1975

RISK RESPONSE MODELS AND THEIR USE IN AGRICULTURAL POLICY EVALUATION*

Richard E. Just

The previous two papers have discussed the possible effects that proposed public policy may have on risk and uncertainty in the agricultural economic environment. Accordingly, I will argue that, before we can adequately evaluate such policies which create new degrees of risk for agricultural producers, we must have better quantitative knowledge of how farmers will respond to changing risk in adjusting input and production decisions. I will then consider models for estimation of the effects of changing risk in agricultural supply response.

Response by decision-makers to changes in risk has long been recognized as an important economic phenomenon. The study of decision-makers' behavior toward risk began to be popularized as early as 1948 with the work of Friedman and Savage and later by the work of Markowitz and Tobin. Many Agricultural Experiment Stations began during the mid-1950's to evaluate the risk associated with various agricultural enterprises (Heady, et al.; Carter and Dean), although some forerunning work had been done earlier (Kling). These studies have freely acknowledged the importance of both price and production-related risk in determining agricultural input decisions and, hence, output. With increased interest in risk, research has centered on stochastic programming models and nonlinear objective criteria (indicative of utility maximization) which could be used to determine optimal reactions to changing risk. But while much work has been undertaken to determine the risk involved in farm decisions and how farmers *should* react

---

*Giannini Foundation Paper No. . I gratefully acknowledge helpful comments received from Gordon King, Darrell Hueth, and Andrew Schmitz.

Paper presented at AAEA annual meeting, Columbus Ohio, Aug. 1975.

to changing risk, it is my contention that the implications of risk for positive response studies have been seriously neglected.

In point of fact, the effects of risk on optimal input decisions have been examined through normative programming approaches (e.g., Charnes and Cooper; Freund) since the 1950's, but the effects of changing risk have thus far been considered only to a limited extent in positive models (Behrman; Just, 1974a). Even with the programming approach, effects of changes in risk have been examined largely on a microlevel. In this paper, however, I will be particularly concerned with estimating risk response at the aggregate level so that policies which affect risk can be adequately evaluated. I will first attempt to demonstrate by way of example the implications of policy evaluation with economic models which do not reflect producers' reaction to changes in risk. I will then briefly review the state of the arts for two existing approaches in risk response estimation, i.e., the normative or programming approach and the positive or econometric approach. These reviews will be restricted to a respresentative (rather than exhaustive) sample of those works which, to me, seem important in terms of agricultural policy evaluation.

THE IMPORTANCE OF RISK CONSIDERATIONS IN POLICY EVALUATION

Most aggregate response and empirical policy analyses, with which I am familiar, have emphasized behavior only toward price and yield levels and have failed to recognize the possible response to changing price and yield risk. If risk response is important in agricultural decisions, however, then the use of such models to evaluate policies which significantly impact on agricultural risk are, in my opinion, of questionable validity. As a case in point, consider the farm commodity programs during the 1950's and 1960's which listed as their goals not only restriction of production and maintenance of income but also stabilization of prices and income. Much research has focused on determining the direct impact of the associated restrictive measures, and policies have been evaluated accordingly. But evaluation of the indirect effects resulting from the associated stabilization has received little attention. Some recent research in California has suggested that response to stabilization is indeed of significant empirical importance (Just, 1974a). Using a positive model which can reflect risk response, the indirect response to stabilization appeared to almost offset the reduction in acreage directly attributable to restrictive measures in the cases of some voluntary programs. This result, of course could not possibly be obtained with an empirical supply response model which does not explicitly recognize growers' reactions to changing risk.

Consider a similar conceptual problem of stabilizing U.S. export demand by means of a world food buffer stock. In figure 1 let export demands D_1 and D_2 each have probability 0.5, and let export supply under uncertainty be respresented by S. Now suppose a world buffer stock authority establishes a price $p^* \overset{=}{+} (p_1 + p_2)/2$ at which it will either purchase excess supply or fill excess demand. Without response to risk, this action would make the expected change in buffer stocks zero (if $Q_2 - Q^* = Q^* - Q_1$). If farmers are risk responsive, however, the more likely result is that the associated price stability will induce a shift in supply to S' as producers become more certain about price and possibly adopt more specialized technology (assuming risk averseness). Hence, excess supplies will generally be larger than excess demands at the announced price; and, as a result, buffer stocks will begin to accumulate indefinitely

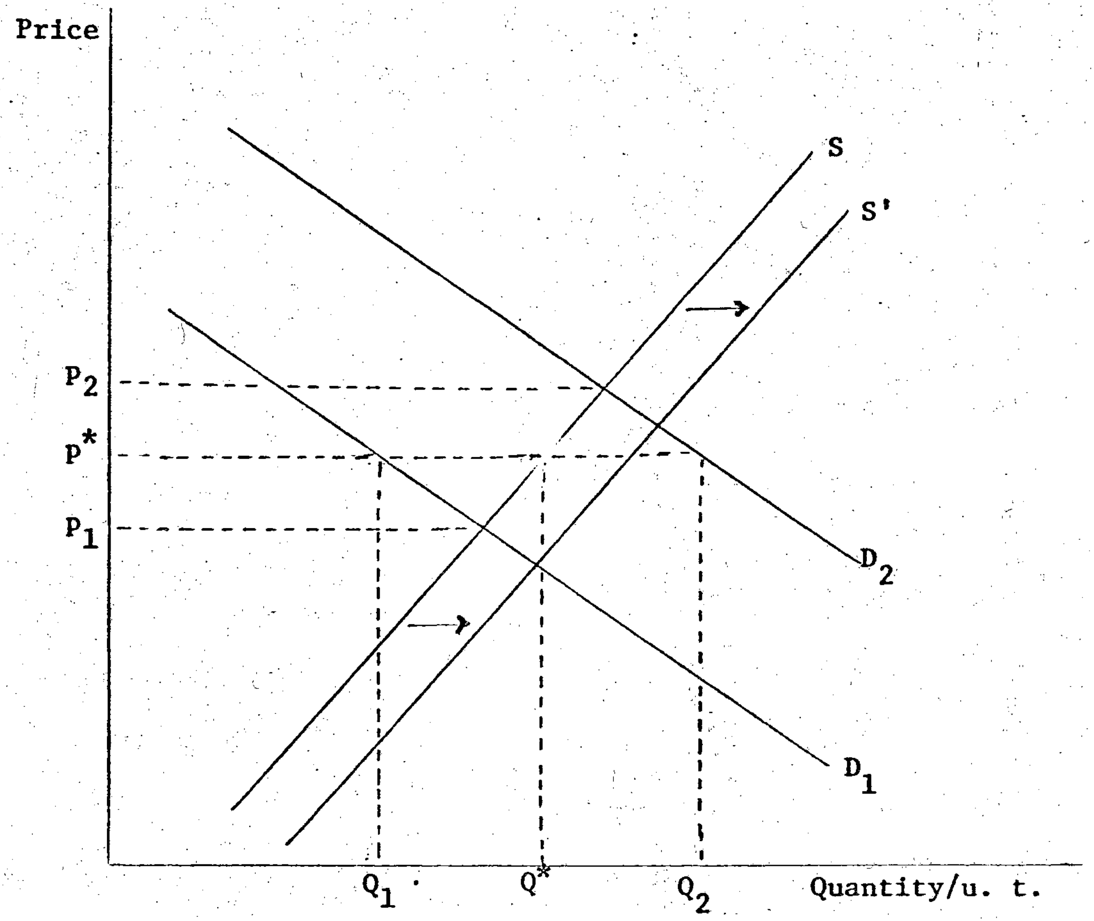

Figure 1.

(in expected value). A similar result would be obtained if p* is merely established as a price support, and the excess supply in years of low demand, $Q^* - Q_1$, is transferred by buffer stocks to years of high demand. The role of risk in supply response thus offers a possible explanation for the accumulation of stocks during the 1950's at price-support and parity levels which seemed in line with historical prices.

Similar arguments could also be made on the input side indicating that destabilizing input supply leads to reduced input demand and, hence, reduced agricultural output. Thus, policies which affect agricultural fuel, fertilizer, and pesticide supplies should also be evaluated not only in terms of their directional impacts but also in terms of their stabilizing or destabilizing effects.

IMPEDIMENTS IN THE DEVELOPMENT OF RISK RESPONSE ANALYSIS

I think it is fair to say that such explicit risk considerations have usually been omitted in empirical policy analysis. The reason, I believe, is two fold. First the underlying theory in most policy analyses is usually considered in a deterministic framework (e.g., Wallace; Griliches; Schmitz and Seckler). Furthermore, even in those studies which work in a stochastic framework, the possibility of response to risk is usually not considered (e.g., Massell, 1969 and 1970; Hueth and Schmitz; Batra and Russell). Most of these studies have avoided the risk problem by assuming profit maximization. But, for example, in Massell's (1970) paper relating to agricultural price stabilization, he explicitly considers producers' risk preferences and still fails to consider the possible reactions to changes in risk. Using figure 1, the gains in producer surplus or profits between S and S' below p*, as well as the associated consumer gains, are thus omitted. Such an omission obviously causes the gains from stability to be seriously underestimated.

A second reason why empirical policy analysis has tended to ignore risk response is that appropriate models have not been developed for estimating risk response. At the session on evaluation of econometric models at the 1974 winter meetings, the general conclusion was that "better models are needed in the agricultural sector" (Popkin, page 158). And King (page 165) argued explicitly that "the most important thrust" in terms of supply response models is in developing "behavioral models relating to producer formulation of expectations of price and yield and risk." In this context, I submit that considerable progress has been made toward flexibility in estimating expectations or first moments of decision-makers' subjective distributions (for prices, yields, etc.) but that similar efforts are also needed to include flexibility in estimating models with subjective second moments if response to changing risk is to be adequately captured. Hence, in the remainder of this paper, I will be concerned with this latter, less-developed problem of risk-response estimation.

NORMATIVE RISK RESPONSE ESTIMATION

Two important possibilities exist for the quantitative determination of farmers' response to stabilization or destabilization of input prices, output prices, and yields. These are the two basic approaches for estimating supply curves (Nerlove and Bachman). In the normative approach, mathematical (programming or control theoretic) models which include price and yield risk can be developed for various farm classifications (I include King's production function approach in this category as did Nerlove and

and Backman). By aggregating results over classifications, the net response to specific changes in risk structures can be examined. In terms of the normative approach, our problem-solving techniques are reaching a rather advanced stage. Stochastic programming algorithms have long been available and have been often used in agricultural settings (e.g., Rae; Hazell: Hazell and Scandizzo; Scott and Baker). Statistical decision theory has also been an important tool for solving agricultural problems of choice among various risky alternatives (e.g., Eidman et al.). Both the stochastic programming and decision theoretic aspects, as well as considerable dynamic generalizations, have been combined in the adaptive stochastic control theory which has been developing in the engineering literature (e.g., Aoki; Murphy). Applications of the more general techniques in adaptive stochastic control to farm decision-making problems have been slow, however, because farmers' possibly multifactored objective criteria are difficult to determine empirically. Furthermore, most of these stochastic and dynamic considerations have been made in programming models only on a microlevel.

The normative approach, however, has not been widely used in aggregate supply analysis other than under the assumption of profit maximization. I am aware of only a couple of studies, such as the one discussed briefly by Hazell and Scandizzo, which attempt to include risk response in an aggregate normative model. And, to my knowledge, all normative work to this point has restricted decision-makers' objective criteria to maximization of a mean-variance utility function of profit. This is a restrictive assumption by itself, but considerable problems have also been encountered with estimation of the mean-variance utility criteria as well as with estimation of decision-makers' subjective expectations for prices and yields (Hazell and Scandizzo, page 243). I anticipate that the development of methodology for determining decision-makers' objective criteria will continue to be slow and thus hinder (although not prevent) reliable aggregate normative estimation of risk response in the near future. However, the methodology for determining individual preferences has been progressing. Halter and Dean, as well as Webster and Kennedy, have developed methods for estimation of individual utility functions of agricultural producers. If better methods of estimating preferences on an aggregate level are developed, then more reliable normative estimates of risk response should be possible. With respect to estimation of producers' expectations for risk, however, the information derived from positive risk-response studies may be needed to improve normative risk models.

POSITIVE RISK-RESPONSE ESTIMATION

The positive approach to risk-response estimation, it seems to me, is more direct and holds promise at least for current research because information about objective criteria need not be specific and because the formulation of producers' subjective evaluation of risk need not be specified (completely) in advance. Simple econometric models of risk response have begun to be used for studying acreage response to both output price risk and yield risk and some models are of sufficient generality to reflect risk aversive as well as diversifying decision-making behavior in a multivariate response framework. The associated empirical work has indicated not only a considerable reaction to changes in risk but also, where the framework is sufficiently general, a significant interaction in risk-related response among agricultural enterprises.

The major approach developed thus far in estimating aggregate risk response involves, as King points out, modifying the general class of adaptive expectations models so that subjective expectations for the mean squared error of adaptive predictions is also included. Where y_t is the decision (response) variable and x_t and z_t are the explanatory (price or yield) variables, a general adaptive expectations model is given by

$$y_t = f(x_t^*, z_t^*), \quad x_t^* = \sum_{k=1}^{\infty} \alpha_k x_{t-k}, \quad z_t^* = \sum_{k=1}^{\infty} \beta_k z_{t-k}$$

where x_t^* and z_t^* represent subjective expectations for x_t and z_t, respectively, for time t. With this model, the squares and cross products of the errors of predictions are, of course, given by $(x_t - x_t^*)^2$, $(z_t - z_t^*)^2$, and $(x_t - x_t^*)(z_t - z_t^*)$. Regarding these quantities as observations on risk (or on variances and covariances), expectations can be formed for the squared error and cross product of error by weighting past observations on risk, similar to the way subjective mean expectations are formed. The modified adaptive expectations model or the resulting adaptive risk model is thus

$$y_t = f^*(x_t^*, z_t^*, u_t, v_t, w_t) \tag{1}$$

where

$$u_t = \sum_{k=1}^{\infty} \gamma_k (x_{t-k} - x_{t-k}^*)^2$$

$$v_t = \sum_{k=1}^{\infty} \delta_k (z_{t-k} - z_{t-k}^*)^2$$

$$w_t = \sum_{k=1}^{\infty} \rho_k (x_{t-k} - x_{t-k}^*)(z_{t-k} - z_{t-k}^*).$$

✓ Since this model reflects not only subjective variances but also subjective covariances, it can possibly reflect diversifying as well as risk-aversive response to a changing risk structure. Although only two explanatory variables are used here for expository purposes, the framework extends in an obvious manner when many explanatory and decision variables are important.

Behrman first began to consider risk response in this manner in a study of crop-supply response in Thailand. Behrman's model is essentially the same as in (1) above except that the subjective covariance term w_t is excluded, and all other subjective weighting parameters in the risk structure are arbitrarily prespecified. His equation is of the form:

$$y_t = a_0 + a_1x_t^* + a_2z_t^* + a_3u_t^{1/2} + a_4v_t^{1/2}$$

where all weighting parameters (α_k, β_k, γ_k, δ_k, ρ_k) are 1/3 for $k = 1$, 2, 3 and zero for all $k > 3$. Behrman defined x_t and z_t as output price and yield, respectively, and y_t as the land area planted to the corresponding crop. In this framework, Behrman found that price and yield risk response was significant in many cases even in underdeveloped agriculture.

In a later study of California agricultural crop acreage response, the model in (1) was applied more generally (Just, 1974a). Interaction in risk response was investigated by considering risk terms for competing crops as well as for the crop in question; and subjective covariance terms, such as w_t (relating different crops), were also investigated. All subjective weighting parameters were estimated rather than prespecified, but the weights were constrained to have geometric distributions related by α_k, $\beta_k = (1 - \theta)\theta^k$, and γ_k, δ_k, $\rho_k = (1 - \phi)\phi^k$, where θ and ϕ are fixed parameters. Results of this study indicated that risk response was important in every case where acreage response was not dominated by strict acreage controls. Although the subjective covariance terms (w_t) were of little importance in explaining acreage response, the interaction in risk response was significant in most cases.

The California study has also led to an important explanation relating to goodness of fit in risk-responsive versus traditional Nerlovian agricultural models and possibly explains a well-known criticism of

Nerlovian models. This explanation, discussed previously by Just (1974a) and King, indicates that the Nerlovian response model has possibly performed well for estimation purposes because in reduced form it can implicitly explain~~s~~ risk response. Both empirical and theoretical findings indicate (particularly when ϕ is large) that most of the effects of changing risk can enter through the lagged dependent variable which is used in estimating the reduced form of the Nerlovian model. Hence, the reduced form of the Nerlovian model (without risk terms) can possibly fit the data almost as well as the structural risk model in (1) when, in fact, risk response is significant. In this case, the predictive power of the Nerlovian model will generally be poorer than the risk model and, in particular, predictions will be poorer than estimation statistics indicate. Although research supporting the latter possibility is not generally published (for obvious reasons), many complaints have been lodged that econometric predictions are poorer than statistics indicate they should be. For example, in their evaluation of econometric models in agriculture, Cromarty and Myers (page 174) observe that "the contribution of the lagged dependent price variable will generally overpower any additional explanatory factors. This leads to internal estimating statistics that always appear impressive (high R^2 and low standard error) and a final estimate which tends to overshoot or undershoot the major turning points." When turning points are at least partially a result of changes in risk, this phenomenon is exactly what the results to which I refer would lead one to expect. An adequate consideration of risk terms thus seems to offer some new possibilities not only for increasing predictive power but also for increasing prior knowledge of the accuracy of predictions (based on estimation statistics for a more properly specified model).

I believe another important aspect of the risk-response studies of Behrman and Just should also be noted. In each case, the response equations were estimated for small agricultural areas. Behrman used changwads (approximately equivalent to counties), and Just used crop reporting districts consisting of 3 to 12 counties each. There are perhaps two reasons why risk response has so far been shown of empirical importance only at a relatively disaggregated level. The first relates to narrowing the class of competing decision variables to manageable proportions so that the important interaction in risk response is estimable (i.e., so that degrees of freedom are sufficient to obtain statistical results). This factor was particularly important in the California study where so many crops are competing at the state level. The second reason for disaggregated estimation has to do with problems of aggregation in risk-responsive equations and pertains also to studies where interaction is unimportant. For expository purposes, consider two overly simplified response functions

$$y_i = a_0 + a_1 x_i^* + a_2 (x_i - x_i^*)^2, \qquad i = 1, 2,$$

where x_i^* is, say, the *ith* decision-makers' weighted price mean over some lag period and x_i is his most recent price observation. The corresponding aggregate model would be

$$y = a_0^* + a_1^* x^* + a_2^* (x - x^*)^2$$

where $y = y_1 + y_2$, $(x_1 + x_2)/2$, and $x^* = (x_1^* + x_2^*)/2$. In this case, no aggregation bias results in the traditional part of the model (where the aggregate lag distributions are averages of individual lag distributions) since $a_0^* + a_1^* x^* = (a_0 + a_1 x_1^*) + (a_0 + a_1 x_2^*)$ for all x_1^* and x_2^* when $a_0^* = 2a_0$ and $a_1^* = 2a_1$. In the case of the risk term, however, we find

$$(2) \quad a_2^* (x - x^*)^2 = a_2^* (x_1 - x_1^*)^2/4 + a_2^* (x_2 - x_2^*)^2/4 + a_2^* (x_1 - x_1^*) (x_2 - x_2^*)/2.$$

Obviously, for general x_i and x_i^*

$$a_2^* (x - x^*)^2 \neq a_2 (x_1 - x_1^*)^2 + a_2 (x_2 - x_2^*)^2$$

for any fixed a_2^*. In effect, the latter right-hand term in (2) introduces noise in the aggregate risk term which prevents accurate estimation of risk-term coefficients and biases the associated statistics toward insignificance. Nevertheless, it has been shown (as is partially intuitive above) that aggregation bias is small if observed errors $(x_i - x_i^*)$ and response equation coefficients are near the same, respectively, over decision-makers, or if lag distributions are the same over decision-makers and observations differ by constant amounts among decision-makers (Just, 1974a). In the case of both prices and yields, these conditions will likely be satisfied only for relatively small groups of decision-makers with similar climatic conditions and enterprise alternatives such as are inherent in the Behrman and Just studies. But obviously, however, it may also be advantageous to disaggregate by farm size, equity ratio, and other characteristics which affect behavior toward risk.

A COMPARISON OF POSITIVE AND NORMATIVE METHODOLOGY

Although positive risk response models have only been estimated for specific annual cropping problems, recent work (Just, 1974b) indicates that the same methodology has interesting optimal properties in a much broader class of problems. A similar framework can be used in both livestock and perennial cropping problems when lagged decision variables are included for all inputs which are partially determined because of decisions made in previous time periods. Technically, the explanatory variables which should be included in explaining each decision variable (in general) are all the variables (prices, productivities, etc.) which together with the decision variables determine all the outcomes of interest to the decision-maker (profit, sales, costs, debts, etc.). Under these conditions, the model in (1), with weights only slightly more general than the geometric ones defined above has been shown to be the optimal fixed coefficient (stable lag function) model when the explanatory variables follow a linear, Guassian Markov process or are at least noisy observations of such a process. Although the explanatory variable assumption in this argument is rather specific, the objective criteria are essentially of full generality not requiring the existence of a utility function or of single-factored objective criteria. Furthermore, the results are of approximate applicability regardless of linearity and normality in the underlying economic environment so long as relevant ranges of the underlying explanatory variable process are approximated by linearity.

in Paper.
Gaussian?

Although a similar generality can be attained in theory with programming or adaptive control theoretic problems, it seems unlikely that the normative approach to risk-response estimation can be applied in specific cases without requiring more limiting assumptions than the above positive methodology where objective criteria are concerned. Application of normative methodology also requires explicit specification of the production function. And unless a sufficiently general, decision theoretic programming model is employed, the formulation of producers' subjective distributions for prices and yields may still need specification--most likely with positive economic methods. I would add, however, that, if these obstacles can be removed, then the information from normative studies should also be useful for policy evaluation; and the arguments of Nerlove and Bachman indicating desirability of both positive and normative estimates would be applicable. Moreover, normative information should be particularly useful for evaluating policies which introduce new variables or constraints which cannot be represented in terms of historical controls and, hence, cannot be evaluated by positive methods until sufficient new data are generated. This possibility of drastic revisions in policy leads to the last point I wish to discuss.

POLICY UNCERTAINTY

Three sources of risk and uncertainty deserve attention in agricultural problems: (1) risk associated with environmental (and technological) factors such as weather, diseases, pests, and improved crop varieties and livestock breeds; (2) risk associated with market factors such as supply in other exporting countries, export demand, input supply, and competing demand for inputs; and (3) uncertainty with respect to policy changes such as the form of government programs, the level of supports, and the regulation of pesticides and wastes. Thus far in this paper and, I believe, as a profession, we have considered risk and uncertainty largely in terms of only the first two sources--environmental and market factors. But in an era of strict governmental controls and strong governmental influence, where policies are subject to quite drastic changes from time to time, uncertainty with respect to government programs may also have a considerable influence on producer decisions. It is not uncommon for several policy alternatives to be tossed around for quite a long period of time before one is finally chosen for implementation. It is my hypothesis that this kind of uncertainty leads to considerable allocative inefficiency in the agricultural sector (as well as the rest of the economy) by creating a diversifying and lagged response to environmental and market factors. This would be especially true with respect to investment decisions. Perhaps if our models adequately reflected the effects of policy uncertainty, it would become clear that our policy changes should come in a more orderly fashion which would allow decision-makers to plan ahead. It may be that changes should be instituted more gradually to allow for sufficient planning and efficient adjustment. In cases where the domestic economy is susceptible to drastic changes in foreign policy (such as with Russian wheat transactions), perhaps domestic policy should be designed at least to remove uncertainty with respect to foreign policy.

Some non-risk-related research has already attempted to determine the need for controlled change in policy. For example, Rosine and Helmberger's work indicates that, because of lagged capital response, "an abrupt termination of farm programs during the decade of the sixties [1964] would have had a very serious impact on the welfare of farm families" (page 726). In point of fact, however, with an adequate consideration of policy uncertainty, such studies may indicate an even greater cost. If farmers anticipate an abrupt policy change, then their organization will probably become more liquid before the policy change than would be efficient. These additional production inefficiencies due to lead capital response may also be important--particularly when anticipations are incorrect.

Evaluation of the effects of policy uncertainty indeed presents a difficult problem but one which should be considered. In some cases, such as with support levels, a risk-response model such as (1) may be adequate. But in many cases where new and untried alternatives are being considered, normative models may also be needed. Perhaps with both of these approaches the Delphi approach or a Bayesian approach of empirically determining subjective probabilities for alternatives will be needed to evaluate policy uncertainty. If this kind of information is compiled on a case-by-case basis, and price and yield distributions can be determined under each policy alternative, then substitution into (1) should indicate some possible effects of policy uncertainty. But if decision-makers' risk preferences can be determined, then a normative approach should also be useful since the continuous relationships usually used in (1) may provide poor approximations when policy alternatives differ drastically.

CONCLUSIONS

Risk response studies have so far been inadequate for meeting all our policy evaluation needs. Although the importance of risk preferences has been often acknowledged on the normative side at a microlevel, only a few positive studies of risk response have been forthcoming; aggregate normative estimates of risk response are extremely rare. Our literature abounds with normative models and methodology which decision-makers can use in determining appropriate responses of all inputs, but so far only acreage response to changes in risk has been well documented empirically. An adequate consideration of risk responsiveness in all agricultural inputs, however, is apparently easily within reach of available methodology--at least with respect to environmental and market factors. Judging, in retrospect to past experience, it seems that some serious mistakes in policy formulation can be avoided if risk-responsive methodology is properly exploited. An evaluation of the effects of policy uncertainty, on the other hand, will be much more difficult but should be equally important in determining the manner in which policy changes should be made.

REFERENCES

Aoki, Masanao. Optimization of Stochastic Systems. New York: Academic Press, Inc., 1967.

Batra, R. N., and W. R. Russell. "Gains from Trade Under Uncertainty." Am. Econ. Rev. 64 (1974): 1040-48.

Behrman, Jere R. Supply Response in Underdeveloped Agriculture. Amsterdam: North-Holland Publishing Co., 1968.

Carter, H. O., and G. W. Dean. "Income, Price, and Yield Variability for Principle California Crops and Cropping Systems." Hilgardia 30 (1960): 175-218.

Charnes, A., and W. W. Cooper. "Chance Constrained Programming." Management Science 6 (1959): 73-79.

Cromarty, W. A., and W. M. Myers. "Needed Improvements in Application of Models for Agriculture Commodity Price Forecasting." Am. J. Agr. Econ. 57 (1975): 172-77.

Eidman, Vernon R., Harold O. Carter, and Gerald W. Dean. Decision Models for California Turkey Growers. Dept. of Agr. Econ., Giannini Foundation Monograph 21, University of California, Berkeley, 1968.

Freund, Rudolf J. "The Introduction of Risk into a Programming Model." Econometrica 24 (1956): 253-63.

Friedman, Milton, and L. J. Savage. "The Utility Analysis of Choices Involving Risk." J. Pol. Econ. LVI (1948): 279-304.

Griliches, Zvi. "Research Costs and Social Returns: Hybrid Corn and Related Innovations." J. Pol. Econ. 66 (1958): 419-31.

Halter, Albert N., and Gerald W. Dean. Decisions Under Uncertainty with Research Applications. Cincinnati: South-Western Publishing Co., 1971.

Hazell, P. B. R. "A Linear Alternative to Quadratic and Semivariance Programming for Farm Planning Under Uncertainty." Am. J. Agr. Econ. 53 (1971): 53-62.

Hazell, P. B. R., and P. L. Scandizzo. "Competitive Demand Structures under Risk in Agricultural Linear Programming Models." Am. J. Agr. Econ. 56 (1974): 235-44.

Heady, Earl O., Earl W. Kehrberg, and Emil H. Jebe. Economic Instability and Choices Involving Income and Risk in Primary or Crop Production. Iowa Agr. Exp. Sta. Res. Bul. 404, 1954.

Hueth, Darrell, and Andrew Schmitz. "International Trade in Intermediate and Final Goods: Some Welfare Implications of Destabilized Prices." Quart. J. Econ. 86 (1972): 351-56.

Just, Richard Eugene. Econometric Analysis of Production Decision with Government Intervention: The Case of the California Field Crops. Dept. of Agr. Econ., Giannini Foundation Monograph 33, University of California, Berkeley, 1974a.

_______________. "Existence of Stable Distributed Lags." Paper presented at the North American Meetings of the Econometric Society, San Francisco, December 28-30, 1974b.

King, G. A. "Econometric Models of the Agricultural Sector." Am. J. Agr. Econ. 57 (1975): 164-71.

Kling, W. "Determination of Relative Risks Involved in Growing Truck Crops." J. Farm Econ. 24 (1942): 694-98.

Markowitz, H. M. Portfolio Selection. Cowles Commission for Research in Economics, Monograph No. 16. New York: John Wiley and Sons, Inc., 1959