in a clear reduction in the insurance costs of all the parameters included, which was fairly poorly visible when franchise at the level of 10% was applied. The observed diversification of the insurance costs (fair contribution) for franchise at the level of 10% can be associated with the previously discussed diversification of the coefficient of variability. The use of franchise at the level of 30% would to the greatest extent reduce the insurance costs of the price itself, due to the fact that relatively few farms demonstrated in this respect losses greater than 30%. As a result, the cumulative loss level was relatively low, which would give a low value of the fair contribution.

A similar relationship applies to the yield, whereby in this case the level of variability was higher than in the case of the price, resulting in the higher insurance costs (more farms exceeded the threshold making them eligible for receiving compensation). Similarly, the large variability of margin values has translated into the high cost of their insurance, particularly in the without subsidies variant. Such significant differences between the insurance costs of individual parameters were not observed in the variants of no franchise and franchise at the level of 10% (the variant of 20% is indirect in these terms). Somewhat surprising may seem the very high price insurance cost (clearly higher than insurance of the yield itself, although with franchise of 30% the relationship was reversed). This observation, just like before, should be associated with the nature of variability of the individual parameters. The variability of prices, although covering a relatively narrow range (Fig. 4), was characterised by a high value (the average coefficient of variability was much higher than that for yields (see Table 3)), although in most cases it did not exceed 30%. Due to this, in the case of "cutting off" the observations with the decreases in the expected value lower than 30%, the majority of the variability would be covered

[7] Insurance contribution with franchise at 0% reflects the value of the fair contribution, while at option 10% and 30% it was assumed that the collected contributions cover only compensations paid with the use of the aforementioned thresholds (losses, respectively, up to 10% and 30% are not covered with compensation, thus in the strict sense of the term thus calculated insurance costs are not a fair contribution).

[8] The loss threshold at the level of 10% corresponds to the solutions valid in the Act (2005) on crop insurance and livestock insurance, while the threshold of 30% corresponds to the rules of support for agricultural insurance included in Article 37 of the Regulation of the European Parliament and of the Council (EU) No. 1305/2013 (20.12.2013), the threshold of 20% plays an intermediate role.

[9] The analogous solution was implemented in the Act (2005) on crop insurance. It is worth noting that in the traditional form the concept of integral franchise usually means that after reaching a specific level of losses, paid compensation covers all losses and not only their value below the threshold determined by franchise.

by insurance, hence the significant difference between the price insurance costs in the variants with and without franchise. The same is true for the yield insurance costs, whereby in this case the distribution of the coefficient of variability was more shifted to the left (Fig. 3), which means that, despite a slightly wider range of variability (dispersion of farms), its average value was slightly lower (Table 3) than in the case of prices, which would result in the lower insurance costs. In the presented specification, the variant assuming franchise of 10% reflects similar correlations as those discussed above, while it is indirect in relation to the two extremes.

It follows from the comparison made that the use of franchise significantly reduces the insurance costs (assuming that the fair contribution only covers losses above the thresholds specified by franchise). However, regardless of the franchise variant the highest costs were characteristic of gross margin insurance. In the context of the considerations made, it should be added that the issue of dividing insurance into individual and index-based was ignored here, which is due to the fact that, from the point of view of the fair contribution, the form of contract is irrelevant (the cost of the fair contribution is estimated only based on deviations from the expected value).

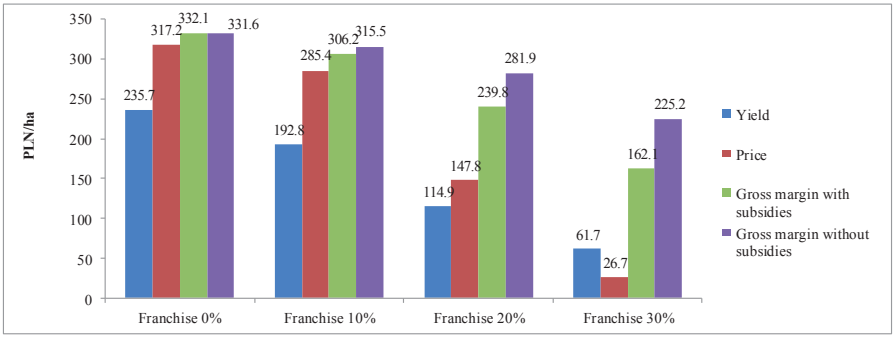

Fig. 4. Theoretical insurance cost of the individual parameters expressed as the fair contribution (pure cost of risk) (PLN/ha).

Source: own study.

Conclusions

Comparative analysis showed that the mechanism of action for index-based gross margin insurance is significantly different from traditional (individual) yield insurance in terms of effects for the farmer. Due to higher variability of the margin value when compared to that of yields and prices, its insurance costs would be clearly higher than for both other parameters. The simulations have also shown that a reduction in the insurance cost through the introduction of franchise (assuming that compensation covers losses only above the threshold determined by the franchise level) would be clearly lower for gross margin than for yields. The assumption of insurance in a form of an index based on the average yield decrease

in the voivodeship would result in a large percentage of errors in award and refusal of compensation when compared to individual insurance. This phenomenon is the result of the so-called basic risk the elimination of which is a prerequisite for the construction of an effective index-based insurance system.

The simulations carried out showed that the average yield per given region (voivodeship) would be a weak index for margin insurance. Among the parameters considered covered by the index-based insurance simulation, the relatively best match was observed in the case of yield insurance (yield index for yield insurance). It is also apparent from analyses that the voivodeship must be considered too large to form a basis for constructing the yield-based index.

Although the studies carried out relate only to winter wheat, the results of the simulation show that the real implementation of the index-based gross margin insurance system (as well as yield insurance) is encumbered with a number of challenges, of which the essential challenge, at this development stage, seems to be the elimination of the basic risk. The development of a system based on the yield index (as well as probably on the margin index) would require data to be acquired in a much smaller area, which is not possible by using generally available mass statistics, and all the more the FADN data. These observations are confirmed by the study by Bardají et al. (2016) showing that a significant diversification of crops and climatic conditions in Europe makes it difficult to implement and support this type of insurance under the centrally managed Common Agricultural Policy. However, the detailed objectives of the new CAP for the post-2020 period are unknown, it seems that the changes being introduced are aimed at facilitating the possibility of support for implementing risk management tools (Tropea, 2016; Farm Ireland, 2018), in particular, at allowing the Member States to adapt their support instruments to the local needs (Graham, 2016).

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WSKAŹNIKOWE UBEZPIECZENIE NADWYŻKI BEZPOŚREDNIEJ W ROLNICTWIE – IDENTYFIKACJA KLUCZOWYCH WYZWAŃ

Abstrakt

W opracowaniu podjęto próbę oceny przydatności indeksowego ubezpieczenia nadwyżki bezpośredniej w porównaniu z tradycyjnymi ubezpieczeniami produkcyjnymi. Analizę przeprowadzono z wykorzystaniem danych FADN, ograniczając jej zakres do przykładu pszenicy ozimej. Przeprowadzone symulacje wykazały, że kategoria nadwyżki cechuje się wyższą zmiennością niż plony czy ceny, stąd koszty jej ubezpieczenia wyrażone „składką sprawiedliwą" byłyby wyższe niż w przypadku tradycyjnego ubezpieczenia produkcyjnego. Zasadniczym problemem ubezpieczeń indeksowych pozostaje jednak ryzyko bazowe związane z możliwością nieotrzymania odszkodowania przez część ubezpieczonych, pomimo poniesienia straty. Przeprowadzone analizy wykazały, że założenie indeksu bazującego na przeciętnym spadku plonów w województwie skutkowałoby znaczącym odsetkiem błędów w zakresie wypłaty i odmowy przyznania odszkodowania w porównaniu z ubezpieczeniem o indywidualnym charakterze. Budowa systemu ubezpieczeń indeksowych wymagałaby pozyskiwania do konstrukcji wskaźników informacji z obszarów o znacznie mniejszym zasięgu terytorialnym.

Słowa kluczowe: ryzyko, ubezpieczenia, nadwyżka bezpośrednia.

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