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## METHODS FOR ASSESSING THE PROPENSITY FOR RISK IN AGRICULTURE

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### ABSTRACT

The aim of the article is to present a survey of existing in specialized literature methods for assessment of the propensity for risk in agriculture and on that basis to draw conclusions with regard to the advantages and disadvantages of the methods and their use for the realization of empirical studies. Methods used in the literature to measure farmers' risk attitudes are classified into two groups, namely direct and indirect methods. We draw the conclusion that there is no ideal and universally good method for assessing farmers' risk attitudes. Each of the methods discussed here carries a certain degree of error probability in the process of assessing the propensity for risk. This necessitates validation of the results of the analysis, which is achieved by comparing the results of the measurement of the variable in the same sample with other methods.

**Key words:** risk attitude, methods, agriculture

Farmers take decisions in a risky environment as a result of existing production, market and financial uncertainty. The way farmers manage risk is largely affected by their propensity to take risks. Studies show that the inclination of farmers to take risks influences the aggregate supply of agricultural products (8), innovation in the sector (8), the financial structure of farms (6) and the marketing decisions of farmers (9). The importance of the variable "propensity for risk" in the context of agriculture makes the issue of assessing its level quite topical.

The aim of the article is to present a survey of existing in specialized literature methods for assessment of the propensity for risk in agriculture and on that basis to draw conclusions with regard to the advantages and disadvantages of the methods and their use for the realization of empirical studies.

In specialized literature there are offered different classifications of the methods for assessing the propensity of farmers to take

risks. Dillon and Scandizzo (5) classify the methods for measuring and assessing the propensity for risk into five groups, namely: 1) methods, based on economic anthropology; 2) econometric methods; 3) methods, based on programming farmer's risk; 4) methods, based on programming the sector risk and 5) methods, based on the theory of expected utility.

Binsvanger (4) distinguishes between two methods for measuring the propensity for risk, namely the method of the certain equivalent and experimental methods.

Anderson et al (1) present several methods for working out the farmer's function of risk preferences, namely: a) the Neumann-Morgenstern method (N-M), b) a modified version of the Neumann-Morgenstern method (or the method of equally likely certain equivalent (ELCE method), c) the method of the equally preferred, but risky result.

Some authors (Mocardi and de Janvry (12); Torkamanil and M. Abdolahi (11)) identify two principal methods for assessing the propensity for risk in agriculture, namely direct and indirect methods (Fig.1) ( The figure is adapted after J. Torkamanil and M. Abdolahi (11)

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The methods for direct measurement of the propensity for risk are based on experiments; studies of the utility function of the subjects under study or on specially designed scales of the propensity for risk. The methods for indirect assessment are based on the observed behaviour or the self-assessment of the persons, whose propensity for risk is studied

(Fig. 1). In order to achieve the goal of the present work there is used the latter classification in view of the comparatively high level of systematization in the presentation of the existing in specialized literature methods for assessing the propensity for risk in agriculture.

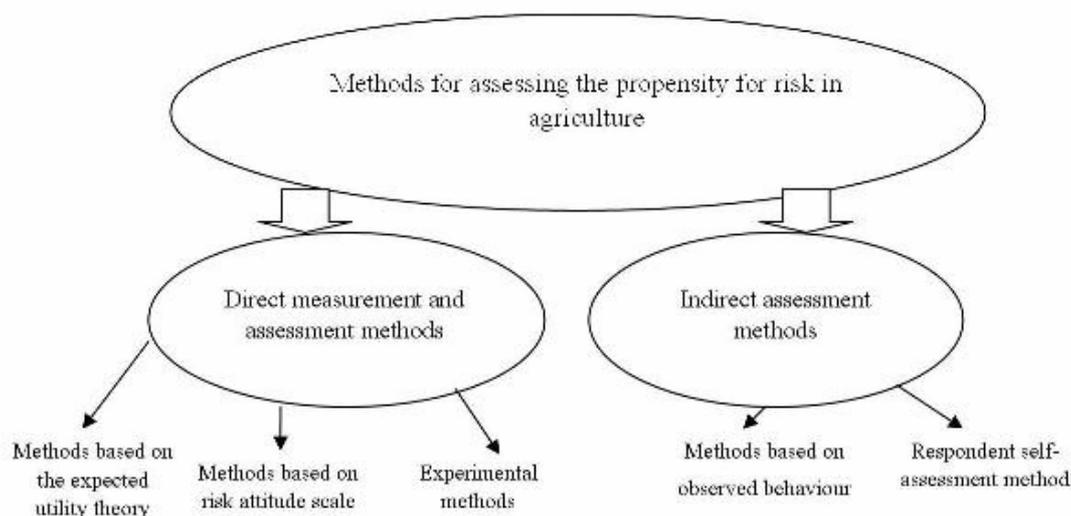


Fig.1 Methods for assessing the propensity for risk in agriculture.<sup>1</sup>

First group of methods: methods for direct measurement and assessment of the propensity for risk.

Methods for measuring the propensity of farmers to take risks, based on the expected utility theory. The theory of the expected utility is the most widely used theoretical framework for assessing the propensity of farmers to risk. Originally conceived by Bernouli (3) it was further developed by von Neumann and Morgenstern (13). The target function of Bernouli has the following form:

$$EU = \sum_{i=1}^n p_i U(x_i), \text{ where:}$$

EU is the total utility of taking the risk.

$p_i$  is the probability of the  $i$ -th result;

$x_i$  is the value of the  $i$ -th result.

(1)

The following axioms of von Neumann and Morgenstern contribute to the development of the theory. First: there is a numerical scale,

which represents the preferences of the individual towards risk-taking. Second: for each result  $x_i$  between  $x_1$  and  $x_n$ , the individual can determine a probability  $p_i$ , at which they show indifference as to either certainly achieving the result, or taking the risk. Third: the total utility of taking the risk is perceived as equal to the expectation of the utilities of the possible results, or:

$$EU = p_i U(x_i) + (1 - p_i) U(x_j). \quad (2)$$

If the behaviour of the decision-maker is compliant with the axioms of von Neumann and Morgenstern, he will assess the results of his choice according to a personal and unique function. The utility function reflects the relation between the expected utility as a result of the risk taken and the utility of the certain return, expressed in money.

The process of elicitation of the utility function includes interviewing of the farmers, which begins with a description of a hypothetical situation (for example the introduction of a

new variety of wheat), at which there are formulated different assumptions, connected with hypothetical levels of profit and loss as a result of the decision that is to be taken. Usually the personal interview is conducted with the help of specially developed software. The elicitation of the utility function requires the farmer to make a comparative estimation of his preferences with respect to the consequences of a particular entrepreneurial decision. The scale of the preferences is built with the help of the researcher, who sets values of the utility for the best and the worst result. The decision-maker assesses the utility of a sufficient number of "average scores" on this scale in order to deduce his individual utility function. One of the ways of its deduction is for the farmer to determine the certain amount of money, which makes him indifferent to the choice between the certain alternative and the expected uncertain amount as a result of taking the risk. Another way is for the decision-maker to determine the probability of the result, at which there will be observed indifference between the risky alternative and a certain result. The attitude of the interviewee towards risk is assessed on the basis of the shape of the curve of the utility function (or the second derivative of that function). If the graph of the function is protuberant ( $U''(x) < 0$ ), the interviewee is regarded as avoiding risk. Conversely, if the graph is concave ( $U''(x) > 0$ ), it is believed that the farmer is a risk-seeker. When the function is linear ( $U''(x) = 0$ ), the producer is considered neutral as regards the risk.

Modified variants of the method of eliciting the utility function are: a) the method of the certain equivalent with an entirely hypothetical risky situation (ELCE-PH method); b) the method of the certain equivalent with a hypothetical, but realistic risky situation (ELCE-R method), and c) the method of the unknown probability of profit (PWD-method).

With the method of the certain equivalent with an entirely hypothetical risky situation the interviewee is faced with a risky perspective with two possible outcomes, the likelihood of occurring of either of which is equal. Each of the farmers must point out the amount of the certain income, for which he would be indifferent to receiving this certain amount or taking of risk. The certain perspective alters progressively until the subject expresses indifference between the risky and the certain

result. At that point the certain perspective is taken as the certain equivalent of the risky perspective. Depending on whether the certain amount is higher, equal to or lower than the average expected amount as a result of taking the risk, farmers are classified as risk-seekers, risk-neutral or risk-avoiding. Thus for example J. Torkamanil and M. Abdolahi (11) carry out a study of the propensity for risk, based on a cluster sample of farmers from the Iranian province of Kerman. Each farmer is asked to point out the amount of the certain income, for which he would be indifferent to the receiving of the same certain amount and the taking of risk with the highest possible profit of 100 mln rials and the lowest possible profit of 10 mln rials, each of the outcomes being of equal probability ( $p = 0.5$ ). The average amount of the expected profit as a result of taking the risk is 55 million rials. Depending on whether the certain income, at which the farmer is indifferent to receiving it and the taking of the risk, is higher, equal to or lower than the average amount of the expected profit, the farmer is classified as a risk-seeker, risk-neutral and risk-avoiding, respectively.

Unlike the method of the certain equivalent and an entirely hypothetical risky situation, with the method of the certain equivalent with a hypothetical, but realistic risky situation, the attitude of farmers towards risk is assessed on the basis of their choices between hypothetical, but realistic alternatives. Thus for example, in the cited study of Torkamanil and M. Abdolahi (11) the questions to the interviewed farmers have to do with the prices of a culture, which all producers in the population produce, namely pistachio. On that basis variations in the prices of pistachio are viewed as an indicator of variations in income and price risk. Farmers are presented with the following hypothetical situation: "Imagine that two months before harvesting your crops you are offered a fixed price contract for the pistachio, according to which the buyer is bound to purchase the whole quantity of your produce. At the time of concluding the contract the projections for the possible prices of pistachio are as follows: 1) 50% likelihood of a price of 10,000 rials per kilogram; 2) 50% likelihood of a price of 40,000 rials per kilogram. What would you rather do: sell the pistachio at the uncertain market price during the period of harvesting the crops, or accept the contract price of 15,000 rials per kilogram?" In case the interviewee chooses the contract price, it is

decremented by a thousand rials until the moment, in which the interviewee shows indifference between the certain and the uncertain alternative. If the respondent chooses to take the risk of waiting for the actual level of the market price, the contract price is incremented by a thousand rials until the moment, in which the respondent displays indifference between the two options. The certain equivalent for each of the farmers is the contract price chosen by them. Depending on whether the certain equivalent is of a higher, equal or lower value in comparison with the expected average level of the market price (25,000 rials per kilogram), each farmer is classified as risk-seeker, risk-neutral or risk-avoiding.

With the method of the unknown probability of profit farmers are put in a risky situation ( $P, E^1, E^2$ ) with two possible outcomes of taking the risk -  $E^1$  and  $E^2$ . The farmer is given the choice between taking the risk and a certain amount of money  $E$ , where  $E^1 > E > E^2$ . The unknown probability of profit ( $P$ ) is found using the following formula:

$$P u(E^1) + (1-P) u(E^2) = u(E) \quad (3)$$

Feinerman and Finkelshtain (6) demonstrate that the required probability of profit can serve as a measurement of the degree of avoidance of risk. In the study conducted by them farmers are asked to state the minimum probability of success (or the needed probability of profit) at which they would invest in a project for the transfer of water. Based on the probability of profit required by them farmers fall into the following three groups:

- at  $P > 50\%$  farmers are viewed as avoiding risk;
- at  $P = 50\%$  farmers are viewed as neutral towards risk;
- at  $P < 50\%$  farmers are viewed as seeking risk.

One advantage of the methods based on the theory of the expected utility is that they provide the possibility to reveal the propensity of producers to take risk in a scientifically justified and comparatively easy (as long as the appropriate software is available) manner.

Along with that this group of methods also has some serious disadvantages, the more important of which are the following: first: their use requires that the primary information should be gathered from the farmers by means of an interview, which entails spending a

considerable amount of time and financial resources; second: in order to answer the questions aimed at working out the utility function, a certain retrospective capacity is required of the respondents; third: if it is uncommon for the interviewees to deal with abstract concepts, they may turn out to be incapable of responding to the questions, regarding hypothetical situations. This is a probable cause of the lack of logic in farmers' responses, registered by some researchers (11).

Methods based on a scale of the attitude towards risk. The purpose of the scale is to provide a quantitative measurement of the attitude towards risk, which, being a latent construct, is difficult to assess directly. In the specialized literature(7) there is put forward the thesis that the attitude towards risk affects the way in which producers manage risk peculiar to agrarian production. On these grounds some authors (2) assume that the attitude towards the mechanisms or tools of risk management reflects the attitude of the producer towards risk. On the other hand, psychometric literature (2) offers evidence of a wide range of variables, which affect the attitude towards risk (including self-esteem, depression, health, etc.). The application of the method involves giving this latent construct a quantitative expression by means of operationalizing it with the help of certain adapted to the specific situation and specific conditions scales, advanced in the theory and used in the practice. The process of building the scale begins with a clear definition of the latent variable "propensity for risk". On that basis there are specified the operationalizing variables, which reflect the propensity for risk. There are made questions or statements (called points), aimed at measuring the level of the operationalizing variables. The respondents assess each point, thus reporting their attitude towards the variable. The results for each individual are obtained by totalling the answers on each point (question or statement). Based on this system of questions and statements there is established a score, which gives a quantitative measurement of the propensity for risk. As a result of this procedure the producer's attitude towards risk is classified according to the degree of avoidance (acceptance) of risk.

An important positive side of this method is that unlike the method of direct deduction of

the utility function, the results of the respondents can be compared.

Another advantage of the method is that the primary information can be gathered by means of a survey. This method of gathering primary information requires a smaller amount of financial resources and time in comparison with the method of the structured in-depth interview, used in assessing the propensity for risk through the methods, based on the theory of the expected utility.

One disadvantage of the method is that there is the potential for errors, which can originate from two sources, namely errors in measurement and those due to incorrect theoretical formulation. The probability of errors, connected with measurement is minimized through a reliability test, while the construct validity analysis, which assesses the theoretical foundation of the scale, is accomplished by comparing the results of the analysis with results of measuring the variable by other methods within the same sample of the population.

Another disadvantage is that the answers of the respondents concerning risk management techniques could - besides the attitude towards risk, - be also affected by their level of awareness, understanding or bias towards the respective risk management technique. This weakness of the method demands the selection of experienced farmers, who in the preliminary stages of the study would be familiarized with a wide range of risk management techniques, which raises the cost of the process of assessing the propensity for risk considerably.

Experimental methods. They consist in putting the farmer in an actual risky situation and a subsequent reporting and analysis of the results of the experiment.

A major advantage of this group of methods is that they provide comparatively reliable information on the propensity for risk of the farmers under study in the particular situation. This is due to two main reasons. On the one hand, with the experimental methods there is no danger of making wrong conclusions, caused by an erroneous specification of the utility function or an incorrect theoretical formulation of the variable "propensity for risk". In many cases such errors arise out of the circumstance that reality is more complex than can be presented with an economic and

mathematical or a statistical model. On the other hand, to farmers it is easier to understand the real, rather than the hypothetical situation. Unlike the other methods for direct measurement of the attitude towards risk considered here, the quality of the measurement with the experimental method does not depend on the individual characteristics of the farmers in the study (for example degree of awareness of the various risk management methods, ability to deal with abstract concepts, retrospective capacity, etc.).

One disadvantage of the method is that it is costly and difficult to use with large representative samples (Despite the above difficulties, some researchers study the propensity for risk in a representative sample by means of experimental methods. Thus in 2007 Harrison (8) conducted experiments, aimed at determining the propensity for risk, with the participation of 253 citizens of Denmark, who were a representative sample of the population of Denmark).

Another disadvantage is that through this method researchers usually measure attitudes towards risk in a specific situation (4). Since in specialized literature there exists proof of the thesis that the attitude of farmers towards risk is peculiar in different situations (10), it would be appropriate to assume that the results of the experiments do not provide accurate information on the general attitude of farmers towards risk.

Second group of methods: methods for indirect assessment of the propensity for risk.

Method of the observed economic behaviour. This method is used for performing indirect assessment of the propensity of farmers to take risks on the basis of observed farmer's decisions such as rates of investment, product mix, etc. One advantage of the method is that it provides the opportunity for the propensity for risk to be studied on the basis of information from available statistics, which is gathered comparatively quickly and inexpensively. A disadvantage of the method is that the assessment of the attitude towards risk is based on a comparatively small number of variables, which are often not directly connected with the attitude towards risk. For this reason researchers (10) of the variable "attitude towards risk in agriculture" regard the method as comparatively inaccurate.

Self-assessment method. With this method it is the producers themselves that assess their attitude towards risk as positive, neutral (neither positive, nor negative) or negative.

One advantage of the method is that in order to use it, it is not necessary to develop special software, nor hold an interview with the respondents. The primary information is gathered at a comparatively small cost of financial resources and time by means of a survey.

A disadvantage of the method is that self-assessment can be influenced by the individual's notions on the kind of attitude towards risk that is approved by society, or can be a reflection of what the individual would like to be.

Based on the above advantages and disadvantages of the methods for assessing the propensity for risk in agriculture there can be made the following general conclusions:

First: there exists no best method for assessing the attitude of farmers towards risk. Each of the methods discussed above has its advantages and disadvantages. This requires that the choice of method should be consistent with the restrictions and the goal of the study, while at the interpretation of the results of the empirical analysis there should also be taken into consideration its inherent weaknesses.

Second: each of the methods discussed here carries a certain degree of error probability in the process of assessing the propensity for risk. This necessitates validation of the results of the analysis, which is achieved by comparing the results of the measurement of the variable in the same sample with other methods.

In conclusion, the study of the advantages and disadvantages of the various methods for assessing the propensity for risk in agriculture is of great significance for the choice of a suitable combination of methods for the realization of specific empirical studies. The precise selection of such methods is a prerequisite for a high degree of reliability of the results of the analyses of the propensity for risk and hence for an explanation of important differences in the behaviour of farmers.

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