Staff Paper Series

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UTILIZATION OF AN E-L FRONTIER TO EVALUATE DIFFERENCES IN RISK PREFERENCE BETWEEN LARGE AND SMALL FARM OPERATORS

by

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Staff Paper 159 July 1980

Presented as a selected paper at the Annual Meeting of the American Agricultural Economics Association, University of Illinois, Urbana, Illinois, July 27-30, 1980.

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ABSTRACT

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Differential adoption of technology has contributed to the large discrepancy in farm income between large and small farms. Opinions vary as to whether the differential adoption is due to differences in resource endowments or to differences in attitudes. Typical field corn production practices used by large and small farm operations in North Florida are utilized to indicate the revealed risk preference characteristics of the two groups. The expected return and the variance of returns are incorporated into an E-L framework to evaluate any differences. The selection of technologies suggests differences in attitudes and preferences. However, the analysis indicates that at the enterprise level the attitude toward risk is similar in both groups.

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The effects of risk are difficult to analyze because risk assessment is a personal matter. The assessment involves subjective judgement about the probability associated with different outcomes which arise from any particular decision. It also involves the assessment of individual preferences between possible sets of outcomes that are associated with alternative choices. Due to these elements of subjective judgement, best operating practices appropriate for one farmer are usually inappropriate for another [4]. If expectations are uncertain it is no longer appropriate to assume, as in the classical theory of the firm, that entrepreneurs are interested solely in maximizing return. Uncertain expectations lead to the acceptance of a more complicated type of motivation in decision making. A farmer is confronted not only with the necessity of considering the expected value of the income stream, but also with evaluating the variability associated with the expected return.

A preponderance of empirical evidence suggests that most farm planners do consider risk in their production decisions [1,3,5]. Thus it obviously makes sense to include consideration of risk when analyzing programs intended to aid attainment of individual's and group's goals and objectives.

When outcomes are uncertain a usual goal of the producer will be to obtain a maximum expected return with a given degreee of safety, where safety can be measured in terms of consistency of return. The highest expected return is not necessarily the one with the least variability. In fact, the highest expected return is most often subject to an unacceptably high degree of uncertainty. Similarily, the expected return with the least variability usually has an undesirably low expected return. Between these two extremes lie alternatives of varying degrees of expected return and variability of return. The proper choice among particular combinations of expected return and variability of return depends upon the willingness and ability of the farmer to assume risk [6,7].

An evaluation of farmers goals and preferences as revealed through their selection of enterprises and technologies indicates a tendency to modify their efforts to maximize expected return in such a way to "limit their regret." An E-L analysis is selected to evaluate this behavior and estimate differing attitudes toward risk. The E-L procedure establishes efficient sets of expected return (E) combined with lower confidence limits of the return (L). The degree of risk acceptable to the individual is expressed by the relative magnitude of the expected return and the lower confidence limit. The lower confidence limit is expressed as $E - k\sigma$. In this context E and σ are properties of the set of returns generated by an enterprise or set of cultural practices and k is a measure of the individuals risk preference.

The preference for risk in an E-L analysis determines the region within which points of tangency between the farmers utility indifference curve and an efficient production set on the E-L efficiency locus are located. The locus of E-L efficient set is commonly referred to as the E-L frontier [2].

Figure 1 illustrates the geometrical representation of hypothetical E-L frontiers. The E-L curves are derived from an Expected Return-Variance of Return (E-V) efficiency locus. Values of expected return are plotted on the horizontal axis while the vartical axis represents values of $E - k\sigma$. Each point on an E-L curve represents an E-L combination

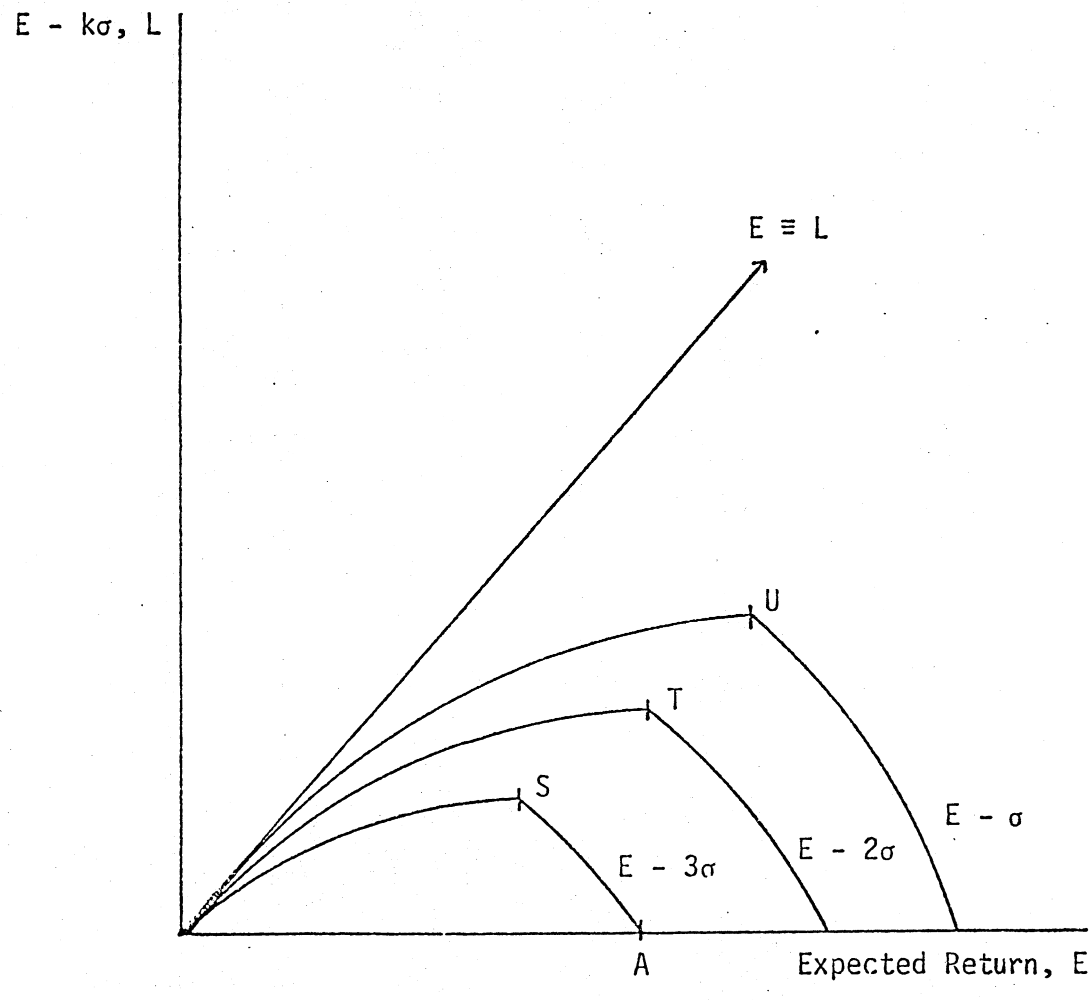

Figure 1. Derivation of efficient E-L sets, E-L frontiers

corresponding to a specific farm production plan. The E-L curves are determined by subtracting k σ from the expected return as represented by the 45 degree line (E = L) [2]. Efficient sets of E-L are located on the negative sloping segment of the E - k σ curve. These sets are the only combinations of expected return and lower confidence limits of return which represent trade-offs between higher expected returns against increased levels of risk [6].

Figure 1 illustrates a family of E -k σ curves indicating alternative sets of E-L combinations associated with various levels of k. The larger the value of k the more risk averse the farmer must be considered because these curves indicate he will be attaining lower values of expected returns coupled with less probability of unacceptably low returns. The lowest curve shown in Figure 1, curve OA, includes only the most conservative farm production plans. The negatively sloped segment of the curve from the point S, to the point where the curve crosses the E axis, A, corresponds to efficient E-L sets consisting of lower values of both expected return and risk than corresponding efficient sets on the other E-L curves [2].

Procedure

The E-L analysis is applied to a study of small and large North Central Florida field corn producers to identify differences in attitudes and risk preference characteristics between the two groups. It was postulated that the attitudes would be revealed through an analysis of the expected return and risk characteristics associated with the typical sets of cultural practice observed in the area.

A survey of County Extension Directors in the five most important

North Central Florida field corn producing counties was conducted to identify those sets of cultural practices which were most typical of corn production by large and small producers. Management variables included in the cultural practice sets include planting date, planting rate, variety maturity rating, kernel moisture level at harvest and irrigation. In addition to the 15 sets identified through the survey 51 additional sets were constructed to provide all possible combinations of management variables for comparison.

Arrays of yields are generated for each of the 66 sets of cultural practices using a corn growth simulation model developed by Dr. W. G. Duncan of the University of Florida Agronomy Department. The simulation model considers soil moisture conditions and daily temperature, radiation and precipitation in simulating the growth and development of the corn plant. In order to provide sufficient observations to identify yield variability resulting from climatic conditions, nineteen years of daily weather data collected in Gainesville, Florida from 1960 through 1978 is used to generate the array of yields. The simulation model is calibrated for North Central Florida conditions using varieties and cultural practices included in yield trails conducted by the Agronomy Department of the University of Florida in 1976 [8]. The simulation yields slightly exceed the trail plot yields for each of the three varieties used in the analysis: Dekalb XL80, Coker 54 and Coker 77. University of Florida agronomists accept the deviations from trail observations as resulting from the assumptions of optimum fertilization and no losses to pests in the simulation model.

The simulation model computes the length of the growing season for each set of cultural practices. The length of the growing season is added to the planting date to obtain the harvest date. The Atlanta #2 corn price corresponding to the harvest date is then multiplied by the yield of #2 corn to determine gross returns. The costs of production computed for each set of cultural practices is then subtracted to obtain net return per acre.

An analysis of variance is conducted on the arry of net returns for each set of cultural practices to compute an expected return and variance of return for each set. Returns per acre is defined as:

(1) $$\pi_{ijm} = (P_i)\ Y_{ijm} - C_{ijm}$$

where π_{ijm} represents the return for the i^{th} year, $i = 1,2,3,...19$; for the j^{th} set of cultural practice, $j = 1,2,3,...66$; and for the m^{th} farm size, m = 1,2,(i.e. small and large farm respectively). P_i represents harvest price, Y_{ijm} is the yield and C_{ijm} represents the cost function.

Expected return for the j^{th} cultural practice and m^{th} farm size is then written as,

(2) $$E(\pi)_{jm} = \sum_{i=m}^{19} (\pi_{ijm}/19).$$

The variance of return, σ^2_{jm} is defined to be

(3)

$$\sigma^2_{jm} = V\ (\pi_{ijm}) = V\ (P_i Y_{ijm}) + V\ (C_{ijm}).$$

Determination of the expected return and variance of return associated with each set of cultural practices provides the information necessary to estimate an E-V efficiency frontier. The E-V frontier in turn provides the basis for the E-L analysis.

Results

In the E-L framework the acceptable level of risk can be represented by $E - k\sigma$. Where E and σ are characteristics of observed production practices and k is determined by the producers perference for risk.

Values of expected return and variance of return have been estimated for each set of cultural practices. The second step is to find the values of k which are associated with each farm production plan corresponding to loci on the negative sloping section of the corresponding E-L curve. This requires that the slope of L, E-kσ, be negative,

$$(4) \qquad \frac{\partial L}{\partial E} = 1-k(\partial\sigma / \partial E) < 0$$

Since the E-L curve is based on an E-V frontier, the observations are used to generate an E-V frontier by regressing variance of return as a function of expected return. The regression is fitted to the most nearly dominating observations produced by the 66 alternative farm production plans plotted in Figure 2 The regression model is:

$$(5) \qquad V = e^{B_1 E + r}$$

The empirical estimate of the model with the standard error in parentheses is:

$$(6) \qquad V = e^{\underset{(0.00187215)}{0.02477525}E}$$

Two important observations are made concerning the E-V efficient set. One, none of the small farm technologies are included in the E-V efficient set. And two, all of the elements in the E-V efficient set include irrigation.

Since irrigation is one of the principle differences between large and small farm technologies, and since all non-irrigated alternatives are completely dominated by irrigated activites a second E-V efficient set is defined for the non-irrigated activities.

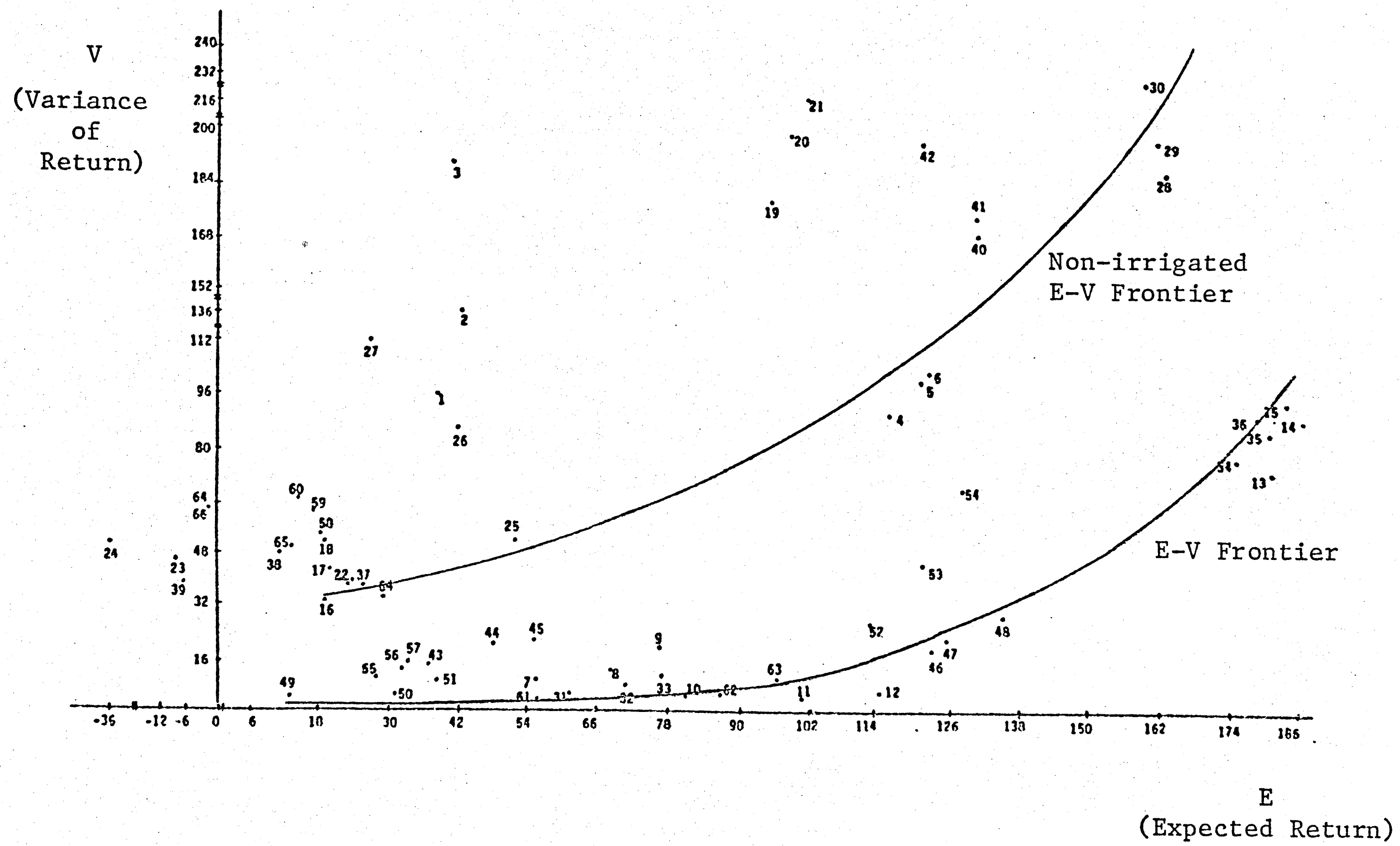

Figure 2. E-V efficiency frontier and non-irrigated E-V efficiency frontier for field corn production technology set.

(7) $$V = e^{Bo + B_1 E + r}$$

The empirical estimate of the non-irrigated E-V fraction is:

(8) $$V = e^{\substack{3.28010861 + 0.012003354E \\ (0.07384494)\ (0.00069174)}}$$

These functions are used to estimate the rates of change of the standard deviation with respect to the expected return ($\partial\sigma/\partial E$) for the irrigated and non-irrigated alternatives.

(9) $$\frac{\partial\sigma}{\partial E} = \frac{B_1}{2} e^{B_1 E/2}$$ and

(10) $$\frac{\partial\sigma}{\partial E} = \frac{B_1}{2} e^{Bo/2 + B_1 E/2}$$

Values of k for each of the efficient production plans can be determined by setting $\frac{\partial L}{\partial E} = 0$ and solving for k using the estimated values of expected return from each of the efficient sets. Predicted k values are listed in Table (1). Each value of k presented in this table represents the value of k that is just sufficient to include that point in an efficient set. Second order conditions insuring maximums require the second derivatives of L with respect to E be negative.

(11) $$\frac{\partial^2 L}{\partial E^2} = -k \frac{\partial^2 \sigma}{\partial E^2} = -k (B_1/2)^2 e^{B_1 E/2} < 0$$

(12) $$\frac{\partial^2 L}{\partial E^2} = -k \frac{\partial^2 \sigma}{\partial E^2} = -k (B_1/2)^2 e^{Bo/2 + B_1 E/2} < 0$$

Hence, second order conditions insuring a maximum are satisfied.

A comparison of the k values in Table 1 shows that efficient small farm sets generate k values which fall in the same range as the k values generated by the large farm sets. This comparison indicates that there is no observed differences in risk preferences between the two target groups.

Table 1. Predicted values of V, σ, and k for the irrigated and non-irrigated E-L frontiers.

Cultural practice set	Estimated values E	V	Predicted values $\hat{V}$	$\hat{\sigma}$	$\hat{k}$
IRRIGATED ACTIVITIES (large farm sets)					
49	13.70	5.89	1.40	1.18	68.12
55	28.02	10.61	2.00	1.41	57.05
50	30.98	8.62	2.15	1.47	55.00
56	32.42	13.26	2.23	1.49	54.03
51	38.43	10.52	2.59	1.61	50.15
61	55.31	5.26	3.94	1.98	40.69
31	62.56	8.60	4.71	2.17	37.19
32	70.08	9.45	5.68	2.38	33.88
10	81.96	6.17	7.62	2.76	29.25
62	86.97	6.33	8.62	2.94	27.49
63	96.03	10.72	10.80	3.29	24.57
11	100.52	6.75	12.07	3.47	23.24
12	114.64	8.54	17.12	4.14	19.51
46	124.89	20.17	22.07	4.70	17.18
47	130.40	21.59	25.30	5.03	16.05
48	136.75	28.88	29.61	5.44	14.84
13	182.55	72.47	92.08	9.60	8.41
15	184.88	92.60	97.56	9.88	8.17
14	187.77	85.24	104.80	10.24	7.88
NON-IRRIGATED ACTIVITIES (small farm sets)					
16	18.66	33.22	33.27	5.77	28.81
22	23.89	38.39	35.43	5.95	27.92
37	26.76	38.31	36.68	6.05	27.44
64	29.83	35.60	38.05	6.17	26.94
25	52.17	54.61	49.79	7.05	23.55
4	115.91	91.03	107.22	10.35	16.05
5	120.15	95.65	112.84	10.62	15.65
6	121.39	102.12	114.53	10.70	15.53
30	157.94	229.88	177.80	13.33	12.46
29	161.82	191.38	186.30	13.65	12.18
28	162.40	189.88	187.61	13.70	12.13

Conclusions

An E-L analysis is used to estimate the differences in risk preference between large and small field corn producers in North Central Florida. Since L is computed as $E-k\sigma$, and E and σ are characteristics associated with the observed technology, it is postulated that differences in the k values which are necessary to just place the observed production practice in the E-L efficient set can be used to estimate differences in risk preference between the two groups.

Two phenomina are observed in the analysis. One, in an E-V framework in the small farm technologies are completely dominated by the large farm technologies. Differences in attitudes are indicated since the small farmer could both increase his expected return and decrease his variance of return by adopting large farm technology, i.e. irrigation. However, the second phenomena becomes apparent in the E-L analysis. The estimates of risk preference for both the large and small farm operators as determined by the k values fall within the same range of values. This indicates that although differences in attitudes, goals and objectives do exist, no discernable differences in risk preference or risk aversion are observed.

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