MODELLING FARM PROGRAM-CROP MIX DECISIONS UNDER RISK: DISCUSSION

The modelling of optimal decisions for individual farm operations has a long history in agricultural economics. From Heady's (1952) classic treatise on agricultural production and resource use through the last three decades there has been a continual stream of new and improved ways to model individual firm decisions. Advances have been made in the technical area of algorithm formulation and solution, the addition of risk, uncertainty and dynamics to the problem structure, characterizations of producer preferences and the modelling of lumpy production quantities. While each new advance has attempted to add more realism to the problem, this realism has resulted in models that are probably more complex than the decision process of the average producer. Whether these models should be regarded as tools to assist producers to make better decisions or as methods for understanding current practices is an oft discussed and seldom resolved question.

The paper I will discuss today is an ambitious attempt to add another layer of realism to the farm planning problem by analyzing the interrelationships between crop mix and government programs. While the benefits of increased realism are often passed off as obvious, careful attention to the costs and benefits of such ambitious modelling attempts would seem prudent.

The key modelling issues addressed by the paper are outlined in the next section with a full discussion of them in the body of the paper. Following this discussion of the papers approach to the problem, a short section on the major contributions of the paper and possible areas for further analysis is presented. The paper concludes with a philosophical summary.

Seven Key Modelling Issues

The author identifies a number of modelling issues that are important in modelling farm program participation decisions. I have modified and added to his list to obtain a list of seven issues that are germane to this discussion. Some are routine, while others are novel and less straightforward. A brief discussion of each issue follows below, with in depth discussion in the next section.

1. Resource availability and productivity

   Resource constraints should reflect the actual situation of the producer and should vary by season and crop as dictated by actual practice.

2. Crop rotation effects.

   The model should not force inflexible crop rotation decisions on the producer but should allow optimal choices each period.

3. Risk effects.

   The model should present risky choices in a consistent manner and allow for sensitivity analysis of tenuous assumptions.

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4. Terminal conditions.

The model should reflect the multi-year planning process either through steady state modelling or the development of appropriate model dynamics.

5. Government programs.

Government programs should be modelled in a way to capture the complexity of the programs and the actual constraints faced by the producer.

6. Multiproduct enterprises.

The model should reflect the many production, marketing and program choices available to the producer and the interactions between them.

7. Indivisibility in choice units.

The lumpy nature of critical decision variables and the all or nothing nature of other choices should be accounted for where possible and reasonable.

The Paper's Approach to Modelling

The paper by Dr. Perry is an excellent effort to address the farm planning problem with careful attention to each of the issues mentioned above. This section will analyze the paper's approach to each to the above issues.

Resource availability and productivity

The paper combines labor and machinery constraints to obtain field time constraints. This fits the particular operation modelled and is a succinct way to summarize a large volume of information. This procedure also accounts very well for seasonal resource supplies and demands. A slightly expanded discussion on which other constraints were actually imposed would have been helpful. The most important constraints in this model have to do with government program provisions and are discussed below.

Crop rotation effects

A common criticism of many farm planning models is the fixed rotations employed. This paper uses a variant of the procedure proposed by El-Nazer and McCarl to allow for flexible rotations from year to year but builds in the appropriate yield enhancing or reducing effects of the previous cropping pattern. While the traditional approach is reasonable for steady-state models, this approach is superior for poly-period models of this type. By modelling crop rotations this way flexibility in choosing between program and non-program crops is also maintained.

Risk effects

Risk modelling relates to both the characterization of uncertainty and decision maker preferences. The paper makes the now standard assumption of a mean-variance utility function and maximizes expected net returns minus a penalty associated with return variance. While criticisms of this approach abound (Chipman), it is a remarkably resilient and useful approximation to reality. The standard alternative in programming models is the MOTAD formulation of Hazell. While the MOTAD approach may be preferred for non-normal distributions, the EV approach has more intuitive appeal. The MOTAD approach also allows standard linear and integer programming software to be used to solve the problem. Whether the use of efficient linear programming algorithms on the expanded problem (due to revenue deviation constraints) is less time consuming than a non-linear algorithm on the original problem is an unanswered question.

The variance-covariance matrix of returns is developed using subjective and objective data. While this is reasonable for the given problem, subjective estimation of covariances is a difficult procedure. The difficulty the author has is factoring the covariance matrix may have to do with the matrix being ill-conditioned due to its subjective nature. An alternative to the Cholesky factorization is factorization by using the eigenvalues and eigenvectors of the covariance matrix. While the Cholesky factorization will work for all positive definite matrices, the eigenvalue method will work for others. While all covariance matrices are positive definite, ill-conditioned matrices may be better handled using eigenvalues.

The use of simulation to obtain returns under a variety of environments is a good choice for this problem. The formulas provided by Bohrnstedt and Goldberger are cumbersome for large matrices and may not fit all models. Simulation also gives the researcher an opportunity to observe empirical distributions and note irregularities or patterns.

A major byproduct of the paper is the development of software to solve non-linear integer programming problems using Bender's decomposition. The development of software to solve difficult problems that are unique to agriculture seems is a worthwhile activity.

Terminal conditions

One of the major tasks faced by the author is to correctly model the dynamics of the farm planning problem. Since government programs are of uncertain life and decisions made on acreage this year affect future program benefits, the proper approach to reflecting these dynamics is essential. The author opts for a polyperiod model that allows for interseasonal choices. This is much preferred over steady-state models given the vagaries of government program provisions. This also allows decisions taken this year to affect the opportunity set for future years.

There is no absolutely correct, yet implementable, way to value terminal rotation patterns and program history given complete uncertainty about future government programs. There is in this case no "rational" or market forecast of the future value of such assets. The authors approach is to value the assets as if the current program would continue in the future. This is a an appropriate choice and reflects the actual decision environment.

Government programs

The major contribution of this paper is its exhaustive attention to detail in modelling the provisions of current government programs. Since many of these programs are mutually exclusive and all-or-nothing, the use of integer programming is essential. Combining integer variables with risk is something that has often been discussed but this is one of the first serious attempts that I have seen. The model clearly is an improvement on the early paper of Muser and Stamoulis since it captures the multiproduct nature of government program choices. Given the complexity needed to correctly model the options available to a producer, it is small wonder that professional farm managers, accountants and lawyers are prone to support current legislation.

Multiproduct enterprises

One of the chief virtues of programming models is the ability to analyze multiproduct firms and the allocation of fixed inputs to among enterprises. As pointed out in a classic paper by Just, Hochman and Zilberman, allocated inputs are perhaps the overriding characteristic of most farm decision problems. In addition to modelling several crops this paper is unique in modelling the multiproduct nature of government programs. Cross-compliance is simply another type of allocated input that is modelled well by this paper. Given the complexity of modelling such restrictions, one has to wonder about the validity of the typical single product worksheets that are often used to model program participation decisions.

Indivisibility in choice units

The paper is careful to model variables in an integer fashion when this is necessary. While adding integer variables to a model greatly increases the computation time, some other integer variables might also be considered. For example, equipment may only be available in discrete units based on tractor sizes. Fixed costs in general are often of a lumpy nature and could be modelled as integer variables. As mentioned above risk modelled using MOTAD is more conducive to integerization since commercial software is available.

The Contribution of this Paper

The paper makes several important contributions to the literature on government program participation and the modelling of farm planning problems. The paper presents a well defined problem in accordance with current program provisions and demonstrates methods that apply to more general problems. The paper is extremely careful it its attention to detail in modelling the reality of crop mix and program participation choices. The list of factors considered is impressive. The methods used are very reasonable for the problem defined. The trade-offs in modelling all choices versus using more general technology and preference relationships are well considered. In attempting to model the program participation decision in an optimal fashion the paper has few equals. Yet, one is left somewhat less than excited about the work involved in modelling a decision farmers make all the time. The key question, then, is whether all the attempts at realism are worth the effort. While no definite answers are available some information could be gleaned with marginal increased analysis.

The paper has a well defined objective function and so a natural metric for defining value exists. What are the changes in the objective function if cross compliance is not imposed? How much less is the optimal value when the government program decisions are not modelled as integer variables? If this difference is very small then there is little financial incentive to invest in better decision procedures. Since the choices will be different depending on the constraints used, there is some value in determining the optimal resource use pattern even when the objective function is similar. It might be useful to express the answers to the integer constrained problem as a percent of the answers to the unconstrained problem. If the answers differ by only a small percent then the more complex procedure seems less justified.

In many cases some choices may be eliminated preoptimization based on obvious dominance of some combinations or activities. Such model reduction could greatly reduce computation time, particularly in integer programming.

The paper presents a clear method for solving the government program participation decision. The major task now is to demonstrate that the simplifications often made lead to incorrect and costly errors which are avoided by using the "correct" procedure.

Philosophical Summary

This paper is as careful and well throughout attempt to model a farm level decisions as I have read. The paper, however, doesn't make me want to cry "Hallelujah" or "Wonderful". This is of concern since the modelling of farm level decisions is an important and time-honored part of our profession. My lack of complete excitement for the paper may be part of a normative malaise rather than any failings of this paper. If the purpose of normative economics is to guide better farmer decisions I am concerned that complex models of this type are beyond the realm of practical usefulness. (Modern computing power has brought the outer realm closer however.) While this model is very faithful to its goal of modelling all relevant factors, it of course ignores many factors that will be considered by a decision maker. A possible answer is that maybe simpler models that perform well are better in practice and better fit the needs of extension. Of course the value of a model of this type is providing a standard against which to measure simpler alternative. Thus the cry for comparisons in the previous section.

On the other hand if normative models of this type are to help us understand producer behavior then they must be compared to actual decisions. This validating of normative models by comparison with positive analyses and the explanation of positive observations by reference to normative models is an important but oft neglected method for improving economic analysis.

The paper then is true to its stated purpose and does an excellent job of meeting its goals. The paper could have a stronger impact by comparing its results with those derived using simple decision rules and by comparing its normative conclusions with those obtained through positive analysis.

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