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Farmers' Perceptions and Information Sources: A Quantitative Analysis

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Abstract

Using the concept of negentropy and ordinary least squares, this article investigates the role of public and private information sources in forming growers' yield perceptions. Paid private consultants reduced the discrepancy between gamma-distributed actual and perceived yield distributions, whereas farm advisor contacts tended to increase the discrepancy between actual and perceived yield distributions for a group of 28 cotton growers in California's San Joaquin Valley. Results were inconclusive for extension research personnel and other agricultural scientists, chemical company meetings, grower meetings, farm publications, and educational level.

Keywords

Information sources, negentropy, gamma distribution

Agricultural producers who understand biological, technical, and economic relationships can make more efficient production decisions. Uncertainty complicates their decisionmaking and forces them to gather information about resource use, output possibilities, and prices from public agencies and private enterprises. In this article, we investigate the role of these information sources in forming farmers' perceptions of outcome probability distributions and eventual profit.

Earlier studies by Beal and others (2), the U S Department of Agriculture (11), and the Environmental Protection Agency (4) have identified major information sources that growers use in their production and marketing decisions.¹ In this article, we describe a framework for empirically investigating the significance of various agricultural information sources on growers' perceptions. We apply our model to evaluate the impact of information sources on yield perceptions of cotton growers in California's San Joaquin Valley.

The Model

The agricultural production function encompasses many variables that a producer may or may not be able to control. The uncontrolled variables necessarily lead to random output levels which can be characterized by a probability distribution. A producer's inaccurate perception of the output probability distribution leads to inefficient utilization of resources and, hence, to decreased profit. If actual and grower-perceived output distributions are known, a measure of the discrepancy between the two distributions can then be developed and related to information sources via regression methods. Regression estimates indicate the role of specific information sources in the formation of accurate perceptions.

Previous studies have measured the discrepancy between the two probability distributions as a function of differences in their means (5, 9). However, a more appropriate measure should incorporate all characteristics of the two probability distributions. Such a measure was developed by Kullback and Leibler (7) and is defined as the expected logarithmic ratio of two probability density functions

$$D = \int \ln(g(x)/f(x))g(x)dx \quad (1)$$

where f and g are perceived and actual densities, respectively. Hobson (6) proved that equation (1)

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¹ Italicized numbers in parentheses refer to items in the References at the end of this article.

is a unique measure of the discrepancy between two probability density functions that is consistent with the rules of conditional probability. This measure is referred to as negentropy in the literature of information theory. Theil (10) regards D as a measure of badness of fit and refers to it as information inaccuracy.

In our subsequent empirical analysis, we assume that actual yields, g_1 , and perceived yields, f_1 , for grower 1 are gamma distributed. The gamma density is non-symmetric and skewed to the right over the range of zero to plus infinity. Use of a gamma density is based on the notion that a below-average yield is more likely than an above-average yield in cotton production. This analysis was originally advocated by Day (3) in his analysis of skewed cotton yield distributions.

The actual and perceived gamma distribution yield densities are

$$g_1(y) = \frac{\lambda_g^{\alpha_g}}{\Gamma(\alpha_g)} y^{\alpha_g - 1} e^{-\lambda_g y}, 0 \leq y < \infty$$

and

$$f_1(y) = \frac{\lambda_f^{\alpha_f}}{\Gamma(\alpha_f)} y^{\alpha_f - 1} e^{-\lambda_f y}, 0 \leq y < \infty$$

where α_g , λ_g , α_f , and λ_f are parameters and must be greater than zero. Ignoring for the moment the subscripts g and f, the mean and variance of a gamma distribution with parameters α and λ are respectively α/λ and α/λ^2 . We calculated these parameters from grower surveys and actual yields.

Given the assumption of gamma-distributed actual and perceived yields, equation (1) becomes

$$D_1 = \ln \frac{\lambda_g^{\alpha_g} \Gamma(\alpha_f)}{\lambda_f^{\alpha_f} \Gamma(\alpha_g)} - \alpha_g \left[1 - \frac{\lambda_f}{\lambda_g} \right] + (\alpha_g - \alpha_f) [\psi(\alpha_g) - \ln \lambda_g] \quad (2)$$

where $\Gamma(\cdot)$ and $\psi(\cdot)$ are the gamma and digamma functions, respectively, and are extensively tabulated. (1) D_1 is zero if the observed and perceived distributions are identical, otherwise, D_1 is positive.

We hypothesize that D_1 in equation (2) is influenced by a grower's characteristics and the information received from various sources. With observations on the sources and amounts of information received by grower 1 and the characteristics of grower 1, a relationship such as

$$D_1 = h(X_1, Z_1) \quad (3)$$

where

X_1 = a vector of the amounts of information received by grower 1 from each information source and

Z_1 = a vector of grower characteristics

may be estimated to explain the discrepancy between actual and perceived yield distributions. Parameter estimates from equation (3) suggest the nature of the contribution made by an information source or managerial characteristic—that is, whether the information source significantly decreases or increases the discrepancy between actual and perceived yield distributions. In our subsequent empirical analysis, we assume that the information growers receive from various public agencies and private enterprises directly affects the distance between the observed and perceived yield probability densities.

Data and Variable Definitions

The time-series of cross-section data used in this study are from a random sample of cotton growers in the San Joaquin Valley of California. Moments of the actual yield distribution were estimated for each of the 28 growers in the sample for the 1970-74 period. Moments of the perceived yield distribution for each grower were estimated through elicitation and the PERT method as modified by Perry and Greig (8). Growers were asked to estimate average yield and yields associated with the 5th (P_5) and the 95th (P_{95}) percentiles. We estimated perceived standard deviation using the relatively distribution-free formula, $\sigma = (P_{95} - P_5)/3.25$, proposed and

tested by Perry and Greig (8) Yield estimates at the 5th and 95th percentiles were used to eliminate highly unlikely occurrences from the more usual stochastic influences

Both the actual and perceived yield distributions are assumed to be gamma distributions We calculated the variable D_1 by substituting method of moments estimates of actual and perceived yield parameters into equation (2) The following variables are included in the model

- D_1 = negentropy of the perceived profit distribution,
- X_{11} = number of times a paid private insect consultant checked grower's fields during the growing season,
- X_{21} = number of extension farm advisor contacts,
- X_{31} = number of times extension research personnel and other agricultural scientists were contacted,
- X_{41} = number of gin and grower organization meetings attended,
- X_{51} = number of chemical company meetings attended,
- X_{61} = number of subscriptions to farm magazines and other periodicals, and
- Z_1 = years of education of the grower

The variables represent public and private information sources (2) and processing abilities (that is, educational level) Field checks by paid private consultants for pest and other related problems capture an extremely important short-term information source Extension farm advisor contacts likewise farm advisor contacts likewise reflect the applied reflect the applied arm of public agencies Extension agricultural research personnel and other agricultural scientist contacts capture the long-term research needs of growers Gin and grower organization meetings represent the role of other growers in the decisionmaking process Chemical company meetings partially capture the role of agriculture's most organized information source Finally, all written materials represent the role of the mass media as an information source

Estimation

We regressed D_1 on the information variables and education to obtain the following result (standard errors in parentheses)

$$\begin{aligned}
 D_1 = & 1.923 - 0.011X_{11} + 0.108X_{21} \\
 & (0.692)^* \quad (0.006)^{**} \quad (0.041)^* \\
 & - 0.019X_{31} + 0.029X_{41} - 0.050X_{51} \\
 & (0.033) \quad (0.040) \quad (0.107) \\
 & + 0.012X_{61} - 0.074Z_1 \\
 & (0.052) \quad (0.051)
 \end{aligned} \tag{4}$$

$$R^2 = 0.479$$

$$F(7,20) = 2.623$$

$$\text{Obs} = 28$$

* = significant at the 5-percent level

** = significant at the 10-percent level

Negative coefficients in equation (4) indicate variables which reduce the discrepancy between actual and perceived yield distributions The significant negative coefficient for paid private consultants (X_{11}) supports growers' decisions to pay for additional information that typically includes pest information as well as soil, plant, and irrigation advice The two variables—extension research personnel and other agricultural scientists and chemical company meetings—have negative coefficients, but are insignificant Grower contacts with extension research personnel and agricultural scientists over the sample period were low, which probably reflects growers' interests in the application of new techniques rather than in basic research The insignificance of chemical company meetings supports the notion that the companies are product-oriented, particularly for pesticides We would expect chemical companies to have a greater role in pesticide decisions The estimated coefficient for education met our *a priori* expectations and was significant at the 20-percent level

Coefficients on the remaining variables are positive, suggesting additional information increases the distance between actual and perceived yield distributions These information sources appear to confuse growers and increase their uncertainty Particularly important is the significant positive coefficient for extension farm advisor contacts This result suggests

information transfer between growers and extension farm advisors could be improved to benefit both parties. A positive coefficient for gin and grower meetings might be capturing the competitive nature of growers or simply stating that information exchanges between growers does not help much in production decisions. We do not rule out the possible important role of gin and grower meetings in marketing decisions, especially those concerning prices. The positive coefficient on publications is not surprising given the multiplicity of views found in different farm journals and trade association magazines. Growers may use publications to learn about new products or practices, but most likely rely on other sources to learn about the application of new products and ideas to their specific farm problems.

Conclusions

Information occupies an important position in an uncertain work environment. Growers understand the important relationships between information and efficient resource utilization. They frequently seek information from a multitude of sources to update their perceived notions of input-output relationships and economic conditions to increase profit. In this article, we have presented a measure for quantifying the distance between growers' observed and perceived yield distributions. Using regression analysis, we then identified managerial characteristics and information sources that significantly affected the distance between observed and perceived yield distributions.

The approach is feasible, as demonstrated by our empirical analysis of the role of information sources in the formation of growers' perceptions. Additional research and more empirical studies need to be conducted before general conclusions can be stated and before the agricultural information network can be altered to improve information transfer and enhance producer profits.

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