...NTIFYING LONG RUN AGRICULTURAL RISKS AND EVALUATING FARMER RESPONSES TO RISK

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A HISTORICAL OVERVIEW OF ESTIMATION OF HISTORICAL RISK COEFFICIENTS: DISCUSSION

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Musser has prepared a useful review on the durable topic of estimating risk measures from economic times series. I worked on this topic in the predecessor project, W-149, in the early 1980s (Young, 1980; Young, 1981; Young, 1984). Many of the issues which we struggled with in W-149 regarding the measurement of risk are still with us. Issues like this one at the interface between abstract theory and quantitative application are frequently difficult. One of the major arguments advanced in W-149 was that procedures used to obtain risk measures from historical data should be influenced by the normative or positive nature of the research application (Young, 1980; Young, 1984). Reassuringly, Musser seems to have reached a similar conclusion in acknowledging that "this issue is intertwined with the research purposes of the risk indices."

I will expand on the argument justifying linkage of risk estimation methodology to the type of research problem before commenting on the specific issues raised by Musser. Theoretically, there is no ambiguity as to the measure of risk in a two-moment expected utility model. It is simply the variance of the subjective probability distribution in the mind of the decisionmaker. Expected utility (EU) advocates defend this conceptualization on both theoretical and practical grounds (Anderson, Dillon and Hardaker). Indeed, subjective probability appears to be advocated by EU theory for both predictive and prescriptive applications. The fundamental theoretical justification is that the decisionmaker's personal satisfaction is maximized by selecting actions whose probability distributions as perceived by the decisionmaker ex ante best accommodate his/her personal utility function. The practical justification is that subjective probabilities are simply more up-to-date and accurate than objective probabilities, as argued in the following passage from Anderson, Dillon and Hardaker (p. 33):

> If several or many historical observations on enterprise revenues are available and judged pertinent, they could be analyzed . . . to provide the desired statistics. However because markets are usually changing and new varieties and new diseases are often emerging, the available historical data may be dubious relevance--in which case assessment must rely heavily on judgement.

In view of the emphasis by EU theory on subjective risk, it is significant that experimental psychologists have shown that people rarely formulate subjective probabilities in the same way that statisticians would (Thaler; Tversky and Kahneman, 1971 and 1974). Tversky and Kahneman (1971) presented results indicating that most

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people exhibit a "belief in the law of small numbers" in estimating probabilities. For example, people base excessive inferences on small samples and display "undue confidence in early trends and in the stability of observed patterns." In general, experimental subjects underestimated the breadth of confidence intervals. People also tend to rely excessively on preconceived stereotypes rather than the available data. Finally, most people depend excessively on readily available information rather than the full data set. For example, the "recent run of experience" might have excessive influence. This could lead a farmer who has had three good crops in a row to be excessively optimistic. Thaler argues that, in general, people tend toward overoptimism in forming probability judgements.

Although people may not form probability judgements in the same way as statisticians, it is hard to argue with the proposition that men and women will behave on the basis of their own personal conceptions of reality. Consequently, consistent with expected utility theory, it seems reasonable to advocate eliciting personal subjective probability distributions for predictive (positive) research studies. As reviewed earlier (Young, 1980 and 1984), some positive applications of risk theory in agricultural economics have elicited subjective probability distributions, but many have not.

Musser advocates (in opposition to traditional EU theory) departing from subjective probabilities or their proxies for prescriptive studies and for studies which provide information on the consequences of decisions. I advocated a similar position in W-149 based upon the following shortcomings of subjective probabilities in normative studies (Young, 1984, pp. 36-37):

1. Procedures for eliciting subjective probabilities are unreliable and subject to bias. Different procedures, interviewers, or both lead to different results (Hogarth, 1975; Tversky and Kahneman, 1975).

2. Even if accurate elicitation were possible, it would be costly and time-consuming to obtain updated subjective probability assessments from each decisionmaker when managerial recommendations are made (Dillon, 1971).

3. Strict adherence to subjective probabilities chains recommendations to the manager's current knowledge. It provides no scope for the comparative advantage of economists and statisticians in assembling, processing, and using new information in prescribing managerial advice. This additional information could reduce long-term psychological pain from poor decision outcomes, even if the decisionmakers must modify their probability assessments.

Although these arguments were originally raised in defence of using objective probabilities in normative studies, agricultural economists have frequently estimated variance or other risk measures from historical time series for positive studies as well. There are a number of reasons why applied researchers have taken this route. Eliciting subjective probability distributions from a representative sample of decisionmakers can be expensive and time-consuming. Furthermore, the results can be subject to considerable variation depending upon elicitation and calculation procedures. Consequently, primarily for practical reasons, researchers have often resorted to readily available regional time series data. In positive applications of this type, historical risk measures are proxies for unavailable subjective probabilities. Consequently, it seems reasonable that procedures used to compute risk measures for positive studies do not violate minimal psychological and practical requirements governing how humans process information. These requirements are codified in the list of criteria cited by Musser from my 1980 paper. A somewhat longer and more logically complete list was presented in an even more obscure revised paper presented at the 1981 W-149 meetings (Young, 1981). Arguments for use of the mean square forecast error relate to the likely use of a series of memories of past forecast errors in assessing riskiness. The requirement that the personal expected outcome should use only information available at the time the expectation is formed is self evident. The other criteria such as greater weight on more recent ("readily available and easy to use") information is consistent with the results of psychological experiments (Tversky and Kahneman, 1971 and 1974).

Musser suggests using the statistical variance as opposed to statistical mean square forecast error as a risk measure for normative or informative research problems. As noted above, I agree that there are strong arguments for using risk measures based upon objective probabilities rather than subjective elicitations for normative studies. Accepting the relevance of objective measures, arguments can be made favoring either statistical variance or statistical mean square forecast error. For uses such as the objective description of crop yield deviations required by the aggregate modeling group in S-232, statistical deviations and related variance measures seem appropriate (Fackler and Young). In rereading my work from 12 years ago, I am less convinced now than I was then that mean square forecast error is the only relevant statistic for normative applications. The following passage summarizes the original argument for mean square forecast error (Young, 1980, pp. 4-5):

> Speaking simply, these [risk] measures should be more than descriptive statistics of a historical time series; they should be computed in way that is compatible with procedures which farmers might use to formulate subjective risk assessments. This increases the likelihood that [normative] "risk efficient" marketing and production plans identified by E-V frontier or stochastic dominance analyses will indeed be considered <u>risk</u> efficient by their potential users.

As noted by Musser, agricultural economists have used a large number of detrending methods to separate "predictable" trend from the true random component. Young (1980) reviewed 14 studies from the 1970s which used the following detrending components: the overall mean, linear time trend, first differences, polynomial time trend, variate difference method, Box-Jenkins ARIMA equations, moving averages, autoregression equations, moving weighted autoregressions, moving weighted linear time trends, and constantly adjusted weighted moving averages. As demonstrated by Adams et al. and by Bravo-Ureta and Helmers, E-V frontiers are very sensitive to detrending procedures and to the functional form used to specify income expectations. Sensitivity analyses by Young (1980) indicated several fold differences in variance indices depending upon types of detrending procedures used. It is important not to "over fit" the data and thereby impute to predictable trend what is, in fact, unpredictable risk.

Musser also reviews the recent work by Fackler and Young in which GLS procedures were used to fit a quadratic trend to a large number of regional data series for crop yields. Simple linear trends were inadequate to portray the concave (and occasionally convex) yield trends. This work demonstrated that stationarity could not be assumed for the probability distributions. Both significant heteroskedasticity and autocorrelation were present for some time trends. Nearly all previous risk analyses using regression detrending procedures have used ordinary least squares and have assumed homoskedasticity.

Musser also discusses the importance of identifying time periods representing homogeneous structure in historical data sets. Most risk analyses use historical data to infer the nature of price, yield, or income risk in some future period for which (positive) predictions or (normative) prescriptions are being made. Consequently, it is important that the results are not "mongrelized" by including old data which are no longer relevant to recent and near-term future conditions. Researchers who have inspected plotted economic time series will recall the increase in level and increase in variability in most U.S. agricultural markets after 1972-73. Fackler and I also suspected that the S-shaped trends in some crops, such as corn in the Southern Plains, might have been induced by the rapid expansion in irrigated acreage of these crops during the late 1960s and early 1970s. It is important to include additional variables for exogenous technology or market developments or to disaggregate the data temporally.

Musser is to be complimented for reviewing the important decisions which must be considered when a researcher operationalizes a risk model. Although considerable advances have been made in risk theory in the last decade, I am less encouraged by the sparse progress in identifying definitive procedures for measuring risk. Individual researchers will necessarily need to struggle with these decisions on a case-by-case basis weighing such factors as data availability and the purposes of the research study.

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REFERENCES

Adams, R. M., D. J. Menkhaus, and B. A. Woolery. "Alternative Parameter Specification in EV Analysis: Implications for Farm Level Decision Making." West. J. Agr. Econ., 5(1980):13-20.

Anderson, J. R., J. J. Dillon, and J. B. Hardaker. Agricultural Decision Analysis. Ames, IA: Iowa State U. Press, 1977.

Bravo-Ureta, B., and G. Helmers. "E,V Frontier Analysis Using Total and Random Variance as Measures of Risk." Paper presented at West. Agr. Econ. Assoc. Annual Mtg., July 20-22, 1980.

Dillon, J. L. "An Expository Review of Bernoullian Decision Theory in Agriculture: Is Utility Futility?" Rev. Marketing and Agr. Econ., 39(1971):3-80.

Fackler, P. L., and D. L. Young. "Notes on Modeling Regional Crop Yields." In Quantifying Long Run Agricultural Risks and Evaluating Farmer Responses to Risk. Proceedings of the 1991 meetings of Regional Project S-232, San Antonio, TX, March 1991.

Hogarth, R. M. "Cognitive Processes and the Assessment of Subjective Probability Distributions." J. Amer. Stat. Assoc., 70(1975):271-89.

Musser, Wesley N. "A Historical Overview of Estimation of Historical Risk Coefficients." Proceedings of S-232 Meeting, U. of Arizona, Tucson, 1992.

Thaler, Richard. "Judgement and Decision Making Under Uncertainty: What Economists Can Learn from Psychology." In Risk Analysis in Agriculture: Research and Educational Developments. AE-4492, Dept. Agr. Econ., U. of Illinois, Urbana, 1980, pp. 225-38.

Tversky, Amos, and Daniel Kahneman. "Belief in the Law of Small Numbers." Psychological Bull., 76(2):105-110, 1971.

__________. "Judgement Under Uncertainty: Heuristics and Biases." Science, 185(1974):1124-31.

Young, D. L. "Evaluating Procedures for Computing Objective Risk from Historical Time Series." In Risk Analysis in Agriculture: Research and Educational Developments. AE-4492, Dept. Agr. Econ., U. of Illinois, Urbana, 1980, pp. 1-21.

__________. "Measurement of Objective Probabilities from Time Series Data." Paper presented at West. Regional Res. Proj. W-149 Annual Meeting, San Diego, CA, Jan. 6-8, 1981.

__________. "Risk Concepts and Measures for Decision Analysis." In Risk Management in Agriculture, ed. P. J. Barry. Ames, IA: The Iowa State U. Press, 1984, pp. 31-42.