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COMPARING OBJECTIVE AND SUBJECTIVE YIELD ESTIMATES: AN EMPIRICAL STUDY IN WESTERN KENTUCKY

by

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A strong case has been made for use of subjective probabilities in decision analysis (Anderson et. al., Bessler, and Hogarth). A variety of elicitation procedures have been developed (Savage, Hogarth, and Anderson et. al.). Of those, the triangular distribution is the most straightforward. A researcher merely asks the decision maker three questions: 1) the most likely outcome, 2) the worst outcome, and 3) the best outcome. This information can be used to develop the subjective probability density function (spdf).

This study examines two basic questions by comparing subjective and objective information from the same set of farms: 1) do producer's subjective assessments correspond to objectively developed pdf's and 2) does the triangular procedure provide consistent results between crops for the same producer? Insights into these issues can provide extension specialists useful information in extension programs that focus on producer-developed expectations. In addition, since the focus here is on farm-level yield pdf's, this comparison can also provide insights into how producer assessment of yield pdf's may influence resource allocation differently than if decisions were made on objectively developed pdf's - potentially important information for researchers who use objective pdf's to develop behavioral models. No known previous study has examined objective versus subjective data for the same farm.

Procedures

Farm-level yield data were obtained from the Kentucky Farm Analysis records. A group of farmers from the Ohio Valley of Kentucky were selected for on-farm interviews to elicit their response to the three questions required for the triangular distribution. Those farmers having at least ten years of participation in the record system were selected. Objective yield data were developed (as discussed below) for farms with 10 or more years of yield data (some farms had up to 22 years of data). These farms were matched with the subjective data and only farms with a complete set of data for both corn and soybeans were retained. A non-random sample of 33 farms remained. These farms provided the basis for comparison of objective and subjective yield data for yellow corn and single cropped soybeans.

Objective Yield Data

Records from the Farm Analysis System are on a planted acre basis. These data were from an area in Kentucky with relatively homogenous soil types. Among the first set of questions is the issue of trends in yields. If a trend exist, use of historical data to develop objective pdf's must adjust for the trend. Rather than adjust each individual farm's data for that farm's trend, it was assumed that an area trend would be appropriate for adjusting farm level data. Thus, the Ohio Valley farms were pooled and a linear trend was assumed:

$$Y = a + b\,(\text{time}) + cD_1 + cD_2 + \ldots + cD_i$$

where D_i is a dummy variable included for each farm so that the intercept could vary for each farm (i.e., a control which allowed mean values to vary by farm). The trend on corn was 1.62 (with a standard error of .118) and the trend on soybeans was .46 (with a standard error of .051). Thus, trend values were significantly different than zero for the area trend values.

Using the pooled regression coefficient on time, each farm's raw yield data were normalized to 1984:

$$Y'_{ij} = Y_{ij} + b\ (1984 - j)$$

where Y'_{ij} = trend adjusted data for the ith farm in the jth year; Y_{ij} is the raw yield data for farm i in year j; and b is the pooled trend coefficient. These normalized data were used to develop farm-level means and standard deviations.

<u>Subjective Yield Data</u>

Procedures for developing the first two moments for a triangular distribution are presented in Law and Kelton:

$$\text{Mean} = (L + M + H)\ /\ 3$$

$$\text{Variance} = (L^2 + M^2 + H^2 - LM - LH - MH)/18$$

These procedures were used to develop mean and standard deviation from data elicited from farmers in the summer of 1984. Thus, the mean values correspond to the 1984 adjustment in the objective data.

Comparing Basic Statistics From Objective and Subjective Data

An implicit assumption of the analysis that follows is that objective information provides a more accurate representation of the actual pdf than subjective information. Thus, objective statistics shall be the basis for comparisons.

Table 1 presents basic statistics for the sample of farms. In general, these statistics suggest that farmers underestimate both expected values and measures of dispersion relative to the objective date. Data in Table 1 also reveals that there is more variability

Table 1 - Basic Statistics and OLS Equations Comparing Objective and Subjective Information

	Objective	Subjective
Mean estimates across farms		
Corn		
Means	119.6	107.8
Standard Deviation	11.1	14.4
Soybeans		
Means	39.6	36.8
Standard Deviation	6.2	6.8
Standard Deviation estimates across farms		
Corn		
Mean	22.1	16.9
Standard Deviation	5.1	5.9
Soybean		
Mean	7.2	6.4
Standard Deviation	2.0	1.8

<u>OLS Equations (with standard errors in parenthesis)</u>

Corn Mean

$$OCM = 64.8 + \underset{(.103)}{.509}\ SCM \qquad R^2 = .44$$

Soybean Mean

$$OSM = 20.5 + \underset{(.133)}{.519}\ SSM \qquad R^2 = .33$$

Corn Standard Deviation

$$OCSD = 24.0 - \underset{(.154)}{.110}\ SCSD \qquad R^2 = .016$$

Soybean Standard Deviation

$$OSSD = 6.7 + \underset{(.204)}{.073}\ SSSD \qquad R^2 = .004$$

between farms in subjective estimates than objective estimates. This indicates that farmers are more variable in their assessment than the variability present in the objective data. Of course such a conclusion is contingent upon the robust nature of the pdf that is obtained from the triangular elicitation procedure.

Ordinary Least Squares (OLS) equations were used to test for significant differences in the first two moments developed from objective and subjective information (objective values are used as the dependent variable throughout -- see Table 1). These results demonstrate that farmers' subjective mean values do correspond with objective estimates of their farm-level mean. However, there is no correspondence between subjective and objective values for standard deviation. In other words, farmers can evaluate expected values, but, they are less able to evaluate measures of dispersion.

Such poor performance associated with the subjective elicitation suggest one of two possibilities: 1) the procedure is unreliable and does not reflect farmer's true assessment capabilities, or 2) farmers simply need better training in developing expectations regarding probabilities. Although there are no highly reliable procedures that can be used to address these two possibilities, one way to assess the consistency of the elicitation procedure is to examine the relative performance (the ratio of objective to subjective values) of the two crops. If farmers are consistent in their error relative to the objective estimates for both crops, this provides legitimacy to the elicitation procedure and suggest that farmers need training in order to assess probabilities more accurately.

The ratio between objective and subjective data was developed and compared in order to assess the efficacy of the elicitation procedure. Basic statistics on the ratios are as follows:

	sample mean	sample s.d.
Objective corn mean/subjective corn mean -	1.12	.109
Objective corn s.d./subjective corn s.d. -	1.47	.605
Objective soy mean/subjective soy mean -	1.09	.169
Objective soy s.d./subjective soy s.d. -	1.21	.458

Thus, on the average, this group of farmers underestimated their corn mean values 12 percent and their soybean mean values 9 percent. They underestimate standard deviation 47 and 20 percent for corn and soybeans, respectively. Of the sample of 33 farmers, 28 underestimate corn means, 25 underestimate soybean means and 21 underestimate both corn and soybean standard deviations.

To examine the consistency in farmer error, the ratios for corn versus soybeans are plotted against one another (see figures 1 and 2). There is a clear relationship between the way farmers assess both mean and standard deviation for corn versus soybeans. Once again OLS was used to test the relationship:

$$OCM/SCM = .70 + \underset{(.09)}{.39}\ OSM/SSM \qquad R^2=.36$$

$$OCSD/SCSD = .38 + \underset{(.17)}{.90}\ OSSD/SSSD \qquad R^2=.47$$

In both cases the relationship is statistically different than zero. The coefficient of .39 in the mean equation suggest that farmers are relatively better at assessing corn means than soybean means. The .9 coefficient in the standard deviation equation suggest that there is

Figure 1 - Comparing Farmers Ability to Assess Corn Yields Compared to Their Ability to Assess Soybean Yields

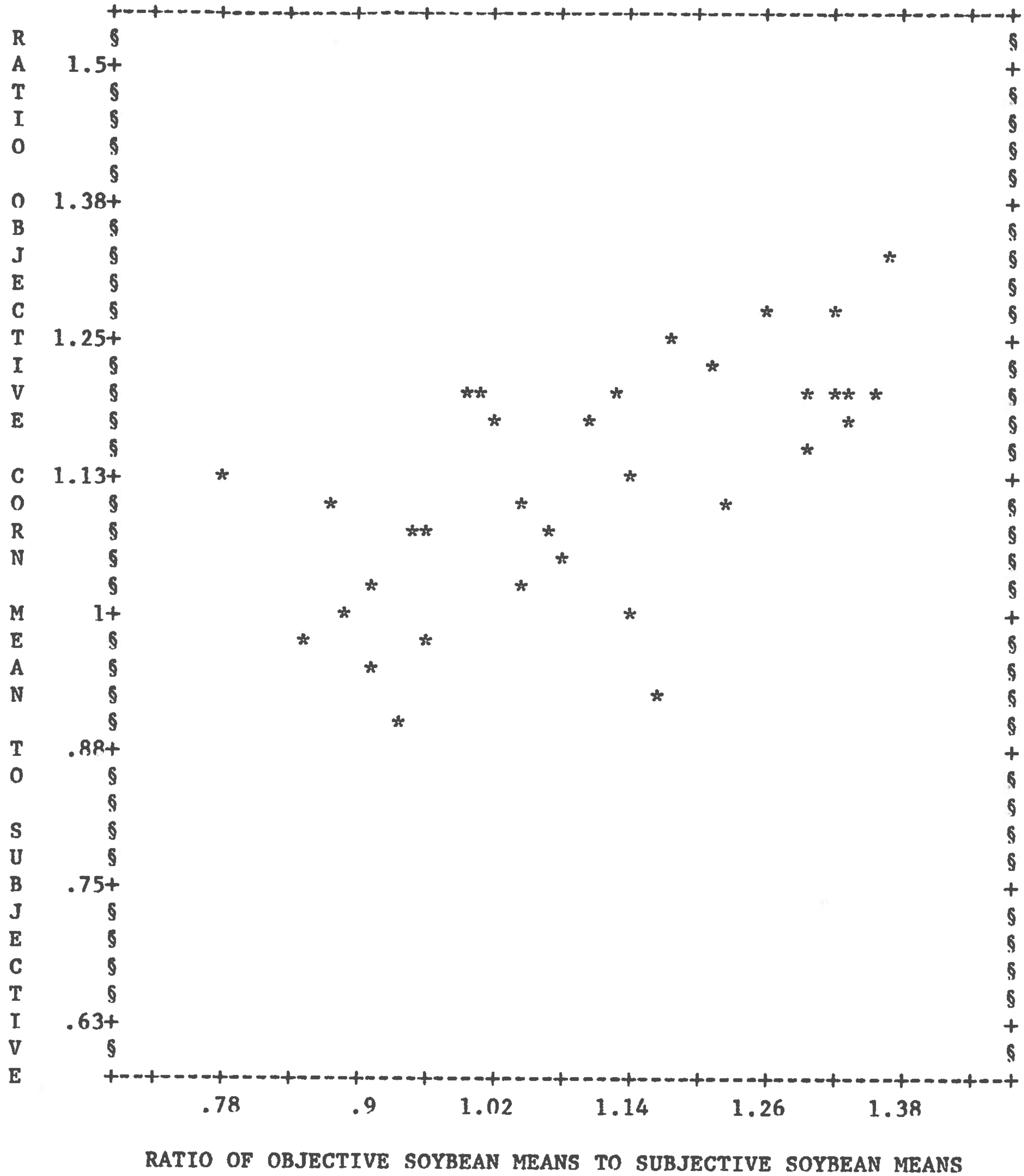
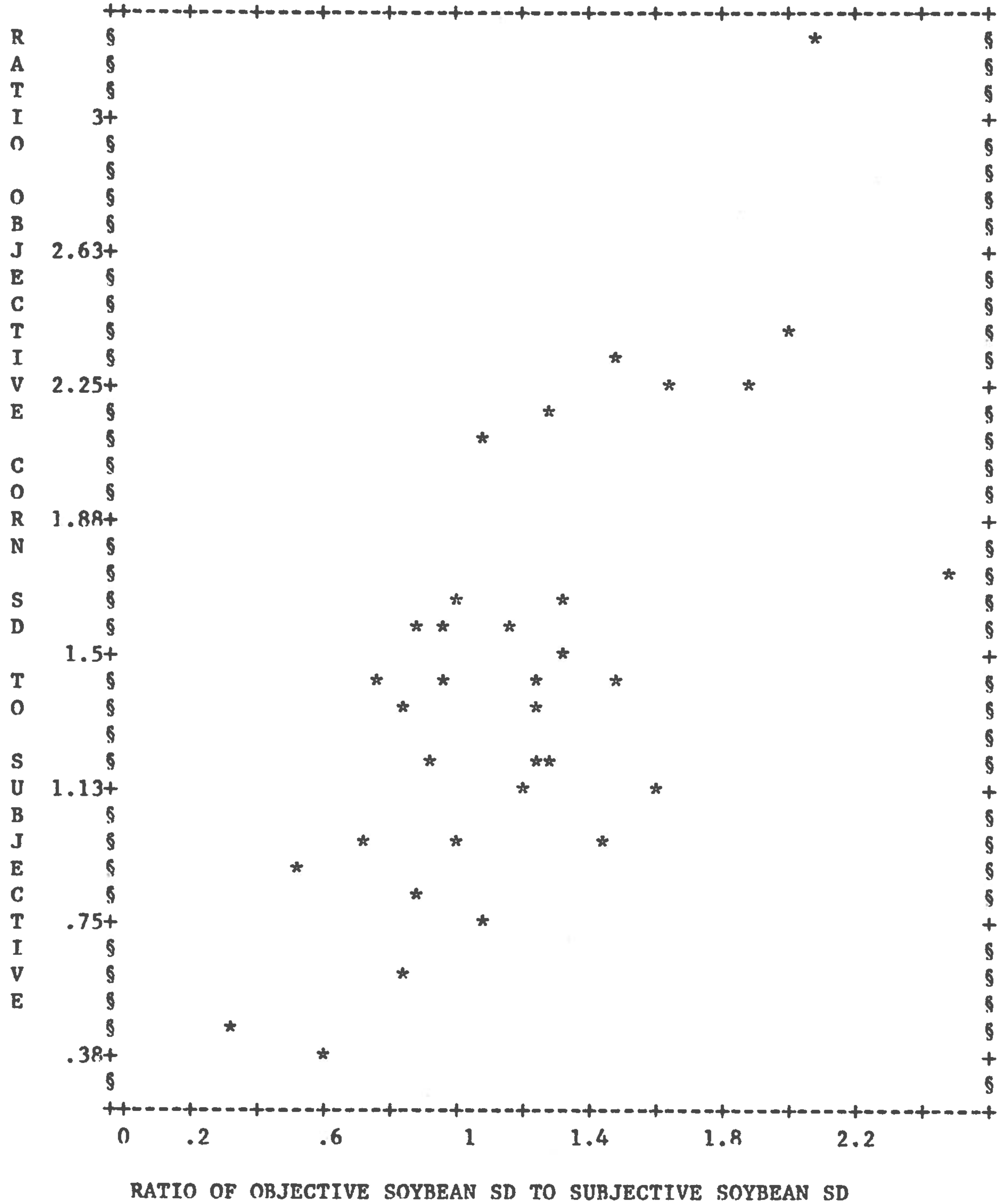


Figure 2 - Comparing Farmers Ability to Assess Corn Standard Deviations Compared to Their Ability to Assess Soybean Standard Deviations.



nearly a one-to-one correspondence in the errors associated with estimates on subjective corn and soybean standard deviations. The R^2 values also suggest that farmers are more consistent in their assessment of standard deviation between different crops than they are in assessing mean values. Therefore, even though farmers are generally unable to assess standard deviation, estimates presented here suggests that they are surprisingly consistent in their error.

Conclusions and Implications

Although this study is limited in that the sample of farms is non-random and relatively small and the elicitation procedure is not as robust as others (e.g., an empirical subjective pdf), the analysis presented represents the only known attempt at comparing objective and subjective data from the same farms. The results lead to a number of interesting implications for both extension and research. First, farmers appear to be able to assess expected values reasonably well, although they do tend to underestimate these values. (One possible explanation for the underestimation is that farmers are not making the same trend adjustment when they assess subjective values as this analysis did in developing objective data.) Second, the use of a triangular elicitation procedure suggest that farmers are poor at assessing measures of dispersion. However, farmers appear to be surprisingly consistent (between crops) in the degree that they over- or underestimate both expected values and standard deviations. This consistency is highly encouraging for extension specialist who are attempting to train farmers to assess risk. Such consistency should mean that farmers would be receptive to a training program designed to assist them in developing subjective probabilities.

The consistency in responses also provides a stronger basis for using objective measures of risk in lieu of subjective measures of risk in research involving resource allocation decisions under uncertainty. If the relative riskiness and perceptions of relative riskiness correspond, research methods that consider risk should not be unduly biased by using objective data. If farmers were inconsistent in their assessments of relative riskiness between crops, objective measures would be inappropriate. A similar argument can be made for the consistency in over and underestimating expected values of different crops. Finally, since farmers do tend to underestimate measures of risk in yields a great deal, this suggests that research techniques that focus on explaining financial behavior and/or risk preferences would be well advised to consider the differences between subjective and objective data sources. For example, if these low estimates on yield risk are typical, this would help explain the low participation rates in Federal Crop Insurance.

REFERENCES

Anderson, J. R., J. L. Dillion, and J. B. Hardaker. Agricultural Decision Analysis. Iowa State University Press, Ames, Iowa, 1977.

Bessler, David A. "Subjective Probability." in Risk Management in Agriculture, edited by Peter J. Barry. Iowa State University Press, Ames, Iowa, 1984.

Hogarth, R. M. "Cognitive Processes and the Assessment of Subjective Probability Distributions." Journal of American Statistical Association. 70(1975):271-89.

Law, A. M. and W. D. Kelton. Simulation Modeling and Analysis, McGraw-Hill, New York, 1982.

Savage, L. J. Foundations of Statistics. Wiley Press, New York, New York, 1954.