Outstanding Master's Thesis for 1986

A Sequential Decision Framework for Evaluating Groundwater Supply Alternatives Under Uncertainty

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Groundwater contamination, like many environmental problems, persists over time, is increasingly more complicated and is associated with a great deal of uncertainty. Today, most groundwater contamination incidents have been discovered only after a drinking water source has been affected. For communities without a municipal water system, contamination often leads to abandonment of the town's aquifer and a costly long term solution.

Sequential decision analysis provides a methodology for aiding decision-makers in evaluating alternative actions, when faced with uncertainty. Its main feature is that it incorporates probabilities about future states of nature and unknown model parameters into the decision procedure. As a result, there is no single best action for the entire planning horizon, but rather a strategy that incorporates all prior chance events into future decisions.

A case study approach, using the town of Whately, Massachusetts, was chosen to demonstrate the use of sequential decision analysis in evaluating water supply alternatives once ground-water contamination has been detected. Whately's groundwater supply was contaminated by leach-ate and runoff from pesticide and fertilizer applications on agricultural lands. The principal contaminants of the aquifer include the agricultural pesticide aldicarb (Temik™) and fumigant ethylene dibromide (EDB).

The water supply alternatives available to Whately were: use of bottled drinking water, installation of carbon-activated filters in each household well, phased development of a municipal water supply system, and connection to neigh-boring water supplies. Other towns facing a different set of alternatives could use the same methodology presented here provided that the benefits and costs of each action, the specification of the states of nature and their probabilities could be quantified.

The value of each supply alternative is determined by quantifying the various effects into economic-efficiency benefits, social costs and income-distributional effects. Project costs include capital costs and operation and maintenance expenses. The major benefit associated with development of a safe water supply is improved human health and longevity.

Results of the base case analysis revealed that any action to alleviate groundwater contamination represents a net social loss to Whately. If the sole criterion is economic efficiency, then the optimal action would be to continue to suffer the ill health effects of contamination. If inaction is unacceptable, connection to neighboring water supplies represents the minimum expected net loss to the town of Whately. Use of an interim action (bottled water or carbon filters) to delay development of a water distribution system is not an economically efficient strategy for most of the cases analyzed. Development of a municipal water system was inferior because it was a high cost system serving a low density population. The estimated health and ancillary project benefits were not sufficient to offset these disadvantages. Based on the results of the sensitivity analysis, development of an expanded water distribution system appeared to be the best alternative to achieve the joint objectives of economic efficiency and a potable water supply.

Master's Thesis Award of Merit

Successful Dairy Farm Management Strategies: A Stochastic Dominance Analysis of Farm Records

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This study analyzed dairy farm records to determine effective farm management strategies. A pooled sample of records from 112 New York dairy farms for ten years was used. First-degree and second-degree stochastic dominance analyses were used to separate the 112 sample farms into successful and less successful groups. This was done for each of four different performance measures concerned with labor and management income or return on equity capital.

After establishing the successful/less successful groupings, the division was examined to make inferences about alternative dairy farm management strategies. This was accomplished with a binary-choice regression model. Sixteen independent variables were selected to represent various characteristics of three areas of concern in developing a farm management strategy: production, marketing, and finance.

Selected conclusions included the following: high levels of milk production along with closely controlling use of hired labor and purchased feed greatly improve a farm's chances of being successful. Hay-making techniques are important to dairy farm success with the utilization of hay crop silage technology superior to that for dry hay production; by implication, selective adoption of new technologies is itself an important management strategy. In addition, a drastic change occurred in optimal debt-asset levels within a very short period of time; this demonstrates the importance of maintaining flexibility in those who are alert to (or able to anticipate) changing circumstances.

Stochastic dominance was reasonably consistent across different performance measures in ranking farms, thus providing a solid basis upon which to evaluate farm management characteristics. Binary-choice regression models provided statistically significant results in establishing the strategies responsible for farm success.

Master's Thesis Award of Merit

The Effect of Acreage Reduction Programs on the Production of Corn, Wheat, and Cotton: A Profit Function Approach

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Acreage control programs have, since the 1930s, been used to support farm commodity prices. Their effectiveness and cost efficiency have been questioned almost as long. One problem is that production is not reduced by the same percentage as diverted acreage. The primary reasons are: 1) participating farmers divert their least productive land; 2) participants and non-participants may apply more non-land inputs to planted acreage; 3) some participating farmers do not comply with program provisions; and 4) non-participating farmers may increase their acreage of the controlled crop. This program failure to achieve proportional output reduction is termed slippage.

Previous studies of slippage have dealt with causes (3) and (4) above, but not (1) and (2). Their analyses of acres harvested or planted ignored the yield effects of acreage reduction programs. Also, their general exclusion of input and output prices resulted in exogenous, diverted acreage variables improperly capturing price effects of the program.

This study examined slippage through econometric estimation of a system of output equations for corn, wheat, cotton, and soybeans. The analysis was based on a multioutput profit function and estimated using SUR. Expected output prices and input prices were incorporated in order to specify all major causes of slippage.

Measuring slippage by a single coefficient, as presented in previous studies and often used by policy-makers, is incorrect. A system of equations, as utilized in this analysis, more correctly accounts for both direct and indirect (price) effects of the programs and allows for prediction of slippage, given expected prices.