EXECUTIVE SUMMARY

RISK MANAGEMENT STRATEGIES IN AGRICULTURE: THE STATE OF THE ART AND FUTURE PERSPECTIVES

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1 Introduction

The purpose of the Seminar was to examine the state of the art in agricultural risk management, and to assess the future prospects for improving how risks are managed by farmers, agribusinesses and rural policy makers. The implicit focus was mostly on European agriculture.

Given the 300 plus pages of papers and the extensive discussions of those papers, to sum up effectively in a limited number of pages means highlighting some common issues. The following topics are addressed in this summary: choice of the SEU model (section 2), risk and risk sharing (section 3), perceptions of sources of risk and responses to risk (section 4), issues in decision analysis (section 5), efficiency analysis (section 6), policy issues (section 7), and future perspectives (section 8).

2 Choice of model—to SEU or not to SEU?

Anderson argues that application of SEU model is accelerating—as a search of the recent literature shows. However, uses of the model seldom reflect that the axiomatic foundation embraces both a theory of utility and a theory of *subjective* probability. This is a key difference between the converted and the unconverted in regard to subjective probability. The unconverted, however, face impossible odds in analysing most real choice situations.

Anderson claims that game theory, for games against nature, was a false start, but if it is dead it won't quite lie down, as was discusses in the Seminar. Moreover, some might have thought that mean-variance analysis would be rendered obsolete by the SEU model, but it has been injected with a new lease of life by Robison in his paper with Hanson. The ideas of pragmatism that Anderson mentions may explain the continued use of the convenient EV approach, despite its axiomatic weakness. A related technique that perhaps should have been painlessly put to sleep is MOTAD. It is an approximation to the EV rule which is an approximation to the SEU rule. In current mathematical programming applications, both direct SEU maximisation and SDRF can be applied, yet MOTAD too lives on because of its ease of application, as again demonstrated in the Seminar papers.

In reviewing the state of the art, Anderson makes specific mention of a lost opportunity in application of stochastic dominance. While stochastic efficiency analysis was slow to be

taken up and has too often been abused, it now seems to be part of the 'normal' science of agricultural decision analysis.

Hertzler's paper is especially interesting. He seems to be saying that his approach of dissecting risk preference and time preference means that SEU is saved. But he then tells us that most of the ways we have been using to implement the model are wrong. We need to press him to be much more explicit as to how we can put his theory to work.

Huirne *et al.* confirm the strong suspicion that eliciting utility functions from farmers is at best a risky business. They found that a significant proportion of farmer respondents revealed a preference for risk—which could be regarded as unrealistic—and they have shown that elicited risk attitudes are very unstable over time. It is time for some intellectual honesty, and for us to admit that, for most farmers in most situations, we really cannot elicit credible utility functions. We must either infer risk preferences from observed behaviour, make an informed guess, probably expressed by the relative risk aversion coefficient, or fall back on efficiency analysis.

It also emerges that we need to give much more careful thought to the argument of any assumed or elicited utility function. Applications suggest considerable confusion, with outcomes expressed in numerous ways, often inconsistently or inappropriately.

Despite the practical problems and theoretical doubts raised by Hertzler and others, the axioms of the SEU hypothesis are so appealing that many agricultural economists are reluctant to abandon them, even when those axioms sometimes are violated. The fact that the model continues to be so widely used suggests that others agree.

Support for the basic SEU model comes from Carpentier and Weaver and from Oglethorpe. On the other hand, Bouzit and Gleyses offered support for the extended decision model proposed by Quiggin, now called Rank-Dependent Expected Utility (RDEU). There is no wholly adequate way of identifying the 'right' model, but it is encouraging to see the healthy debate, as illustrated in the Seminar papers.

3 Risk and risk sharing

Scandizzo and Cucculelli offer a new insight into the measurement of risk. Their paper provides a means of avoiding the tricky business of eliciting a utility function. Scandizzo and Cucculelli suggest that risk aversion may be bounded by the market opportunities to buy and sell risk, provided that the risk arbitrage market is sufficiently well developed. However, as Anderson and Hazell suggest, and as Scandizzo and Cucculelli found, not all the markets for risk are fully developed. Nor do most farmers participate actively in existing markets. Such market failure is a topic for further future research.

The Seminar papers illustrate a growing interest in risk sharing, and hence in the structure, conduct and performance of markets for risk. For example, Pennings and Meulenberg look at the interesting possibility of a futures market for production quotas; and Rister *et al.* examine rice marketing strategies in Texas.

The comment by Scandizzo in the discussion that moral hazard, adverse selection and asymmetry of information characterise all risk-sharing situations is important and has too often been overlooked. More work is needed to develop the implications of this proposition.

4 Perceptions of sources of risk and responses to risk

Patrick and Musser provide useful evidence about producers' perceptions of the sources of risk and their responses to those risks. Producers do not always see risk in the way that analysts do, and do not match their responses to risk very closely to their risk perceptions. Perhaps producers need further education about risk and risk management. Certainly, because risk is so tricky, we can be sure that there is too little guidance offered to managers by agricultural educators and advisers—a clear challenge for the future.

Of particular interest is the importance that respondents in the Patrick and Musser study attached to family sources of risk—something largely ignored in the literature. Observations during the discussion suggested that risk analysis is best conducted in a combined farm-household context.

Some presentations and discussions have provided a different but practical view of risk and risk management: not all risk analysis must be quantitative. By ignoring qualitative approaches we may be missing much of the game. Certainly, farmers and other decision makers in agriculture have managed risk, with more or less success, without recourse to the esoteric quantitative analysis of much academic research. What is more, farmers the world over have been coping with risk for thousands of years, with little or no help from academics!

5 Issues in decision analysis

Assessing probabilities to measure risk

Risk aversion may have received too much attention relative to the proper measurement of risk. The SEU hypothesis implies that all probabilities are subjective, but that does not justify picking numbers 'out of the air'. Rational choice requires giving the 'right' degree of effort to probability assessment, drawing on whatever sources and methods are relevant. Bayesian statistics offers part of the foundation for such assessments, but does not provide all the answers. A number of papers deal with aspects of probability assessment.

Rasmussen has provided an interesting example of the quantification of variability in agriculture. Such work is needed in other contexts if risk analysis is to be more widely applied in European agriculture.

Horst *et al.* have introduced us to the use of conjoint analysis for measuring risks. Their research leads to investigations of how this method can be adapted to give probability estimates, and how the approach compares with alternatives, such as the Delphi method.

Jensen offers an exciting possibility of adapting Bayesian networks and influence diagrams to the task of updating judgements to improve the quality of decision making. His approach also goes beyond simple Bayesian revision and is worth further examination to determine its best use.

Despite some good papers, we have only skimmed the surface of risk quantification. Work is needed to improve the quality of probability judgements about, say, weather variables important to farmers. Can farmers, extension personnel, agricultural researchers or policy makers make better use of sparse data and avoid bias in subjective probability estimates? Why is so little work done in agriculture on the calibration of subjective probabilities? This information is needed to help assessors reduce bias in their probability estimates. Such questions are important items for the future R&D agenda.

Partial analysis

Anderson has pointed out the errors of omission and commission in many partial risk analyses and has provided a useful pragmatic solution to these problems. Pragmatism is likely to be the order of the day if risk analysis is to move from theory to application by farmers and other practitioners in agriculture.

The view that risk aversion may not be as important as many people seem to think in partial analysis tends to be confirmed by Anderson. Anderson's assertion that background risk must be taken into account in analysing a risky investment is confirmed in the paper by Mahul.

The dynamics of risk modelling

This important and challenging topic is considered in a number of papers. It is the main theme of the Hanf paper, although his discussion ranges far beyond this topic. Kennedy has offered a suggested objective function for use in dynamic programming. An important issue is to understand more clearly the consistency between this approach and Hertzler's ideas about risk aversion and time preference.

Noell and Odening deal with the dynamics of probability revision as learning, allowing for shifts in risk preference over time. Although essentially a theoretical paper, Nielsen provides an approach to investment planning. An interesting contribution of this paper is the dynamic treatment of price uncertainty—another example of the elaboration of 'better' methods of measuring risk. Kristensen and Jørgensen provide a more powerful method of dealing with dynamic modelling problems using a multi-level, hierarchical Markov process. Even if Hanf is right that the problems of agricultural investment planning in a risky world remain complex, considerable work is focusing on finding effective solutions.

The importance of downside risk

Only a couple of papers, especially Hanf's, addressed the topic of downside risk, a neglected area of study. An important reason to account for risk in decision modelling is when assumed certainty leads to errors in assessing the expected payoffs. This will usually occur when there is embedded risk and the processes are non-linear. Because of diminishing returns (or increasing marginal cost), the expected value of the choice criterion will be less than the value under assumed certainty. The risk premium deducted from expected value to derive certainty equivalent for a risk-averse decision maker is only one example of this phenomenon. Again, the emphasis on risk aversion has been excessive relative to the neglect of proper risk analysis, especially overlooking downside risk. Current software tools such as the @Risk add-in to Excel or Lotus 1-2-3 spreadsheets simplifies the stochastic budgets needed to represent the distributions of choice consequences properly.

6 Efficiency analysis

McCamley and Rudel offer a new and useful way of conceptualising generalised stochastic dominance analysis. In explaining their graphical method, they give a number of insights into stochastic efficiency analysis. Perhaps methods such as theirs will help to 'demystify' stochastic efficiency analysis, extending its use to a wider group of users, and satisfying Anderson's concern about 'missed opportunities'.

Extending the range of applications
Several papers extending the range of applications, include those by Huirne *et al.* on income and sire selection; Da Silva Carvalho *et al.* on discrete stochastic programming to account for yield variability in planning mixed livestock-crop farms; Saatkamp *et al.* on contagious disease control; Berg on input use; and Chaherli on land allocation with stochastic crop returns and government intervention. Oglethorpe's paper is an assessment of the sustainability of farming in a risky world; a topic that will receive more attention in future. The 'risk' of an unsustainable earth is of paramount importance to society.

Direct vs indirect applications
The Seminar discussion about the scope for application of methods of risk analysis was interesting but rather inconclusive. The consensus was that the scope for direct application of comprehensive methods of decision analysis was limited, but by no means an empty set. However, the main scope lies in using decision analyses to better understand risky choice situations as an underpinning to the intuitive choice of risk strategies. Perhaps that scope will change as agricultural production becomes more 'industrialised', justifying higher investments in decision support systems, especially for repeated decisions, but also for case-by-case decision analyses.

7 Policy issues

Anderson and Hazell provide a useful overview of the risk-related reasons for policy intervention and of the main policy instruments. As they note, a key issue is whether the failure of market mechanisms for risk bearing is strong enough to warrant policy intervention. Even if intervention is warranted, the possibility of being ineffective or counter-productive, should be faced. Problems of moral hazard, adverse selection, size of risk, and administrative and political failure can undermine many well-intentioned interventions. Of course, as Anderson and Hazell explain, some areas, such as large-scale irrigation and agricultural technology development, seem to universally require government action.

The government itself can be a main source of risk, especially as it becomes involved in agricultural and related markets. Yet the process of liberalisation and deregulation to get governments out of farming also adds to risk.

Future policy work on risk should focus on making risk markets work better. When markets do function, they are almost certainly more effective and efficient than government alternatives. Only where market failure is real and where policy instruments can be effective should official intervention be considered.

8 Future perspectives

'Good' probability specifications
A 'code of best practice' is needed for making the best probability judgements in a variety of situations, especially when data are sparse or biased, or when there are opportunities to learn about the uncertainty through time.

Measures of downside risk
Non-linearities in stochastic systems usually make the expected value of the choice criterion less than would be calculated under assumed certainty. Thus, there is a need for more risk analyses that measure downside risk by better measuring the distribution of returns.

Stochastic dominance analysis
The use of stochastic dominance analysis allows a growing appreciation of the advantages of shifting distributions of outcomes to the right, rather than concentrating on reducing spread. Risk is often thought of as the variance of the relevant distribution. Stochastic dominance characterises risk in terms of the entire distribution—its location, spread, and general shape. Once methods of stochastic efficiency analysis are improved and extended, there may be less concern about the limitations of utility functions and problems with their elicitation.

Understanding, improving and explaining markets for agricultural risks
Markets usually work better than governments in helping farmers cope with risk. Thus, more effort needs to go to understanding, improving and explaining markets for various kinds of agricultural risks.

Greater use of software packages
Developments in software packages for risk analyses could be the theme of a future conference. User-friendly decision aids play a vital role in educating decision makers about risk analysis and in bridging the still wide gap between theory and practical applications. Electronic communication systems are involved as well. Significant progress in software development is occurring and further communication about these technologies is needed.

Risk analyses in European agriculture
More activity on risk in agriculture is expected in Europe as farmers and agribusiness become more exposed to international markets and as the policy environment becomes more unstable. Time will tell!