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A SUGGESTED CRITERION FOR SELECTING BETWEEN E-V AND STOCHASTIC DOMINANCE ANALYSIS TOOLS

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A SUGGESTED CRITERION FOR SELECTING BETWEEN E-V AND STOCHASTIC DOMINANCE ANALYSIS TOOLS

Recent works by Kramer and Pope, and Musser *et al*., compared and contrasted traditional mean-variance (E-V) analysis and stochastic dominance as techniques of assessing risk preferences. Both techniques have strengths and weaknesses. It seems appropriate to establish a criterion of choosing between the techniques so as to capitalize on the strengths. The objective of this note is to suggest such a criterion.

The characteristics of E-V analysis and stochastic dominance are well documented and detailed coverage will not be presented here. Both techniques are aimed at eliminating inefficient choices from the set of all possible choices available to the decision maker (Hanoch and Levy, p. 335). Assumptions about the risk averseness of the decision maker provide the framework for these techniques to decide between efficient and inefficient choices. Additionally, E-V analysis assumes that only the first two moments of a probability distribution are important in the decision of choice. This assumption implies a normal probability distribution unless the decision maker's utility function exhibits increasing risk aversion as wealth increases (Feldstein, p. 6; Tobin, p. 13). Therefore, if the alternatives are normally distributed, E-V analysis provides a powerful tool, especially if the analysis involves a continuous choice set.

Stochastic dominance is best suited for discrete choice efficiency analysis, but if a continuous choice efficiency is being made, it must consider an infinite number of choice alternatives (Kramer and Pope).

Stochastic dominance has the ability to consider all moments of the distribution, therefore, it is able to cope with skewness in particular. The inability of E-V analysis to do this has left it open to criticism. Until a technique is developed as flexible as E-V analysis however, the researcher needs to be cautious in discarding it for risk analysis.

The key weakness of E-V analysis hinges on its use of only the first two moments of the distribution of alternatives. It, therefore, would seem appropriate to test the distribution for evidence of non-normality.[1] An appropriate small sample test is the Shapiro-Wilk W-statistic which has been shown to provide an effective test for normality in sample sizes as small as twenty (Shapiro and Wilk). This is particularly relevant since sample sizes are often relatively small in situations where E-V or stochastic dominance may be used. If larger samples are available (e.g., larger than 50), then a test such as the Kolmogorov-Smirnov D-statistic can be used to test for normality. (Both statistics are available in the Statistical Analysis System.)

Use of a test for normality would provide a decision criterion when economic considerations failed to suggest characteristics of the distribution of alternatives. Kramer and Pope reason that, "returns both in and out of the farms program are not normally distributed (or symmetric) because the program serves to reduce the probability of low income events (p. 120)." The implication is that farm commodity programs result in a distribution skewed toward higher incomes since the lower incomes are effectively "chopped off." Such economic reasoning would, of course, have to take precedence over the statistical test for normality.[2] Musser et al., on the other hand, did not have any a priori economic reasoning to expect particular characteristics in the distributions they were considering. They were investigating an integrated pest management production system. Because of the lack of *a priori* guidance they chose to contrast results from E-V and stochastic dominance analysis. This is a situation where the *a priori* use of a test of normality would have provided useful in selecting a particular analytical tool.

Table 1 contains the Shapiro-Wilk test results for the Musser *et al.*, IPM study. Of the four management levels included, the Shapiro-Wilk test indicates that number three is not normally distributed and is, in fact, positively skewed. This conclusion lends support to the concern expressed by Musser *et al.* relative to the skewness of management level three (p. 122-123). They note that "a favorable skewness is not sufficient for stochastic dominance to conflict with E-V analysis---the desirable positive skewness of level three was not sufficient to overcome its unfavorable mean and variance in reference to four (pp. 122-123)."

Table 1. Shapiro-Wilk "W" Statistic Test for Normality of Georgia IPM Study.

	Net Profit	
Management Level	"W" Statistic for Detrended Data	Probability of Smaller Value
I	0.960	0.41
II	0.940	0.16
III	0.877[a]	0.01
IV	0.972	0.63

a. Indicates a possible departure from normality at the 99 percent level of confidence.

Another aspect of stochastic dominance versus E-V analysis is also graphically presented in the Musser _et al_. study. They state:

> In an E-V framework, level two, which is the most conventional pesticide treatment method, and level four, which has the highest level of IPM, are both efficient. More risk-averse producers could be hypothesized to likely use level two, while less risk-averse producers would be hypothesized to adopt level four (p. 123).

Stochastic dominance, on the other hand, concluded that only management level four was efficient. The reason Musser _et al_. concluded that management level two would be selected by risk-averse people is because it has a smaller variance and, of course, a smaller mean than level four. Porter and Gaumnitz empirically found that low variance, low return choices are more often included in the efficient set with E-V analysis than with stochastic dominance analysis.[3] Stochastic dominance is a more powerful analytical tool in that it is based on both a necessary and sufficient condition and thereby not functional form dependent, and does not incorrectly include low variance, low return options in the efficient set as E-V sometimes does. Thus, with E-V analysis the more risk-averse producer would be led astray. In such cases, the Shapiro-Wilk test would indicate to the scientist E-V analysis is probably not appropriate. Porter and Gaumnitz warn that E-V analysis may not yield accurate decisions for highly risk-averse decision makers. They also conclude that the less risk-averse decision makers will be more indifferent between the use of E-V and stochastic dominance analysis because in higher variance, higher return ranges these techniques do not systematically vary in their choice of an efficient set.

With the availability of these research tools and the powerful small sample tests for normality, it would seem that scientists do, indeed, have the capability to choose the technique best able to analyze a distribution of possible outcomes. E-V analysis has an advantage over stochastic dominance when considering a continuous choice set. Therefore, if the Shapiro Wilk test does not indicate a departure from normality, choice of E-V analysis may be advantageous, especially since it is more widely understood and research results may be expected to receive wider application.

Footnotes

1. There are, of course, distributions other than the normal that are fully described by the first two moments. The normal, however, has the advantage of combining two normal distributions produces a normal distribution.

2. Kramer and Pope later conclude that "large and small outcomes are truncated by the program (p. 125)." This would indicate that even though the distributions of interest may not be normal, evidence is not available to suggest they are not symmetric. In fact, truncation of the tails could be of little consequence. A Shapiro-Wilk test for normality of the probability distributions used in the Kramer and Pope work failed to indicate a departure from normality in any of the alternative commodity program participation levels they considered.

3. Porter and Gaumnitz were comparing E-V analysis with second degree stochastic dominance (SSD) for stock portfolios. SSD includes beyond the assumption more is preferred to less that decision makers are risk-averse. See Hadar and Russell for a discussion of SSD.

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