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RISK ANALYSIS FOR AGRICULTURAL
PRODUCTION FIRMS: CONCEPTS,
INFORMATION REQUIREMENTS AND POLICY ISSUES

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Methodological Issues Involving Investment
and Growth Under Uncertainty--A Discussion

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The papers by Reid and Musser, and Nelson raise some important methodological issues related to research in farm investment and growth. Agricultural research economists are criticized for their preoccupation with models. It is meaningful, therefore, that this session focuses on the methodological approaches we take in our modeling efforts. Second, this session on farm investment and growth has timeliness, considering the current state of the farm economy and many individual producers.

Reid and Musser identify several important research issues which are fundamental to various analytical approaches to farm investment and growth. These research issues evolve from the need to incorporate time, uncertainty and farm organizational complexity jointly in our models of farm investment and growth processes. It is interesting and useful to note that these methodological concerns have been expressed in the recent past by agricultural economists involved in W-104 (Western Regional Research Committee on Economic Growth of the Agricultural Firm). This discussion of the paper by RM attempts to identify some of the concerns which are in common with the research agenda suggested by Barry (1977) at the conclusion of W-104.

A majority of the paper by Reid and Musser develops a review of the theory of intertemporal choice and associated axioms of utility, behavioral assumptions, and conditions for optimal consumption and investment decisions. The authors demonstrate that when a debt limit is introduced (as in the case of imperfect capital markets) Fisher's Separation Theorem between investment and consumption decisions need not hold. The presence of a debt constraint gives rise to a "premium" (liquidity) which is the individual's subjective rate above the market rate for trading current and future funds. Reid and Musser show that the investment/consumption optimum can be preserved for the wealth-maximizing decision maker when the appropriate subjective discount rate is used. While the argument for such a subjective rate is theoretically justified, implementation of this concept to maintain the validity of our present value methods of investment analysis needs to be shown. This issue has relevance with regard to the decision to replace farm machinery when one considers the simultaneous aspects of the production-investment-replacement decision within a multiperiod analytical framework.

The authors correctly point out that capital budgeting methods need not result in maximization of market value of wealth when imperfect capital

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markets exist, even though the appropriate discount rate is used. It is useful to note here that the problems which Reid and Musser associate with optimal investment/consumption choices under imperfect capital market conditions are equally problematic with regard to disinvestment/consumption decisions in agriculture.

The theoretical development necessarily abstracts from several financial factors related to debt limitations, which are the legitimate concern of researchers. Barry (1977) suggests that "loan limits by type and source of credit are also important measures for the firm . . . and are responsive to the borrower's choices . . ." (p. 13). Borrowing provides cash and repayment of debt reduces cash for the farm business. Borrowing and repaying debt also affect the firm's liquidity position. Barry states that, "the costs of using liquidity provided by a credit or cash reserve depend on the borrower's liquidity preference. Hence, behavioral research is needed to estimate parameters of relevant liquidity preference functions" (p. 13). Few topics in farm finance are as timely and relevant as this issue of farm liquidity and the associated cash flow impacts of debt service on the survival and investment/disinvestment strategies of farms and ranches.

Reid and Musser extend the model of intertemporal choice by combining the theories of choice over time with choice under conditions of uncertainty. The time-state preference approach is used to demonstrate that with complete and perfect markets the Separation Theorem can be extended to include separability of the level of consumption and level of investment, and separability between the level of consumption and the level of risk in productive investment activities. They relax the complete markets assumption and show that under uncertainty, production and consumption decisions are no longer completely independent. More importantly, the authors suggest that the imposition of a debt limit under uncertainty negates the use of market values in determination of optimal investment decisions. Reid and Musser state that a "methodologically correct" analysis would need to employ a multidimensional utility approach (for time and states of the world) to consider debt limits under risk and substitution between periods. The assumptions of weak and strong conditional utility independence (joint preferential independence and utility independence, respectively) which underlie a multidimensional utility analysis may be difficult to substantiate (especially utility independence), and quite difficult to implement if many possible consequences and investments are to be analyzed. The authors concede that current research methods are practical alternatives, but the limitations should be recognized.

Barry formulates a multivariate utility function which hypothesizes a functional form for expressing variate preferences and time preferences for dated events. The variates which are identified include: 1) consumption (with attributes of minimum requirements, liquidity preference, risk preference for income variability and skewness, and level of consumption), 2) net worth (with attributes of minimum requirements, liquidity preferences on structure of assets and liabilities, risk preferences toward asset values, and level and rate of growth of wealth,) and 3) other utility elements. The stability of utility functions for changes in time, wealth, size of gain (loss), and several other factors is open to question. Barry makes the important observation that once the relevant utility variables have been identified, a sequential ordering (rather than a joint equilibria) of variables may be undertaken and each objective achieved to some desired level

before the subsequent objectives are met. An example of this form of behavior is the farmer who must first satisfy minimum consumption requirements then minimum liquidity demands, each with acceptable degrees of certainty, before attempting to increase profits or farm size. Two discussion points can be made. First, the relevant utility variables are likely multi-attribute, and involve more than consumption, and will remain difficult to characterize at a point in time as well as over time. Second, given that several utility variables are considered, the attainment of joint equilibria as suggested by Reid and Musser may not be characteristic of the intertemporal choices made by farmers.

Reid and Musser provide a valuable insight into past research with regard to integration of market alternatives into risk management strategies. A substantial amount of research energy has been expended to analyze the usefulness of marketing strategies (e.g., hedging) in reducing price risk under the assumption that production and investment activities are held fixed. Additional research needs to consider the interrelationship of production-investment and marketing alternatives and the associated cash flow attributes (magnitude, timing), all subject to the strategic cash flow requirements of the farm household and business. Clearly, it is one of the major objectives of the S-180 regional research effort to provide a stimulus to undertake research in farm risk management which is integrative in nature.

The authors are to be commended for their efforts to show that these research issues derive from fundamental concepts of intertemporal choice and assumptions about complete and perfect capital markets in agriculture. The methodological problems which Reid and Musser and Barry have identified are endemic to agricultural research, and it is important to realize that these questions have been raised by agricultural economists for some time. It is also important to bear in mind, however, that farm production, investment, marketing, and financing decisions which affect farm liquidity, survival and growth will continue to be made with or without the benefit of research.

The paper by Nelson proposes to explore the concept of diversity in agriculture. Measures are defined and an illustration of their interrelationships is developed. The conceptual issue of diversity, however, embodies several additional normative and prescriptive questions which I believe are not addressed. I suggest that there exist two dimensions to diversity which appear to be methodologically different. First, there is diversification as a risk management strategy under which one assumes that perceived risk is the underlying motivation and a conscious effort is made to reduce risk exposure. The second research approach is to question why diversity exists (e.g., seed varieties, livestock breeds, etc.) and attempt to characterize the diversity which one observes and relate those measures to what might be motivating diversity. Nelson's paper emphasizes the second research approach. Both research approaches to diversity involve measurement problems, value judgments, and use of fundamental distribution theory.

The stated objective of the paper is to examine the validity and redundancy of several diversification measures found in the industrial organization and risk management literature. Nelson concludes that all the measures of diversification, which are implemented in the analysis of Sacramento farms, do measure a common underlying concept of diversity. The paper addresses but does not resolve the question concerning the degree of redundancy to be found among the measures.

Validity of the various measures as indicators of an underlying phenomenon associated with risk management is not tested in the paper. Along this same line of reasoning it is not clear just what the measures of diversity are to measure with regard to farm investment and growth. Are the various measures to be indicators of the risk-reducing consequences of diversification, or just measures of the organizational complexity reflecting diversification efforts?

Nelson suggests that choice of units of measure and selection of resources, assets, revenues, or farm profits to represent the distribution of farm effort among alternative activities is an important research decision. The author states that the clustering of concentration ratios for acreage, revenue, and profit variables supports the importance of units of measure. Factor analysis for these same variables indicates nearly identical factor loadings. I conclude that the selection of variables to characterize the distribution of farm effort did not significantly affect the reported empirical results. The author states that farm records "cause imprecision in proportions calculations" of farm effort. It is not clear from the discussion why such imprecision need follow from farm records. Nevertheless, a sample of farms is used to generate survey data for subsequent multivariate analysis in the paper.

Based on factor analysis, Nelson suggests that additional determinants (e.g., crop rotations, variations in land quality, differences in management skills, and personal preferences) should be considered in addition to risk management to analyze allocation of farm effort. It is my contention that these additional determinants are in fact a significant part of what we identify as risk management. Crop acreages and rotation patterns, farm revenues and profits are expected to reflect risk management decisions which incorporate information concerning agronomic and land quality factors, etc.

The paper identifies the variate difference method and the single index method as two alternative procedures for estimating variance-covariance parameters of the distributions. While variate differencing has been demonstrated in prior studies of price, yield and returns variability, the general applicability of the method is questionable. The method has been applied to county-level yields and gross returns data in North Dakota for the major crops of wheat, durum, barley, sunflower, and corn on continuous-cropping and fallow systems (Wendland, 1981). Resulting estimates of the random component of variation for several crops were inconsistent and difficult to resolve with perceived levels of risk. One of the potential problems with the method involves the relationship between the assumed underlying distribution and the number of successive differences required to reduce the standard error ratio (the ratio of the standard errors at the $(n+1)$ th and n th stages of differencing) below a critical value at an acceptable level of significance. Non-normality of the underlying distribution is one of the potentially important problems in its use. Nelson states that the single index (beta) method has questionable stability properties when derived from time series data. In addition, the use of the derived index for predictive purposes and in ex ante risk management is not clear.

The author advances a number of useful propositions in the paper with regard to the relevant set of measures of diversity which could be considered

in farm firm risk research. Sharpe (1977) contends that factor-analytic techniques to determine a few factors with high explanatory power may not be as useful as the identification of factors which "represent anticipations about important economic variables affecting more than one firm" (p. 131). This tends to support the use of factor analytical methods in analyzing the risk environment in agriculture when the intent is to develop ex ante approaches to risk management.

The paper challenges agricultural economics researchers to reconsider the growing finance and risk management literature which has dealt primarily with variance-based measures. The industrial organization literature embodies a set of viable alternative measures of diversification. However, these measures are not explicit as to the risk-returns trade-off (or, analogously the risk-growth trade-off) which forms the basis for much of the literature on investment and growth under uncertainty. While the paper has dealt primarily with productive-organizational diversity, it would be useful to explore the role which diversity in financial organization and market activities play as legitimate areas of diversification with implications for integrated farm risk management strategies.

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