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Dynamic Programming for Risk Analysis: Discussion

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To set the stage for my remarks, I feel it is appropriate to classify the presentations of Burt and Young in terms of the research objectives suggested by Antle in his discussion of risk and production appearing in the 1983 December issue of the AJAE.

Within the scope of risk analysis research, Antle delineates two categories: (1) research directed at explaining or predicting firm-level or farm behavior and (2) research directed at improving the decision-making process. The presentations of Burt and Young fall into the latter category. Given this objective, one can ask two questions:

(1) What can we teach farmers and agriculturalists (or what else do we need to learn) about the temporal nature of price and output distributions?

(2) What can we teach farmers and agriculturalists (or what else do we need to learn) about risk aversion in a temporal setting?[1]

With our current research technology I would submit that we can provide a great deal of information in answering the first question and have not done our job in this area. By the same token, I am not convinced we have made a great deal of headway in addressing the second question. With these thoughts in mind, let us now turn to specific discussions of the presentations of Burt and Young.

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[1] It is perhaps useful to temporarily digress and indicate that agriculturalists other than farmers benefits from our efforts to model and optimize dynamic agricultural systems. We should recognize our colleagues from supporting disciplines (primarily agronomy and animal science) as a formal clientele group. The interaction among agricultural disciplines is, of course, nothing new, and has been the subject of previous discussion (Dillon; Swanson; Talpaz). However, in the study of dynamic stochastic systems and behavior under risk, the importance of quality interaction seems to me to be even more critical. I also feel we have an important teaching role to fulfill.

Young and Kooten's Flexcropping Application

Basically, I will point out four major concerns which I feel are of interest. First, the EPIC model is used to generate frequency data for the purpose of estimating stochastic yields and soil moisture levels using ordinary least squares. Given the complexity of EPIC, what was the level of state variable suppression in the analysis? Moreover, why not just use the simulation output to simply compute yield and soil moisture expectations?

Second, the elicitation procedure appears to be in terms of production levels rather than wealth. It would seem that producers' yield forecast assurance levels are inherently linked to their individual financial position.

Third, the elicitation procedure ignores soil moisture forecasts. That is, within period preferences are considered. However, preferences or assurances with respect to transitions across periods (or years) are not treated.

Lastly, the structure of the objective function appears to take the form of a within-season modified mean-variance criterion rather than a safety-first criterion per se. In the paper, Katoaka's lower bound, L, is defined as,

$$L = ER - Z_{(1-\alpha)} \sigma$$

where ER is expected return, σ is the standard deviation, and $Z_{(1-\alpha)}$ "is the desired confidence - level statistic from the appropriate probability distribution." Thus, for the present application, $Z_{(1-\alpha)}$ essentially serves as a weight on σ. This formulation ignores soil moisture uncertainty.

The conceptual difficulty of treating within period uncertainty using an expected utility function becomes apparent in Young and Kooten's results. Under conditions of high barley prices, long run risk is less for the expected value maximization criterion than the within period moderate risk aversion criterion. That is, by virtue of the fact that the decision-maker is risk averse to within period disturbances and ignores uncertainty across periods, overall variation is increased for this problem formulation.

Burt's Risk Oriented Criteria Functions

Burt initially summarizes the standard Markov chain DP model. Selecting the special case of an ergodic process Burt discusses two models that consider maximization of long-run expected gain per period.

Use of an ergodic process and maximization of long-run expected gain per period are probably of minor relevance for dynamic agricultural applications since discounting is ignored and the computational algorithm for the nonergodic process is somewhat cumbersome. However, in the initial section of the paper Burt does address the conceptual problem of replacing the immediate return function with a von Neuman-Morgenstern utility function.

Burt's terminal control formulation in which returns are compounded to the end of a finite planning horizon suppresses the resolution of temporal uncertainty. In Burt's formulation, immediate returns (and their distributions) do not surface until the terminal period. In reality, however, it is the timing of the resolution of these return distributions that matters. Mossin's 1969 AER communication reveals that the independence condition of the expected utility model is violated in a simple two-period utility maximization model depending upon the time at which uncertainty is revealed. Based on Mossin's discussion, I feel Burt's terminal control formulation is conceptually incomplete.

In general, I feel both papers lack a conceptual underpinning for analyzing intertemporal risky choices. Casual inspection of the economic literature indicates that the temporal resolution of uncertainty in the context of risk averse behavior is not straightforward (Kreps and Porteus; Mossin; Spence and Zeckhauser). As applied economists we should be careful to avoid *ad hoc* modeling efforts. This is particularly true when dealing with the expected utility (EU) model since Shoemaker's 1982 JEL review also reveals several weaknesses of the EU model even in a static setting.

Future Directions

In establishing a research agenda for analyzing the temporal risks in agriculture I feel we should consider both a long and short term strategy.

At present, a well developed operational theory of intertemporal risk aversion appears to be unavailable. Perhaps the major contribution in the long term would be a temporal counterpart to the static EU model. However, a temporally tractable EU model may not be possible.

In the short run I feel we should concentrate on better dynamic risk neutral models. Great care should be given to problem formulation, data sources, and parameter estimation. Emphasis should shift from the level of individual enterprises to whole-farm planning applications. At the level of the enterprise the current emphasis on the value of information of dynamic sequential strategies should be maintained (Bosch and Eidman; Karp et al.; Sadeh et al.). Hopefully, the use of these results will have some impact on expert systems and artificial intelligence technology in agriculture.

A potentially fruitful area of research may be the application of optimal stabilization theory to whole-farm planning. Stabilization theory is well established in macroeconomic literature. Moreover, stabilization theory explicitly treats the problem of system control and econometric estimation. Interestingly enough, Boehlje and Eidman's recent farm management text provides a framework for developing a formal whole-farm stabilization model. A key advantage to this approach would be the ability to obtain meaningful results in the near term for academic researchers as well as clientele groups.

In summary, dynamic programming and multi-period optimization has much to offer agriculture as a decision-making tool. However, formulation of relevant dynamic models will likely be slow process requiring interaction among various academic disciplines and clientele groups.

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