

How to deal with global concept of Risk in Agriculture? Comparative overview of the literature.

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Abstract.

Research background: Risk is an important aspect of the agriculture business. The uncertainties inherent in the changes in input and output prices, climate and biological variables, agricultural policies and government decisions, global markets and the volatility, sales, world trends in the consumption, environmental legislation and other factors that impact agriculture can cause big differences in farm production and in general in farm income.

Purpose of the article: The aim of the paper is twofold. The first task is to survey and classify the main types of risks in agriculture, risk evaluation methods, approaches for estimation and to present the applications of these methods across the literature. The second aim is to point out how to measure the risk in agriculture enterprises.

Methods: In the recent years, there was an increase in the number of risk studies with potential to further deepen and develop the previous studies. This study provides a literature overview of risk studies in agriculture. More specifically, this paper discusses the sources of risk in agriculture, summarizes the literature and methods of measuring the risk and comments the problems with risk evaluation in agriculture.

Findings & Value added: The objective of this paper is to provide the methodological conclusions for further research about risks in agriculture and opportunities of risk evaluation. This review is expected to prompt researchers to perform new theoretical studies and stimulate to analyse and measure risks in agriculture.

Keywords: *agriculture; global concept of risk factors; risk management; risk perceptions*

JEL Classification: *Q14; F69; D81; G32*

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1 Introduction

The problem of measuring and managing risk in agriculture is a topic of continuing interest in the last years. Farmers make decisions in risky and uncertain changing environment. Agricultural producers face many uncertainties that can affect their production. Agriculture is a sector that is particularly dependent upon the conditions of the natural environment and thus, it is exposed to a wide spectrum of risks, especially those which have climatic or natural background. The external environment of the agricultural enterprise has several major dimensions, each of which can be considered a source of uncertainty. [1] identified five major dimensions: technological, climatic, social, political, and economic. Each of these dimensions represents an important source of risk for agricultural enterprises. Patrick classified the business risks according to their sources to five farms risks (market or price risk, production risk, technological risk, legal and social risk and human sources of risk. [2]

The consequences of farmer's decisions are generally not known when the decisions are made. Kaan identified the biggest sources of risk in agriculture as the variability of prices and the yield of the farm. [3]

Risk and uncertainty are two terms basic to any decision making framework. Hardaker et al. defined risk as imperfect knowledge where the probabilities of the possible outcomes are known, and uncertainty exists when these probabilities are not known. [4] A more common usage of these terms would state uncertainty as imperfect knowledge and risk as uncertain consequences [3].

The risk studies define the risk management as choosing among alternatives to reduce the effects of risk. Further added that for an individual farmer, risk management involves finding the preferred combination of activities with uncertain outcomes and varying levels of expected returns. From this point of view, Kaan defined risk management as choosing among alternatives for reducing the effects of risk on the farm or ranch, which in turn effects the farm or ranch's welfare position. [3] Patrick studied the risk management strategies in agriculture and wrote, that generally farmers would like to avoid major losses, but would also like to be in a position to benefit from favourable events. [2] The trick is to effectively manage risk without unduly sacrificing gains [2]. Risk management can be divided into two groups. Firstly, the role of the state (government) in supporting the income of agricultural producers through the variety of tools like mutual funds, income stabilization fund, contract farming, lease contract, tax exemption and credit facilities and ad hoc support (see [5]). Secondly, the risk must be managed by the farmers on their own. Hardaker et al. wrote that effective risk management involves anticipating outcomes and planning the strategy in advance given the likelihood and consequences of events, not just reacting to those events after they occur. [4] Over the years, farmers have used several risk management strategies. Mishra and El-Osta divided these strategies into two groups. [6] The first group include management strategies that reduce risk within the farm's operation (e.g. enterprise diversification, crop insurance, and holding liquid reserves of cash and credit). The other strategies focus on transferring the risks outside the business, such as hedging, forward contracting of commodities and inputs.

Developing appropriate methods for assessing attitudes to risk in agriculture becomes an important goal for the research. The oldest method is the attitudinal method in which individuals are asked how they would act in various hypothetical risky situation, usually games of chance. There have also been a number of econometric studies for estimating risk aversion parameters and attitudes to risk in agriculture (see [7], [8]). Estimates of risk aversion coefficients, based on assumed utility functional forms, have been valued in predicting producer's responses to proposed policy. Just and Peterson estimated the production function with calibrating the concavity for agricultural producers of the utility

function. [9] Several studies focus on risk assessment in agriculture, which follow each other but also revealed weaknesses in previous work.

The purpose of this paper is to review the risk agriculture literature. More specifically, this study discusses the major sources of risk in agriculture, summarizes several methods of quantifying risk and shortly discuss the methods how to manage the risk in agricultural enterprises.

The remainder of the article proceeds as follows. In the next section is presented the literature overview with the summary in the table, which focuses on the risk evaluation methods and present the applications of these methods across the literature. The methods are then described, followed by a discussion of the problems with risk evaluation in agriculture. The article ends with a summary and concluding remarks.

2 Material and methods

The business of farming is inherently risk, because of its dependence on the climate and biological variables. Variation in weather, insect infestations, and plant diseases, for instance, can hurt crop quality and reduce yields, changes in aggregate supply and demand for agricultural products can lead to substantial changes in prices and changes in regulations can alter farmer's production practises and costs [10]. In addition to production and price risks, agricultural enterprises are also often exposed to financial risks associated with borrowing the capital. The analysis of agricultural economics risk studies, see: [2], [11] and others pointed out the main risk types in agriculture, their features and the key factors. The study of the literature summarizes the classification of risk types in agriculture into: production risk, credit risk, personal risk, political risk and economic risk. It is possible to determine the interactions between all these types of agriculture risks.

Therefore, farmers have to develop risk management strategies, which can timely identify all the types of risks. In agriculture it is extremely important to evaluate and manage agriculture risks and to select the best management methods.

Measurement of risk attitude has a long history and has several approaches. Scientific literature describes a lot of risk evaluation methods which focus on different types of risk. However, the sector of agriculture is specific considering the differently types of risk (natural processes, biological assets, plant and animal diseases) and it is not easy to say which methods should be used in agricultural sector.

In the risk studies the methods of risk evaluation can be divided into two groups, quantitative and qualitative models. Qualitative risk modelling techniques are focused on the causes and consequences, while the quantitative techniques concentrate on event probability calculations. Agricultural risk studies present several methods to estimate farmer risk preferences. Most of the risk evaluation methods included only one risk type, e.g. production, financial, personal, economic or political. It is difficult to choose an efficient evaluation risk method. Quantitative methods require massive data sample for the study and also a professional statistical knowledge. Qualitative methods depend on a knowledge and experience or the decision-maker.

3 Results and discussion

This study is a pilot study, which aims to obtain a theoretical basis for measuring risk in Slovak primary production farms. The purpose of the study is to gain a theoretical knowledge about the applied risk evaluation methods and to summarize conclusions about the possibilities of measuring risk in agriculture.

3.1 The comparative overview of the risk literature in agriculture

Table 1 summarizes the significant risk studies in agricultural sector. In the first column are the names of the authors of the scientific study and the year of the study. In the second column is the applied method assessing risks in agriculture. These studies mostly focus on a limited set of risk sources and widely used econometric approach estimation of attitudes to risk. There was an increasing number of risk agriculture studies in the last years with the parametric econometric approach to model the risk averse or risk responsive behaviour of farmers. The pilot study by [7] and the next extension by [8] contained a new econometric approach which differs in providing explicit econometric estimates of risk aversion, and examines how risk attitudes are influenced by changes in wealth and income. In summary, the available econometric evidence suggests that enterprises rebalance their production portfolios such that when the perceived risks of an enterprise increase, farms substitute toward less risk enterprises.

Schurle and Tholstrup seek to use the evaluation model to estimate the relationships between enterprise mix (farm size, location of the farm, age of the operator, financial obligation of the farm, machinery investment, government program payments and a measure of returns to the operation) and variance of income (variability of income). [12] These risk method is called Variation-covariation method and uses massive historical data and is highly adaptive.

Several studies dealing with risk in agriculture are based on the creation of a questionnaire (see [2], [10], [13]). The risk quiz developed in the scientific studies help measure the risk attitudes and ultimately the knowledge of farm's risk attitude is helpful in understanding the feelings in certain situations. Questionnaire is an effective tool for identification a wide range of risks, management strategies and needs for assistance. These studies of risk compare and simultaneously evaluate and interpret the results of the questionnaire.

The risk evaluation methods used to measure the risk in agriculture are specific, because of its close relation to the nature. Our analysis of literature pointed out the main risk evaluation methods used for agricultural risk evaluation. As the most applied method is the econometric approach, based on the parametric approach to function estimation.

In the third column is the area of agriculture, which the research studies dealt with. The most of studies is dealing with agriculture as the whole unique sector.

The fourth column shows the type of study: Theoretical, Theoretical and Practical or Practical. However, it is not easy to say which risk evaluation method should be used in agricultural sector. The most of the scientific risk literature introduces the new risk evaluation methods and models. That is why the most research studies are theoretical with the aim to developed new risk methods for assessing risks in agriculture. Some studies (e.g. [7], [8], [14] and others) have verified their new proposed risk evaluation model on a sample of data of farms. These studies therefore also included the practical application of the proposed risk evaluation models. Some research studies have focused only on the practical application of already known theoretically created risk models in agricultural sector (see [12], [15], [16], [17] and others).

Table 1. Literature overview of selected risk studies in agriculture.

<i>Author (s)</i>	<i>Applied techniques</i>	<i>Application field</i>	<i>Type of the study</i>
Hanson et al. (2004) [10]	Questionnaire	Organic Farmers in U.S.	Theoretical (define risks in Organic Agriculture)/Practical
Moschini, Hennessy (2001) [18]	Modelling price and production uncertainty with utility function Econometric estimation of supply models with risk	Agricultural Producers	Theoretical (selected empirical issues and risk management for agricultural producers)
Hardaker (2000) [19]	Risk aversion and the utility function	Agriculture	Theoretical (Measures of risk aversion, Methods of risk analysis)
Bardsley, Harris (1987) [7]	Econometric estimation of attitudes to risk	Agriculture: Grazing Industries	Theoretical/Practical (The estimation econometric method was used for the data sample)
Bar-Shira (1991) [8]	Econometric estimation of attitudes to risk	Agriculture	Theoretical (derive the relationship between changes in deterministic wealth and random income)
Eidman (1989) [1]	Direct elicitation of utility functions, The risk interval approach, Experimental methods, Observed economic behaviour	Agriculture	Theoretical (summarize the methods of quantifying risk and methods to manage risk)
Kaan (2000) [3]	-	Agriculture	Theoretical (define risk bearing ability and risk attitudes)
Lipinska (2016) [5]	Descriptive method and Dogmatic analysis of normative acts	Agriculture in Poland	Theoretical (The role of the government in production risk management)
Mishra, El-Osta (2002) [6]	Two logit models were developed to identify the factors influencing the likelihood of using hedging of futures and crop insurance	Sole proprietorships in U.S.	Theoretical/Practical (The factors influencing operator decisions to purchase insurance or hedging)
Salvati, Carlucci (2010) [15]	Indirect approach: Indicators of land degradation risk in agriculture	Agriculture in Italy	Practical (Estimation and validation of land degradation in Agriculture)
Patrick (1998) [2]	Questionnaire	Agriculture	Theoretical (Questionnaire for measuring the risk attitudes, elements for decision making of farmers)

<i>Author (s)</i>	<i>Applied techniques</i>	<i>Application field</i>	<i>Type of the study</i>
Just, Peterson (2003) [9]	Estimation of the concavity utility function of risk aversion	Agricultural producers	Theoretical (Expected utility theory is not appropriate framework to explain the decisions of farmers under risk)
Bar-Shira et al. (1997) [20]	Estimation of risk aversion coefficients: econometric approach	Farms in Israel	Theoretical (Methodology to assess the effect of wealth changes in the measures of risk aversion)/Practical (data sample)
Antle (1989) [21]	Econometric approach to risk attitude estimation	Crop-production farms	Theoretical (Estimation of risk attitudes wherever pooled farm-level cost and returns data are available)/ Practical (data sample)
Bougherara et al. (2017) [22]	Cumulative prospect theory and a multiple-prior model	French farmers	Theoretical (model of risk and ambiguity preferences) Practical (estimate preferences by farmers)
Koundouri et al. (2009) [23]	Parametric approach of the production function	Finnish cereal farmers	Theoretical (propose a technique which allows simultaneous estimation of production technology, risk attitudes and land allocation decisions)/ Practical
Jin et al. (2017) [13]	Survey instrument and a complementary experiment	Farmers in China	Practical (Questionnaire measure a judgement of farmers willingness to take risks in general)
Groom et al. (2008) [17]	Agent production model under risk: econometric estimation	Cypriot farmers	Practical (The importance of estimating the risk preferences in evaluating the impact of drought management policies)
Kim (2008) [24]	Structural approach adopted Antle's (1989) non-structural approach	Farmers	Theoretical (The suggested approach provide farmers risk attitudes over time, which includes all types of risk)
Elamin, Rogers (1992) [16]	Hazell's MOTAD model (1986)	Agriculture in western Sudan	Practical (developed the risk aversion coefficients with programming method)
Kimura, Antón (2011) [25]	Holistic approach : interaction between all sources of risk, strategies, policies	Agriculture in Australia	Practical (the report about risk management system in Australia and their policy implications)
Schurle, Tholstrup (1989) [12]	The ratio of variance and the covariance: Variation-covariation method	Farms in Kansas	Practical (Relationships between business risks and farm characteristics)
Hardaker et al. (1997) [4]	Summary of the risk strategies in agriculture	Agriculture	Theoretical (risk management strategies in agriculture, issues in decision analysis)
Zhao et al. (2008) [14]	Capital structure analysis, Myers's (1984) pecking order theory	Farms in Illinois	Theoretical (joint effects of the signalling, pecking order, and trade-off theories on capital structure) /Practical (demonstration on data sample of farms)
Pope (2003) [11]	Econometric models of risk response	Agriculture	Theoretical (Summary of risk response studies)

Source: Own processing

3.2 Discussion of the problems with risk evaluation

After the analysis of the risk evaluation models, it can be concluded that an integrated evaluation method is the most appropriate choice in risk evaluation in agriculture. However, the integrated risk evaluation can see the agricultural risks holistically. The aim of this paper is to study and describe the theoretical background of the risk evaluation methods in agriculture with the aim to present a logical framework of integrated risk evaluation. Figure 1 provides an illustrated logical scheme of the integrated risk evaluation method in farms in Slovakia. Due to the data of Slovak farms available on our department, we decided to the risk methods explained below.

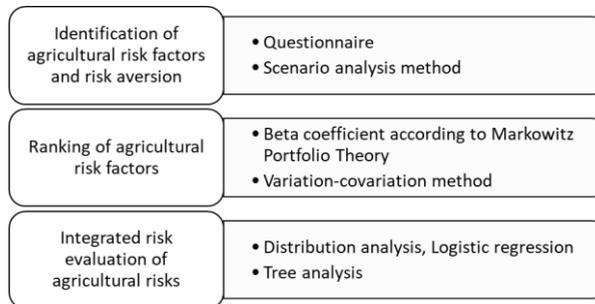


Fig. 1. Scheme of the integrated risk evaluation method in farms

Source: Own processing

The first step is to identify the risk factors and risk aversion in the farms. A questionnaire will be used for the purpose of obtaining initial information on Slovak agricultural enterprises, their attitude to risk and the methods used to eliminate risk through risk management strategies. The results of the questionnaire can describe and identify the risk and its factor that poses the greatest threat to the success of the farm. Another output of the questionnaire will be a description of the risk elimination tools used across the Slovak farms. The second method will be the scenario analysis, which will help to look at the key factors that multiply the number of rough scenarios. This method can include quantitative and qualitative data. This method is broadly used in decision-making and it is based on assumption that future events cannot be predicted with certainty. The result of the analysis is the identification of the key factors and the compression of the scenarios. A farmer can use this method to identify the risk and its factor that poses the greatest threat to the success of the farm.

The second step is to identify the risky and non-risky agricultural enterprises. To meet the target will be used Beta coefficient according to Markowitz Portfolio Theory, which is a measure of volatility of systematic risk. To calculate Beta coefficient will be used variation-covariation method, which uses massive historical data about Slovak farms. This method is highly adaptive and will help to identify the risky farms.

The third phase of agricultural risk evaluation uses three multivariate statistical methods. The data are taken from the previous stage of the risk assessment model. The model is made by taking into account the financial ratios from the financial statements. Based on the distribution analysis, logistic regression and decision tree analysis will be selected the statistically significant financial ratios, which will help to classify the farm in the group of risky farms. This logical framework helps farmers to identify the most problematic areas on the farm and to make the rational decisions on time.

In summary, this evaluation in agriculture will help distinguish between risky and less-risky farms and also can describe the characteristics of risky farms.

4 Conclusion

It is not easy to say how to analyse risks in agriculture and to evaluate or manage them. It is difficult to separate different types of risk because risks affect each other and interact. To measure the risk in agriculture are used several quantitative and qualitative methods. The most analysed method is the econometric estimation of parameters of the utility function. The risk studies also used variation-covariation method, scenario analysis, logistic regression, questionnaire and others. Many studies are mostly theoretical. The main goal of the studies is to developed new risk models for measuring the risk in agriculture. The aim of the practical application across the research studies is to verify the theoretically described method on the data sample.

This article presents a theoretical background about the risk measurement methods used and analysed in the scientific literature. Secondly, this paper presents a logical framework about the risk measurement in Slovak farms and discuss the options, possibilities and outputs of the risk methods. Finally, this paper gives the answer to the question: How to deal with the global concept of risk in agriculture?

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