Risk and Uncertainty Analysis with Networks of Decisions

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Paper presented at the EAAE 2011 Congress
Change and Uncertainty
Challenges for Agriculture,
Food and Natural Resources

August 30 to September 2, 2011
ETH Zurich, Zurich, Switzerland

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1 Introduction

In this paper an applied approach for analysing economic problems under risk and uncertainty based on networks of decisions (NODs) will be discussed. It can be shown that network of decision analysis can help to understand complex decision problems under risk and uncertainty in single case situations. A variety of decision criteria like expectation values and a special ANOVA can be used to get better knowledge about prediction and controllability of the decision problems.

2 Method

Decision tree analysis lacks possibilities to represent complex multiple causal decision structures. On the other hand common regression analysis of the second type (in the terminology of Fisz (1963) is not able to analyse single case problems. But a regression analysis of the first type is able to analyse causal structures of single case problems.

Leserer (1987, 1989) showed that NODs may represent causally ordered decision structures. Let $A_{ij}(t)$ $(i = 1,\ldots,L,\ j = 1,\ldots,M_{it},\ t = 1,2,\ldots;\ L,\ M_{it} \subset \boldsymbol{N})$ be the decision alternatives of *L* agents (or groups of agents) over time where there are M_{it} alternatives for the *i*-th agent in period *t*. Let further $B_{ij}(t)$ denote the set composed of decision alternatives which influences $A_{ij}(t)$ in the sense that $A_{ij}(t)$ occurs if and only if $B_{ij}(t)$ occurs. Finally let $p_{B_{ij}(t)}(A_{ij}(t))$ be the conditional probability of $A_{ij}(t)$ under the restriction of $B_{ij}(t)$. The pair $(A_{ij}(t), p_{B_{ij}(t)})$ represents a network of decisions (NOD). A NOD can be seen as a extended decision tree approach with the possibility to analyse multi-depending structures.

Criteria for decision can be derived on probability characteristics of the NODs such as the joint and conditional probability mass function of random variables, conditional expectations, variance-covariance-matrices and variance decomposition (Recke, 2004). These characteristics can be taken for prediction and control in decision analysis under uncertainty.

3 Results

This approach allows carrying out a multivariate regression analysis of first order and it helps to get the factor combination with the greatest conditional expectation value, a decision criteria for prediction. As an extension to decision tree analysis the part of the variance that comes from the explanatory variables can be taken to analyse the controllability of the decision problem. This can be done on the basis of the conditional variance formula (Ross, 1994).

Subsequently, on the basis of the decision criteria important insights in the predictability and controllability of typical single case situations are possible (Recke, 2004). In typical decision situations under risk and uncertainty like investments information can reduce uncertainty and induce them to choose between alternatives. If people face risk and uncertainty and use information to improve their knowledge in a decision process under uncertainty, this process can be divided into several stages. For the approach presented here the decision process is limited to three stages. In the first stage there is no knowledge about the decision situation and about structures and probabilities. Under this condition decision criteria will not help to improve decision analysis. If, in the next stage, the decision-maker is able to recognise the causal structure of the decision situation without being able to make probability judgements, it might be possible to decide on the basis of conditional expectations. If at stage three the decision-maker possesses knowledge about the structure and can make probability judgements, then the variance formula can be used to gain insights into the controllability of the decision situation derived from variance components. At this stage sensitivity and simulation analysis can improve the outcome (Recke, 1999).

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Keywords: networks of decisions, decision criteria, variance analysis, prediction, control