"Microeconomic Stochastic Production Modelling: Foundation for Policy Analysis Under Risk": A Critique

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The paper by Edna Loehman, Michael Kaylen and Paul Preckel (LKP) sets out to correct agricultural policy analysis for price and income stabilization when it is based on "... a supply equation with output related to price .... However, in the case of production under risk, such supply models may not adequately describe output effects due to potential incentive problems". As an example of the potential incentive effects the authors mention the moral hazard problem of insurance. Also, LKP describe unanticipated shifts in resource allocation from price stabilization programs which they contend are not revealed by models which ignor risk considerations.

The expected utility model which LKP describe has the following features. There is a hypothetical firm that can produce two crops with two inputs and land allocation between the two crops. Inputs affect both mean and variance of output. There is randomness built into the product price and yield distributions of each crop. A numerical computer routine (MINOS) is used to solve the maximation problem for various stabilization policies and policy options. The government policies examined only apply to one of the crops, and they take the form of either yield insurance, price insurance, revenue insurance or combined yield and price insurance. The base case without any government programs is solved for various assumed levels of the Pratt-Arrow constant risk aversion coefficients (r) using the utility function, $U(\pi) = -e^{r\pi}$. The summary statistics given for each government program for the sample problem are: fraction of the land allocated to crop 1; optimal inputs X_1, X_2 on each of the two crops; mean and variance of yield, revenue, net income and government cost; and risk reduction of the program relative to no program (in certainty equivalent units). Hypothetical, constant marginal products of inputs and effects of inputs on yield variance are used. The authors assume that there are uniform distributions of product prices and Beta distributions of crop yield. The program crop is assumed to have the more variable price distribution.

The various tabular results of the sample problem help reveal some of the consequences of incorporating risk in policy studies. Extreme moral hazard on the part of farmers facing yield insurance is shown (Table 3). Only the less risky crop is grown, about 65 percent of the land is not planted at all and the program cost is quite high. Likewise, the tables show that price

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insurance encourages large acreage shifts, while yield insurance shifts input use more. The modelling exercise shows the complexity of production choices even with just two outputs and two inputs when both inputs, land allocation and government programs affect revenue distributions. It is helpful to have tables which show how sensitive input and land allocations are to program provisions. Also, unlike most agricultural policy analysis these authors give government cost parameters (means and variances) for the various program options. The description of the government programs are simple, but the authors point out that the policy simulations can be altered to include acreage limits or total government expenditure limits.

Model Shortcomings

The LKP model has serious shortcomings which must be corrected before consideration can be given to this approach for analysis of agricultural price supports or crop insurance. There seem to be flaws in the specification of the optimization problem, there is no treatment of market effects and the authors assume that government programs are exogenous to commodity conditions.

In the specification of the utility function related to production of risky crops, the model does not consider several risk dimensions and usual technology features. When a business gets larger or smaller it usually affects total risk exposure, but this can not be accomodated in this model which does not allow for leases or land transactions. Secondly, the production technology used in the LKP model is a very special case with the implicit assumption of input non-jointness in the production of the two crops (Just, Zilberman and Hockman). Nonjointness simplifies the profit function and makes it separable in output prices, but this requires that there are no economics or diseconomics of producing more than one crop. The supply function of crop 1 does not depend upon the output price of crop 2. Most empirical studies have rejected the nonjointness hypothesis in agricultural crops (Shumway). Another simplification made is that there are only two crop enterprises to select from. Most farm situations have a broader menu of crops and several nonagriculture (off-farm) income opportunities which often provide important diversification possibilities. A two enterprise model with two inputs is a limited view of farmer production choices under risk.

A second area where the LKP model is deficient is in their treatment of product markets. Product prices are assumed to be determined outside the model. It would be a simple matter to take random draws from product price and yield distributions which have negative covariances built into the stochastic specification (Anderson, Dillon, Hardacker). This would be especially important for a domestically consumed crop with a more inelastic demand function. In addition, the effects of

government programs on product prices other than for the two crops in the model are ignored. This was a problem in the 1985 Farm Bill provisions as well. Shifting just 1 percent of the wheat acreage to a small, non-program crop like sunflowers could cause a twenty-five percent increase in sunflower acreage and a drastic decrease in price (Fleischer). Price supports can also induce production increases by farmers in other countries who are not subject to the area or marketing limitations. This has been very significant in the case of tobacco, dairy, feed grains and other commodities. Concentrating the analysis on two crops without consideration of supply shifts for these two crops produced in other countries will certainly over state the stability in world markets for these commodities.

Input prices are also considered to be exogenous in the model. Demand for risk reducing inputs could fall when government programs provide insurance. Alternatively, demand for all inputs could increase when programs increase expected product prices. These effects on input prices and the welfare effects on input suppliers are not in the model. Such input demand shifts can often result in significant disruptions of input markets. The unexpected decline in fertilizer and pesticide demand following the PIK program and the opposition of the hail insurance companies to early versions of the disaster payment programs are recent examples.

Finally, the model of LKP treats policy options as exogenous. This is a fairly common approach in most agricultural policy studies. However, policy changes are not likely to be unrelated to commodity conditions. Farmers probably have some expectations of price support levels prior to price support announcements. To accomodate expected support levels might require a multi-period model with commodity stocks, spot price levels, past program costs and other similar dimensions. Models of the legislative procedure for agricultural programs are being developed, but risk management may not be very important in the minds of legislators. Bruce Gardner in his paper before this group last year asserted that

> "... policymakers have not been interested in stability or risk management. They have been interested almost solely in farm income support. The evidence for this assention, in addition to the neglect of pure stabilization proposals, is that every farm program that has approximated a pure stabilization approach like the Federal Farm Board has died; and every program with stabilization elements that have survived has been converted to a price support or subsidy program like the Farmer-owned reserve or the Federal Crop Insurance Program."

Modifying the model of Loehman and associates to account for the features I have outlined would make it very complex. It is appropriate to recall that their intent was to provide better micro foundations in policy analysis. They have shown that

simulation of random conditions and optimization of input and land allocations which affect variances can be combined with government policy options for stabilization.   My suggestion is that they try to make their specification of the technology more complete, that they add correlated yield and price distributions and that they begin bringing in other product and input market effects.   At a minimum, tabulation of input expenditures, including other crops and considering supply shifts of other products would be helpful.   Adding an endogenous policy sector probably won't be feasible except through constraints on expenditures and limits on shifts to alternative crops.

The authors may have an overly complex model which gives too much attention to risk reducing inputs.   They may be emphasizing the stabilizing effects of agricultural policy much more than legislators want to.   However, the exercise seems worth more effort, and it will probably be read by both agricultural policy and risk specialists.

References

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