RISK REDUCTION IN CORN PRODUCTION WITH WEATHER PUT OPTION

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Abstract

Since the late 1990s scientists have discussed the use of weather derivatives to hedge weather conditioned yield volatility in the agricultural sector. The hedging efficiency is depending on the contract design (Weather-Index, Strike-Level, Tick-Size). The basis risk consisting of the basis risk of production and the basis geographical risk, however, remain with the farmer. In this paper we quantify the risk reducing effect of rainfall put-options by applying a stochastic simulation. For this simulation we analyzed the yield data we obtained from corn producing farm located in the central part of Srem, Serbia. A nearby weather station contributed the meteorological data.

Key words: Basis risk of production, corn, geographical basis risk, revenue, weather put option

Introduction

Today the significance of weather conditioned risks for the agricultural sector is evident; however, its relevance has increased over the last years, since the occurrence of extreme weather phenomena surged constantly in many regions of the world. The European Union has paid particularly high attention to the risk management in its recent agricultural market reforms to avoid successive variations in food prices. The research of crop insurance in Europe has been long actualized, while in Serbia only a small number of papers are devoted to this subject. The fact is that always after a flood, drought or a strong storm it comes to intensified discussions about crop insurance which can compensate for the loss in production (Breustedt, 2003). Economic attractiveness of different instruments for risk management, such as insurance, depends on the farmers’ exposure to different risks (Berg, 2005). So far loss of yield insurances has been the first choice to deal with weather induced risks. In addition to traditional yield insurance, some authors suggest the need for expansion of the multi-risk crop insurance which is mainly present in the developed countries of Europe and North America (Berg, 2002). Today, even the actual index-based insurance considers the possibility of using weather derivatives in agriculture (Turvey, 2001; Berg et al., 2005; Müßhoff et al., 2005; Marković et al., 2011a). It is significant that the most important aspects of the insurance market in the developed countries can also be applied to the countries in transition.

Weather derivatives are a relatively novel tool to deal with the quantity risk of production. They are financial derivatives (like e.g. futures or options) which serve to swap weather risks. They may refer to temperature, rainfall or other meteorological variables. Weather derivatives however, have some striking advantages over traditional insurances. Firstly, the derivative holder does not have to prove the defect nor has he to evaluate its extent. Furthermore the moral hazard problem does not emerge at all. Despite these advantages the market for weather derivatives in the agricultural sector is still fairly small. Indeed, there are some promising practical tests ongoing, in particular in the USA and Canada and scientist point to numerous potential applications (Turvey, 2001; Vedenov et al., 2004). Nevertheless, it is still unclear in how far weather derivatives will establish in agribusiness in the years to come.

The aim of this paper is to provide the basic theoretical assumptions about the weather derivatives as a new financial instrument in crop insurance and to quantify the basis risk of a corn production in the central part of Srem (Serbia) with regards to a rainfall put-option and to evaluate the hedging efficiency of this derivative. To attain this goal we analyze and compare three cases: 1. Revenue without put-option; 2. Revenue with put-option, with basis risk; 3. Revenue with put-option, without basis risk.

Material and methods

The analysis of the functionality of weather derivatives inherits three steps: The statistical modeling of the observed meteorological factor, the determination of the price of the derivative and the determination of the risk profile of the analyzed farm with and without the application of the derivative (Müßhoff et al., 2007). For the case at hand we analyze a put-option, which is referring to
rainfall. We set the cumulating period from April to August, since the correlation between the corn yield and rainfall is at its maximum during this period (Marković et al., 2011b).

On the basis of empirical metrological data for the years 1999 to 2008, which we obtained from the weather station „Rimski Šančevi, Novi Sad“, we estimated the probability distribution for the rainfall index. Further we obtained the corn yield data for the same time period from the mentioned farm in Srem. The yield data allows the development of a production function. This production function displays the correlation between rainfall and the corn yield. To avoid pricing difficulties, which often occur when it comes to evaluate weather derivatives fairly, we decided to price the option according to the “fair premium” approach in the actuarial sense.

Results and discussion

The basis risk is a potential impediment for the break-through of weather derivatives since it represents a source of uncertainty for the farmer. The basis risk consists of the basis risk of production and the geographical basis risk. The basis risk of production refers to all individual risk factors which are connected to a specific farm and its entire production process. The geographical basis risk emerges from the divergence of the point of reference (the weather station) of the derivative and the point of production. As the distance of these points increases the geographical risk increases, too. This divergence plays a minor role regarding temperature based derivatives, but it is of vital importance when it comes to rainfall derivatives since the variability of rainfall is much closer connected to the location than temperature is. The entire basis risk remains with the farmer because weather derivatives have no influence on it. Consequently this risk is unhedgeable. Therefore, derivatives can never achieve a perfect correlation between the variation in yield and the weather factor(s), they refer to. This imperfect correlation and consequently the imperfect hedge can discourage farmers from buying derivatives.

![Graph 1. Fair premium and payoff of put option in corn production](image)

Graph 1. Fair premium and payoff of put option in corn production
Data on rainfall were taken from a reference meteorological station close to the place of production. The weather index based on the monthly amounts from April to August is at the level of 300 mm (strike level), while the tick size is 100 RSD/mm (1 EUR = 100 RSD). The payoff is limited to 180 mm, which means that if the rainfall is below this level, it is not going to be paid more, but the payoff remains the same. The weather contract is valid for five months and the payoff is possible if measured rainfall is below the strike level (Graph 1).

Consequently we calculated on the basis of our model for each of the three mentioned cases the distribution of the corn yield. In our model the corn yield depends solitary on the rainfall and the basis risk. The comparison of the distribution with and without the rainfall option gives us finally the hedging efficiency. The developed model incorporates the basis risk of production and the geographical basis risk in its specifications of the index. Both risks combined as the basis risk show a strong influence on the hedging efficiency. The maximum hedging effect occurs at 10 percentile. In comparison with having no rainfall put-option the farmer can hedge 10,000 RSD/ha with the put-option, considering the basis risk, and even 20,000 RSD/ha when not considering basis risk (Graph 2). Consequently the hedging efficiency of the rainfall put-option is substantial in our example. However, as the basis risk increases the hedging efficiency is decreasing as well. When the farmer has to consider additionally transaction costs then the deployment of rainfall put-options as a risk management tool is clearly questionable.

Graph 2. Revenue distribution of corn production, with and without option

Conclusion

Our results show that potential sellers of rainfall put-options have to offer a wide range of custom-made options, which allow farmers to pick the most appropriate one for their individual basis risk of production. Furthermore, the sellers are in need of a dense net of weather stations as reference points to minimize the geographical basis risk. These conditions surely scale up the complexity for sellers, but they are inevitable to raise farmer’s interest in rainfall put-options in particular and for weather derivatives in general.
References


