LEVEL AND VARIABILITY OF NET INCOME FOR SELECTED DAIRY BUSINESS MANAGEMENT STRATEGIES

By

Wayne Alan Knoblauch

Instability of farm product prices has become a characteristic of American agriculture. Price variations result from fluctuations in yields caused by weather and other natural or physical hazards, changes in demand, and in recent years, a greater impact on prices from grain exports has been in evidence. Farm costs are also variable, and tend to increase with the inflationary conditions of the country for manufactured farm inputs and with weather or other natural conditions for farm produced inputs such as soybean meal. Yet, farmers' costs commitments for production, and family living expenses are relatively fixed in a given year. Thus, farmers are faced with variable production expenses which must be paid; and fluctuating product prices and yields.

As a result of increased variability in prices and costs, important managerial problems face many farmers. What business management strategies could a farmer follow to achieve a level and variability of income stream that meets his income expectations and level of risk avoidance? This question was analyzed for a representative dairy farm in this research effort.

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An empirical analysis of the level and variability of net income for thirty-six dairy and one cash grain business management strategy was facilitated by first developing a synthetic dairy farm. An 80 cow dairy farm was constructed with specified acreage, field equipment, feeding, housing and milking, and waste handling systems. Specific strategy components examined were ration, buying versus raising herd replacements, crop rotation on acres above those required for feed production, and mode of sale for excess calves.

Linear programming techniques were employed to determine net farm incomes and labor requirements for each of the strategies in 1975.

Time series estimates of enterprise costs of production, product prices, and yields were developed back to 1960. It was from these time series estimates that net farm incomes were calculated and a linear and logrithmic regression line fitted. Also, time series estimates of property takes federal and state income tax, and self-employment tax payments were deducted from before tax incomes.

The major findings of the research were: (1) a greater variability in farm product prices and input costs in the 1970 to 1974 period over the 1960 to 1969 period; (2) feeding a ration containing 50 percent forage dry matter from haylage and 30 percent from corn silage, buying replacements, raising excess calves to a dairy beef market weight and selling corn grain from excess crop acres was the highest income generating

strategy in 1975; (3) an all corn grain rotation provided the highest mean income and variability level for many strategies; (4) selling excess dairy calves as dairy beef produced the highest mean income, deacons the median, and veal calves the lowest; (5) a ration containing 50 percent forage dry matter from haylage and 50 percent from corn silage was the highest mean income level ration, a ration containing 100 percent forage dry matter from haylage the lowest, and a ration containing 7 pounds of hay equivalent per day with the remainder corn silage the median. This was reversed, however, in the 1970 to 1974 period when low and median income rations exchanged positions; (6) replacement stock purchases from off farm sources versus raising replacements changed rankings from strategy to strategy; and (7) rankings of selected strategies mean income and variability remain unchanged after tax reductions.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

CHAPTER I

INTRODUCTION

Instability of farm product prices has become a characteristic of American agriculture. Price variations result from fluctuations in yields caused by weather and other natural or physical hazards, changes in demand, and in recent years, a greater impact on prices from grain exports has been in evidence. Farm costs are also variable, and tend to increase with the inflationary conditions of the country for manufactured farm inputs and with weather or other natural conditions for farm produced inputs such as soybean meal. Yet, farmers' costs commitments for production and family living expenses are relatively fixed in a given year. Thus, farmers are faced with variable production expenses which must be paid; and fluctuating product prices and yields.

As a result of increased variability in prices and costs important managerial problems face many farmers. What business management strategies[1] could a farmer follow to achieve a level of variability of income stream that meets his level of risk avoidance? This question is analyzed for a representative dairy farm in this research effort.

All references and footnotes appear at the end of each chapter.

Present Farm Economic Environment

In recent years, prices received by farmers and the costs of purchased inputs have been more variable than during the decade of the sixties. The coefficient of variation for the selected farm product prices presented in Table 1 was greater in the 1970 to 1974 period than the 1960 to 1969 period for all commodities examined. Corn grain and wheat prices had larger increases in variability in 1970 to 1974 over 1960 to 1969 and also exhibited the greatest absolute variability. Base milk prices increased slightly in variability during the 1970 to 1974 period but were the most stable of all farm product prices examined.

Farm input costs also increased in variability during the most recent period, but two exceptions exist. Farm wage rate variability was approximately equal to the two period, whereas less variability existed in the 6-24-24 mixed fertilizer cost.

Variability in gross income for field crops is the result of both price and yield variability. Table 2 shows the variability of prices, yields, and gross income for corn grain, wheat, oats, and soybeans. In the 1960 through 1969 period, the yield variability of all crops, except wheat, was greater than the price variability. However, during the 1970 through 1974 period, price variability was greater than yield variability for all crops.

When comparing the two time periods, price variability was greater in the 1970 through 1974 period for all crops

Table 1. Variation of Selected Farm Product Prices and Input Costs[a]

	Time Period			
	1960 to 1969		1970 to April 1975	
	Standard Error of Estimate	Coefficient of Variation	Standard Error of Estimate	Coefficient of Variation
Farm Product Prices				
Corn ($1 bu.)	0.10	9.30	0.44	25.52
Oats ($1 bu.)	0.06	9.22	0.17	17.30
Wheat ($1 bu.)	0.19	12.05	0.85	34.37
Soybeans ($1 bu.)	0.26	10.35	1.10	25.14
Hay ($/T.)	1.64	7.75	3.29	11.16
Base Milk ($/cwt.)	0.36	7.52	0.57	8.13
Choice Steers ($/cwt.)	2.06	7.82	4.09	10.91
#1 & #2 Hogs ($/cwt.)	2.93	15.02	5.85	19.25
Prices Received Index	7.61	3.04	37.85	10.47
Farm Input Costs				
Soybean Oil Meal (#/T)	6.64	9.38	59.55	45.55
Farm Wages ($/hr.)	0.07	5.65	0.11	5.58
Anhydrous Ammonia ($/T)	6.52	4.87	40.55	33.09
Gasoline (¢/gal.)	0.01	2.33	0.11	31.07
Diesel Fuel (¢/gal.)	0.004	2.48	0.05	21.88
6-24-24 mixed fertilizer ($/T)	25.89	46.63	20.03	19.81
Index of Production Items (cost)	4.24	1.52	47.16	10.67

Source: Michigan Farm Economics and Michigan Crop Reporting Service

[a]Linear regression was used with time as the independent variable to eliminate any upward trend from the variability calculation. All prices and costs are for south-central Michigan except indicies which are for the United States. All prices and costs are on a monthly basis, except wages, fertilizer, and fuels which are quarterly.

Table 2. Price, yield per acre, and gross income per acre variability for field crops*

	Price		Yield Per Acre		Gross Income Per Acre	
	Standard Error of Estimate	Coefficient of Variation	Standard Error of Estimate	Coefficient of Variation	Standard Error of Estimate	Coefficient of Variation
Corn Grain						
1960-1969	0.09	8.94	6.50	9.87	7.93	11.95
1970-1974	0.56	31.46	6.97	9.22	27.25	21.76
Wheat						
1960-1969	0.21	14.29	2.76	7.17	9.70	17.14
1970-1974	0.59	28.50	4.65	12.40	20.89	27.71
Oats						
1960-1969	0.04	6.60	6.31	11.29	3.77	11.36
1970-1974	0.18	20.50	6.14	12.94	13.12	38.44
Soybeans						
1960-1969	0.25	10.73	2.46	12.17	8.21	17.36
1970-1974	0.96	22.07	0.97	4.11	16.51	48.36

*Yields are Michigan Crop Reporting Service estimates for Eaton County and prices are those at the time of harvest paid by local grain elevators in south-central Michigan.

analyzed. Yield per acre variability was approximately the same for the two periods for corn grain and oats, with more variability for wheat and less for soybeans during the 1970 through 1974 period.

As yield and price are combined into gross income per acre; more variation existed for all crops during the 1970 through 1974 period than the previous 10 year period.

Upon examination of livestock enterprise variability it was found that price variability was greater in the 1970 through 1974 period for hogs and less for beef cattle, while base milk prices exhibited the lowest and approximately the same variability in both time periods (Table 3). The same is true for gross income variability. It is greater for hogs and less for cattle in the latter period while milk sales were the most stable.

In summary, the economic environment in which dairy farmers operate has, in recent years, exhibited much more variability of product prices and input costs. The preceding presentation has established the fact that greater variability has been in existence for individual commodities and inputs. In a later chapter, enterprise and whole farm net income variability are measured.

Problem Statement

Resulting from the greater variation in farm product prices and input costs (see Table 1), dairymen are faced with an economic environment which has much more uncertainty

Table 3. Price and gross income variability for livestock enterprises

	Price		Gross Income	
	Standard Error of Estimate	Coefficient of Variation	Standard Error of Estimate	Coefficient of Variation
Hogs[1] ($/cwt.)				
1960-69	2.41	12.24	15.93	12.26
1970-74	4.99	16.87	32.98	16.89
Beef Cattle[2] ($/cwt.)				
1960-69	8.41	29.17	84.08	29.16
1970-74	4.22	11.21	42.18	11.20
Milk Sales[3] ($/cwt.)				
1960-69	.35	7.23	49.13	7.24
1970-74	.60	8.69	84.11	8.71

[1]It was assumed three groups of feeder pigs could be marketed per year, in April, July and December.

[2]It was assumed the cattle would be placed on feed in the Fall and sold the following June and July.

[3]Milk sales are for a cow producing 14,000 pounds of milk, allowing only Base Milk to vary.

than in previous years. Consequently, an analysis of net farm income variability of possible farm business management strategies is needed.

This research focuses on selected business management strategies a dairyman could follow toward attainment of his farm goal, whether that goal be growth and expansion, stability of income, or contractions and retirement. Strategies under the general headings of flexibility and diversification are analyzed. A dairy farm representative of those in southern lower Michigan with respect to herd size, farm acreage, technology, and financial characteristics is examined.

The resultant net income variability for each business management strategy can then be compared and the individual dairyman can choose the level of income and variability which most closely matches his acceptable level.

Research Objectives

The research objectives are:

(a) to describe the present economic environment in which Michigan dairy farmers must function,

(b) to identify those Michigan dairy farms which are potentially most affected by the recent changes in prices of inputs and outputs,

(c) to analyze selected business management strategies for controlling the effects of price and cost changes on the level and variability of net dairy farm income,

(d) to appraise the implications of adopting alternative strategies on the Michigan dairy farming industry.

The following business management strategies are examined for a representative dairy farm:

(a) raising replacements for the milking herd on the farm versus buying replacements off the farm,

(b) selling the excess calves as deacons, versus feeding the dairy calves to a veal market weight of 250 pounds versus selling them as dairy beef at 800 to 880 pounds,

(c) growing cash crops for sale on excess acres above those required to produce feed for the dairy herd,

(d) varying the dairy ration. Proportion of roughage dry matter in the feeding component:

(1) 100 percent from hay crops,

(2) 50 percent from hay crops, 50 percent from corn silage,

(3) 7 pounds hay equivalent per cow per day, remaining from corn silage.

(e) growing only cash crops for sale.

Each strategy category, a through e, is examined for three differing time periods: the relatively stable price-cost period of the 1960s, the more variable period 1970 to 1974, and the total period, 1960 to 1974.

Methodology

In order to evaluate management strategies, a knowledge of possible future income variation is needed. Obviously, information on the future is not available. However, it may be assumed that the patterns of weather and other variables affecting production and incomes tend to be repetitive in nature. If so, the historical data of the type presented earlier may provide an adequate basis for predicting patterns for the future and therefore, for evaluating alternative strategies.

Sources of Data

To measure the production variability of crop enterprises, data on yields for individual farms over a period of years are needed. Unfortunately, these data are not readily available. For this study Crop Reporting Service estimates for Eaton County, Michigan, were used.

Milk production and the dairy livestock production activities are assumed to be constant. That is, fixed quantities of feed are required to produce a hundred pounds of milk or gain in weight. However, the cost of purchased and grown feed is variable. Therefore, for livestock enterprises, the sources of variability are price and cost related, the same as for crop incomes. But, an added impact on whole farm income is felt because livestock do require a fixed amount of feed and thus, net farm income is also affected by an increase or decrease in sales of cash grains in good yield or bad yield years.

Price variability is measured on a harvest or selling time basis with the prices quoted being at the local elevator, or livestock market level in south-central Michigan.

Additional data sources used are the Telfarm Farm Records Project of Michigan State University; and Telplan, a computerized farm management decision aid package also of Michigan State University. Telfarm and Telplan data were the major sources of data for construction of the representative dairy farm. Additional sources too numerous to mention were also utilized and are quoted at the point of their use.

Construction of a Synthetic Dairy Farm

A synthetic dairy firm was constructed so as to have the same internal and external characteristics as a typical dairy farm in south-central Michigan. Due to the large number of dairy business management strategies examined (thirty-seven), only one herd size is analyzed. An 80 cow dairy farm with a feeding system, milking and housing system, field and manure handling machinery, and acreage are specified which are believed to be representative of south-central Michigan.

Calculation of Level and Variability of Net Income Before and After Taxes

The level and variability of net income before and after taxes of thirty-seven dairy business management strategies are calculated using the actual prices, yields,

and estimated costs in each of the years 1960 to 1974. This was accomplished through a transformation subroutine of a computerized regression package. The subroutine added the various enterprise gross incomes, subtracted production costs and yielded the net income before taxes figure.

In further analysis, selected strategies were examined for level and variability of income after taxes. This calculation was performed by Telplan Program five.[2]

Presentation of Results

The results of the level and variability of net income calculations are presented in an income opportunity framework. Income opportunity points serve as a means of studying the relationships between selected resource and management strategy situations. The points are constructed by plotting the average income and its standard deviation or standard error of the estimate of regression for each strategy on an X - Y axis. Points are used rather than a continuous function due to the relationships assumed among strategies. That is, a farmer will either raise all of his replacements or he will purchase all of his replacements.

Results of the study are also presented in graphic form, showing mean income, variability estimates, and the range of the observations providing for further analysis.

Outline of Disseration

Chapter II contains a review of the literature pertaining to methods of calculating and measuring yield and

income variability. Chapter III presents the estimates of commodity prices, input costs, field crop yields, labor and investment requirements, and the costs and returns for milk, veal, dairy beef, and field crop production.

Chapter IV describes the analytical model, its linear programming and regression components, and the method of calculating net income variability. Chapter V contains the empirical findings of the net income before tax calculations and Chapter VI contains the net income after tax findings and implications.

The last chapter, Chapter VII summarizes the study, its objectives, methodology, empirical findings, and implications.

Chapter I Footnotes

[1]A distinction is made in this research effort between a strategy, and a tactic. When used in this study, a strategy is a long-run commitment to a particular farm organization. In contrast, tactics are within year or short-run decisions. The decision to produce milk; invest in buildings, equipment, and livestock is a long-run decision, a strategy. A tactical decision would be the choice of a feed supplement.

[2]The Telplan System involves the sharing of computer expertise for educational purposes in either the classroom or extension work with farmers, consumers, agribusinesses, and others. There are over 50 programs available on the system. These programs range from a capital investment model and a least cost dairy ration model to a model of human nutrition.

CHAPTER II

REVIEW OF LITERATURE AND RELEVANT THEORY

Introduction

Risk and income variability have been the topics of many research efforts in agricultural economics. Much of the empirical work was associated with Great Plains agriculture where yields were highly variable. Yet, as a result of recent increased variability in prices and costs, more effort has been given to this task in the Mid-West as well.

The purpose of this chapter is to briefly review some of the methods used in past research efforts to measure and evaluate income variability and to discuss the relevant theory. No attempt was made to summarize all research efforts dealing with risk and uncertainty in agriculture. Only major works directly relating to this research problem are summarized.

Review of Literature

A publication entitled "Studies in Yield Variability" by Bostwick[1] completed in 1963 examined the winter wheat yield variability in Montana. The objective of this research was to determine prior yield variability and construct yield probability functions to assist managers in

making planning decisions. This was accomplished through the use of the extreme value statistical distribution with the data being 5,000 wheat yield observations over thirty-five years.

Oklahoma State University publications entitled "Production and Income Variability of Alternative Farm Enterprises in Northwest Oklahoma"[2] and "Income Variability of Alternative Plans, Selected Farm and Ranch Situations, Rolling Plains of Northwest Oklahoma"[3] were completed in the early 1960s. The first publication was designed to estimate production, price, and income variability of major crop and livestock enterprises. The second publication estimated the income variability of different enterprise combinations and determined the probable effect on capital accumulation and survival of farm operators using the alternative plans. The later research effort presented the results of the study in an income opportunity framework. This income opportunity framework allows the returns and variability estimates of alternative farm organizations to be examined with the farmer deciding on the level and variability of income which meets with his preferences.

Heady, Kehrberg, and Jebe[4] at Iowa State also were involved in estimation of income variability. Their publication "Economic Instability and Choices Involving Income and Risk in Primary or Crop Production" involved measuring variances and correlation coefficients of income from various enterprises. These enterprises were combined into a farm

organization with an income variability measured by a mathematical formula. That formula stated that the variance for the whole farm is the sum of the variances of the enterprises plus the covariance of the enterprises. This formula was then expanded to account for the proportion of the enterprises in the total farm. With this method of calculation many different combinations and proportions of enterprises could be easily examined. However, when the number of enterprises combined was three or greater, the formula becomes complicated and makes variability calculations difficult. The Iowa State study, like the Oklahoma studies, presented the results in an income opportunity framework. A graph was constructed which easily depicted the trade-offs between income and variability.

In a more recent empirical research effort, Scott and Baker[5] described, "A Practical Way to Select an Optimum Farm Plan Under Risk." The Scott and Baker effort differs from those research efforts previously discussed in that a quadratic programming model was used to generate income variabilities. The quadratic programming model incorporates income variances and covariances of possible enterprise combinations. The model also contains a risk aversion coefficient, but no one has been able to quantify a correspondence between a risk aversion coefficient and a decision maker's utility functions. This model has therefore had little empirical use in that regard. The quadratic programming risk aversion model is the same as a linear programming

model with one exception, That is the risk aversion coefficient. By varying the values of the risk aversion coefficient, points on the efficient frontier will result. This model works well for cash crops, but modifications would be needed for fixed animal units. Here again, as in the past reviewed works, an efficient frontier or income opportunity framework is presented which allows the decision maker to choose the level and variability of income which meets with his preferences.

Bary and Robinson[6] follow the analysis of Scott and Baker that farmers are capable of processing risky information in terms of their own risk-return preferences. But, they are concerned that risk results are somewhat obscure and may not lead to the best choice. They apply a lexicographic utility analysis to extend that treatment of risky information. In their model, the decision maker first determines a threshold level of income and the probability with which incomes must exceed this level. Next, the decision maker identifies portfolios that meet the threshold income, and finally chooses among qualifying plans on the basis of highest expected values.

Just[7] in the journal article titled, "Risk Aversion Under Profit Maximization" explores the alternative explanation of risk aversion behavior of the firm based not on utility maximization but rather on expected profit maximization. He points to the fact that in utility maximization, where both price and quantity variation can be important,

profit maximizers are sensitive only to quantity variability. The implications of the Just article are that care must be taken in empirical analysis of firm behavior in order to discern between profit maximization and maximization of some nonlinear (mean-variance) utility function. The problem of a sometimes highly correlated price--production value may make it impossible to show that production variability is not the underlying reason behind empirical significance of price risk models. Thus, he concludes that emphasis should be placed on the importance of considering risk in agricultural supply response models, and that these studies can correctly ignore changing production risk even if producers are profit maximizers.

"Measuring Farmers' Trade-Offs Between Expected Income and Focus-Loss Income" by Webster and Kennedy[8] examines the other aspect of the previously discussed risk models. In the study, they estimated sets of indifference curves for five farmers who were willing to forego expected income for increases in a probabilisticly defined minimum income. The information obtained through the quadratic utility function was to be used for predictive purposes and in farm planning.

Relevant Theory

Risk and Uncertainty

Many economic principles are based upon the assumption that the future can be predicted with a specified degree of accuracy. However, as necessary as the estimates of the

future are, they cannot be known with total accuracy. Yields, prices, and costs in the future are not known and are very difficult to predict with a high degree of accuracy. The lack of perfect knowledge therefore influences decisions, the application of economic principles, and the treatment of farm management problems.

Frank Knight outlined the degrees of knowledge in 1921.[9] Professor Knight's classification was as follows:

I. Perfect Knowledge

II. Risk

   a. a priori

   b. statistical

III. Uncertainty

If perfect knowledge were available, the choices of a decision maker would be greatly simplified. Strategies could be mapped for an indefinite period of time into the future and the precise outcome would be known. As perfect knowledge is not found in actual conditions, no further comments on this classification will be made.

A risk situation exists when the future can be predicted with a specified degree of probability. With a risk situation, the chances of a specific event occurring are known.

Knight has two subclasses of risk. The first is a priori, the second statistical. When adequate information is known in advance about the general possibilities and the probability of a specific event occurring, a priori

probability prevails. Statistical risk results when the probability of a future event can be stated on the basis of many observations.

Knight's final classification, uncertainty, results when there is no basis for assigning a probability to future events. The decision maker must decide what outcome is most likely and commit his resources to that strategy.

In recent years, a distinction has been made in the classification of uncertainty. A decision maker may find himself in one of the following situations:[10]

1. Inaction
2. Learning
3. Involuntary Learning
4. Forced Action
5. Risk Action

Inaction occurs when one believes that the marginal cost of learning is greater than the marginal revenue or utility, therefore, no action is taken. Learning occurs when the marginal cost of acquiring information is less than the marginal utility derived from that information, therefore additional learning is profitable. An involuntary learning situation results when the decision manager is unwilling to learn, but an outside force makes it necessary to learn or some learning occurs regardless of the volition of the manager. Forced action occurs when the decision makers information is inadequate for him to decide, yet an outside force makes it necessary for him to act. When the marginal cost of acquiring

additional information equals the marginal revenue from obtaining information a risk action situation occurs. The action may be the decision to act or the decision not to act.

Decision Making Under Risk and Uncertainty

The relaxation of the perfect knowledge and foresight assumption makes risk, uncertainty, and learning aspects of management with respect to institutions, technology, human elements, and prices necessary. As these assumptions are relaxed, the following decision criteria become relevant in the determination of the appropriate strategy.

Under risk situations, the probability distributions for each state of nature are known. For each strategy, the outcome under each state of nature is multiplied by the probability attached to it and summed for all the states of nature to arrive at an expected value. Then strategy with the highest expected value is the most desirable.

However, under uncertainty situations, no knowledge of the probability distributions exist. The following decision rules become relevant in these situations.

Maximin Criterion

Wald[11] suggests that one examine the minimum gain associated with each action and then take the action that maximizes the minimum gain. This is a pessimistic criterion that directs attention to the worst outcomes and then makes the worst outcome as desirable as possible.

Maximax Criterion

When following the maximax strategy, the decision maker would choose that plan of action which has the maximum possible value as an outcome under the specified states of nature. An individual following this strategy is likely assuming more risk, i.e., a gambler.

Minimax Regret Criterion

Savage[12] suggested that a transformation of the gains table to a regret table and then the application of the minimax criterion is an improvement over the Wald formulation. If the decision maker takes an action and the state of nature occurs for which the gain is largest for this act, then he will have no regret. However, if he takes an action for which the gain is not the largest, and that same state of nature occurs then he will have a regret of the difference between the largest gain and that which he receives. These regrets as described above are calculated for each state of nature and the Wald criterion applied.

Hurwicz Index

Hurwicz[13] suggests that a weighted combination of the maximum and minimum gain be calculated and then choose the action with the highest weighted value. The method of obtaining the weights for use with the Hurwicz index is highly subjective and at the present time no one has suggested doing this with decision makers.

Laplace Criterion

If a decision maker is completely ignorant of which state of nature might occur, one could assume equal weights calculate the expected gain for each act and take the act with the largest expected gain. This decision criterion is known as the Laplace criterion.[14]

Minimum Variance

The minimum variance decision rule is to choose that strategy which has the smallest range of outcomes. One who follows this strategy would be much more certain of the outcome than one who followed the other decision rules previously discussed.

Uncertainty Precautions

Flexibility and diversification are management strategies which can be used to off-set changes in prices, costs, and yields. Flexibility involves planning in such a way that new information can be taken into account as it becomes available. An example of flexibility would be farm buildings or field machinery which can be used to house different types of livestock or in the production of many differing crops.

Flexibility can be of three types: (a) time, (b) cost, and (c) product. Time flexibility can be introduced into the strategy either through selection of products or production processes. Apple production, a product which requires several years to begin production and then remains in production several more years is a highly inflexible crop in comparison to

corn or wheat production. The production process also allows for flexibility. Steers which are fed low quality forage through the winter months, allowing for more time in which to decide upon a weight at which to market provides more flexibility than feeding steers a high grain ration immediately. Feeding such a high grain ration usually necessitates feeding to a higher slaughter grade.

Cost flexibility is important when time flexibility is limited. Cost flexibility allows for changes in output or selection of inputs within a long-lived physical plant. It makes the expansion or contraction of output as prices dictate possible. Farmers sometimes choose low cost calf housing on dairy farms rather than the more permanent slatted floor automated units. The low cost housing allows for cutbacks in numbers or the elimination of the calf enterprise without serious cost consequences.

Product flexibility is important also. In the case of raising dairy calves, they can be sold as deacons, veal, or dairy beef. Calves therefore allow for more flexibility than the purchase of feeder steers for resale as slaughter animals.

The management strategy which will be most closely examined in this study is diversification. Diversification is a means of profit maximization through reaping the gains of complementary relationships and in equating substitution and price ratios for competitive products. It can also be employed as an uncertainty precaution where the immediate objective is not one of profit maximization but one of stability of income.[15]

Diversification may be followed as a fixed or inflexible plan for production. As an uncertainty precaution it is generally followed to lessen income variability or the probability of income falling below some critical level; it incorporates no special provisions for reaping large gains. In contrast, flexibility may be incorporated into production plans to both lessen income variability from one year to the next and to increase the expected total value of the income stream.

Diversification is mainly a method of preventing large losses; flexibility is more nearly a method of preventing the sacrifice of large gains.

Diversification can be accomplished by:

(1) increasing the amount of resources used, and

(2) the resource level is held constant, and part of the resources are shifted to other enterprises.

The general form of the equation which calculates the total income variation as a result of enterprise combinations is:

$$\sigma_{\tau}^2 = \sigma_A^2 + \sigma_B^2 + 2q\ \sigma_A\ \sigma_B$$

where:

σ_{τ}^2 = total income variation of the operation,

q = the correlation coefficient between enterprise A and B, and

σ_A, σ_B = the standard deviations of A and B.

However, when two enterprises are combined, the proportions of A and B in the total are important. The equation

now becomes:

$$\sigma_{\tau}^2 = P^2 \sigma_A^2 + (1-p)^2 \sigma_B^2 + 2q(P)(1-P) \sigma_A \sigma_B$$

where:

P = the proportion of A in A + B.

The above stated enterprise income variability relationships are examined more fully in a later chapter.

Managers Utility Functions

The theory of utility and consumer choice are very much a part of economic theory.[16] They are easily transferred to a theory of managerial choices among risk situations. In Figure 1, a hypothetical managerial utility function depicting the relationship between income and variability of income has been drawn.

All points on this curve are points which the manager or decision maker is indifferent between. Point A, a low income-low variability position, and Point B, a high income-high variability position are points of indifference to the decision maker whose preferences this curve represents.

One now needs to draw a curve which represents the possible strategies or combinations of resouces which forms curve 2 in Figure 1. This curve depicts the actual trade-off between income and variability which exists in the strategies examined.[17] The point at which the two curves intersect and have the same slope is the efficient point for attainment of that specified level of utility depicted by curve 1.

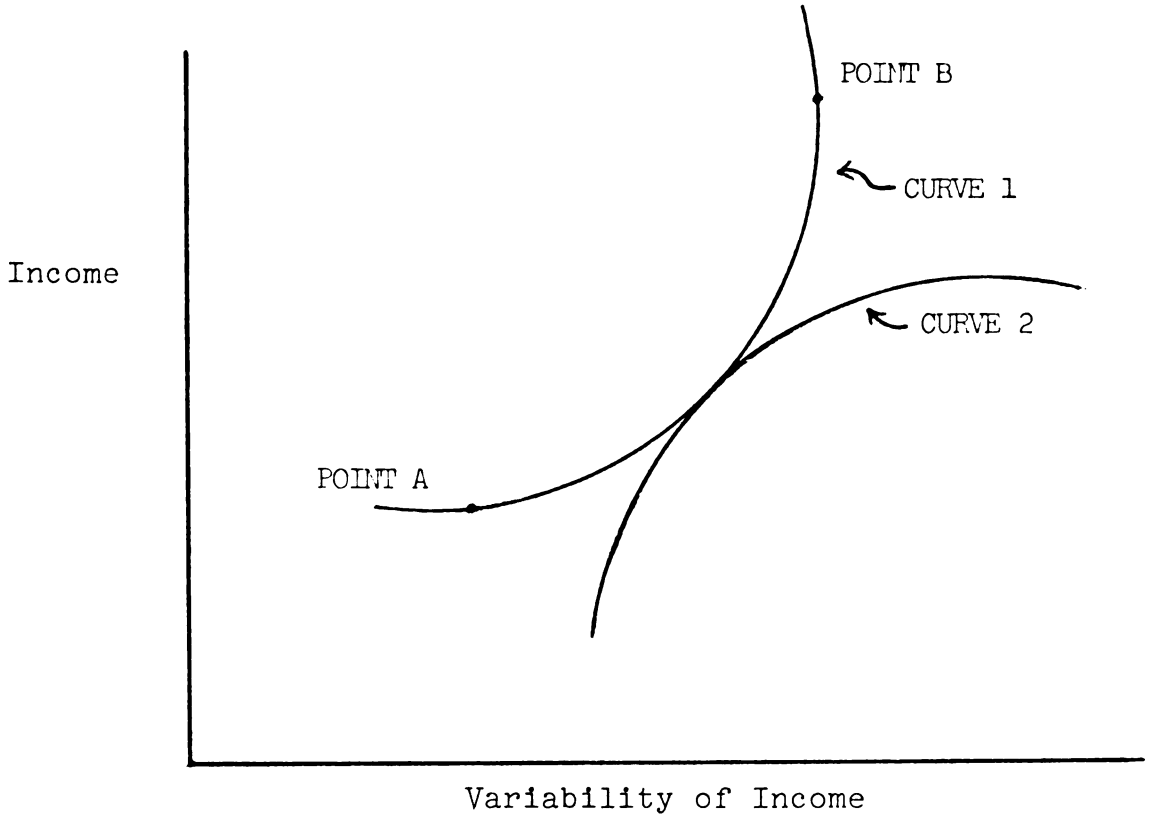

Figure 1. Income opportunity and utility curves.

The decision maker's problem of choosing strategies is not as simple as presented above. An infinite number of curves like curve 1 exist only at different levels of utility or satisfaction. Also, when certain fixed factors are considered, a smooth curve does not result and only points which cannot be connected remain to be analyzed.

As curve 1, the decision maker's utility curve is different for each decision maker, broad statements as to desirability of resource combinations where trade-offs exist cannot be made. And as yet a satisfactory measure of utility has not been discovered, so curve 1 is relatively useless for

broad interpretations. This research will therefore center on the analysis of curve 2, the possible combinations of resources and the corresponding trade-offs with income and variability. By doing so, the decision maker is left to match his preferences as to level and variability of income with strategies.

Chapter II Footnotes

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[12]Ibid.

[13]Ibid.

[14]Ibid.

[15]Heady, Earl O., Economics of Agricultural Production and Resource Use (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1952), pp. 500-518.

[16]For a more complete description, see Braff, Allan J., Microeconomic Analysis (New York: John Wiley and Sons, Inc., 1969), Chapter Three.

[17]Curve 2 is not a true opportunities line because of the assumption of nondivisible units of input.

CHAPTER III

SYNTHETIC FIRM AND SOURCES OF DATA

Introduction

In order to determine the level and variability of the selected business management strategies, a synthetic firm was developed which simulates milk production, dairy livestock production, and selected field crop enterprises. The synthetic firm is designed to be a "representative" dairy farm within the specified production technology-herd size category. The firm is representative in the sense that it exhibits the same internal and external characteristics as those found in south-central Michigan. That is, a given synthetic firm represents a population of dairy farms which have essentially the same input-output relationships and have similar input and product market situations.

As a linear programming and regression model is employed, the construction of synthetic firms involved the estimation of prices of inputs and outputs, the level of constraining resources, and the input-output relationships. Also, estimates of the capital investments required for each of the synthetic firms are needed.

Variability of Prices, Costs, and Yields

A time series estimate of farm product prices and field crop yields for the years 1960 to 1974 was taken from market information in south-central Michigan and Michigan Crop Reporting Service estimates of yields for Eaton County, Michigan. Prices of the commodities used in this study are the actual prices paid by local elevators, livestock markets, or by milk marketing associations in south-central Michigan. Yield averages in Eaton County are used to estimate variability of crop production. For the purpose of this study, the same variability is used only with slightly higher yields to reflect above average management.

Cost of production time series data were estimated by a different method. Given the cost of production for the 1975 year, indices of the major components of each enterprise cost of production were used to estimate past years' cost of production. Fertilizer, supplies, fuel, hired farm labor, and building materials cost indices were used to estimate the various enterprise cost of production figures. These time series estimates of costs, prices, and yields are used in the regression analysis and presented in Appendix A.

Price and Cost Estimates

The estimates required to develop the synthetic firms were derived by examining data from a number of sources and making judgements on these data.

The prices of most inputs in the milk production,

livestock production, and crop production activities are relatively standardized and are referenced as presented. However, some prices require further discussion and are so presented below. (Note these prices and costs are for the year 1975.)

Milk

A price estimate for milk of $8.60 per cwt. is based on the prevailing base milk price.

Land

All crop producing land is assumed to be in the Soil Conservation Service Land Capability Class I or II. An average price of $600 per acre is assumed.

Labor

Although some of the producers represented by the synthetic firms normally have full-time hired labor and/or additional family labor, the assumption for this study was that labor required beyond that available from the operator would be hired on an hourly basis. It is assumed that labor could be hired as needed at a wage of $3.25 per hour.

Constraints

The only resources assumed to have a limited availability for the purpose of this study are operator labor and land. It is assumed that the direct operator labor availability is 50 hours per week for 50 weeks, or 2,500 hours per

year. Although survey information indicates that Michigan dairy farmers work close to 60 hours per week, 10 hours are deducted for time to do miscellaneous chores, repairs, and up-keep of equipment and buildings.[1]

In addition to the constraint on operator labor, a restriction is placed on the number of cows in the dairy herd. Thus, for the synthetic firm, the size of the herd is predetermined at 80 cows and forced into the solution at that level. This constraint, in turn, is the crucial factor in determining total labor, land required to grow feed for the herd, and capital requirements of the dairy farm.

Total operator labor availability and feed requirements for the dairy herd are shown in Tables 4 and 5. Table 6 presents the total crop acres assumed in each synthetic firm. These acreages are averages from those farms reporting on the Telfarm system.

Labor Requirements

The labor requirements for the production activities are shown by month in Table 7. Estimates include the time required to do milking, including time to collect cows, prepare and clean equipment, feed both forage and grain; and the time required for complete waste handling, including bedding.

One herd size (80 cows) was analyzed. Open lot, free stall housing is assumed with a double four herringbone milking parlor.

It is assumed that the feed is stored in concrete tower silos equipped with mechanical unloaders. With open lot

housing, the feed is unloaded directly into the feed bunks.

Table 4. Restrictions on Operator Labor Availability.

Month	Hours of Labor
January	220.7
February	199.4
March	220.7
April	213.6
May	220.7
June	213.6
July	220.7
August	122.0[a]
September	213,6
October	220.7
November	213.6
December	220.7
TOTAL	2,500.0

Source: Good, Darrel, "Potential Impact of Environmental Pollution Abatement Alternatives on the Michigan Dairy Farming Industry," Unpublished Ph.D. Thesis, Michigan State University, 1972.

[a]Two weeks vacation are assumed during the month of August.

Wastes are assumed to be handled as a solid and are stored with the open lot system. A tractor equipped with a front end loader and scraper blade is utilized to collect and load the manure.

For the crop production activities, Telfarm estimates of labor needed on the specified farm size were used.

Table 5. Annual feed needs per cow and per cow and replacement at 14,000-pound milk production level.

	Per Cow and Replacement			Per Cow		
	Ration[a]			Ration[a]		
	A	B	C	A	B	C
Hay Crop Silage (Tons)	11.3	26.5	5.4	9.3	22.3	3.8
Corn Silage (Tons)	11.6	-	15.1	9.75	-	13.2
Corn Grain (Bu.)	65.3	95.9	57.6	39.3	67.7	31.1
Soybean Meal (Lbs.)	750	50.0	1350	675	25.0	1300
Di-Cal Phosphate (Lbs.)	52.1	27.6	64.3	52.1	27.6	64.3
Salt (Lbs.)	50.0	50.0	50.0	50	27.6	50.0
Limestone (Lbs.)	0.0	0.0	6.0	0.0	0	6.0

[a]Ration A is a ration containing 50% forage dry matter from haylage and 50% from corn silage. Ration B contains 100% from hay crops, and Ration C contains 7 pounds hay equivalent per cow per day, the rest corn silage.

Source: Telplan Program Two, Michigan State University, Department of Agricultural Economics.

Table 6. Owned and Rented Acres in the Representative Dairy Farm.

	Acres[a]
Owned	265
Rented	118
TOTAL	383

[a]Tillable acres.

Source: Telfarm Data, Michigan State University, Department of Agricultural Economics, 1974.

Investment Requirements

The capital investments for the synthetic firms are presented in Tables 8, 9, and 10. All investments are at a 1975 new price level.

The investment requirements which are unaffected by dairy ration are presented in Table 8. A value of $650 per dairy cow was assumed. While the price of livestock varies, the prices assumed for the dairy cows and other livestock are averages for the specified quality in south-central Michigan.

The field cropping equipment investment is an estimate of a machinery complement likely to be found on an 80 cow dairy farm. The prices are again on a 1975 price level and the prices of individual items are shown in Appendix Table A6.

Items from Tables 8, 9, and 10 are combined in Table 11 to give the total investment requirements for each of the 37 business management strategies analyzed. In addition, labor required above operator labor is presented.

Table 7. Estimated labor requirements.

Labor Period	Milk and Livestock Production				Crop Production Activity				
	80 Cows	80 Cows +R	Dairy Beef	Veal	Alfalfa Haylage	Corn Grain	Corn Silage	Soybeans	Wheat
					Hours Per Acre				
January	2.7	3.9	1.2	.6	-	-	-	-	-
February	2.4	3.5	1.2	.6	-	-	-	-	-
March	2.7	3.9	1.2	.6	-	.25	-	-	-
April	2.6	3.7	1.2	.6	.12	.5	.5	.61	-
May	2.7	3.9	1.2	.6	1.3	.62	.62	1.26	-
June	2.6	3.7	1.2	.6	1.2	.5	.5	.56	-
July	2.7	3.9	1.2	.6	2.5	.12	.12	.69	.88
August	2.7	3.9	1.2	.6	.63	.12	.12	-	1.33
September	2.6	3.7	1.2	.6	1.8	1.25	2.5	.61	1.47
October	2.7	3.9	1.2	.6	-	1.5	2.5	.61	-
November	2.6	3.7	1.2	.6	-	.37	.25	-	-
December	2.7	3.9	1.2	.6	-	-	-	-	-
TOTAL HOURS	31.7	45.6	14.4	7.2	7.55	5.23	7.11	4.34	3.68

Sources: Darrel Good, "Potential Impact of Environmental Pollution Abatement Alternatives on the Michigan Dairy Farming Industry," Unpublished Ph.D. Dissertation, Michigan State University, 1972. And Telfarm Estimates, Michigan State University, 1974.

Table 8. Investment requirements for dairy farms of items unaffected by dairy ration.

Investments		80 Cows
Freshening Milk Cows		52,000
Bred Heifers		16,800
Open Heifers		9,600
Calves, Under 6 Months		1,350
Bulk Milk Tank		7,400
Milking System and Building		33,400
Field Cropping Equipment		62,730
Feed Handling Equipment		2,700
Manure Handling		23,506
Milk Cow Housing		39,397
Replacement Housing		9,200
Machinery Storage		3,600
Land	(265 Acres @ 600/A)	159,000
TOTAL		420,683

Sources: Telplan 02, Michigan State University and Dairy Systems Analysis Handbook by C. R. Hoglund, Federal Extension Service Sponsored, Michigan State University, unpublished.

Table 9. Investment requirements of items affected by dairy ration.

	Corn Silage Storage	Hay Crop Silage Storage	Grain Storage	Total
	----------Dollars----------			
80 Cows				
With Replacements				
Ration: A	17,674	28,924	14,627	61,225
B	-	67,795	16,441	84,236
C	23,002	13,838	14,207	51,047
Without Replacements				
Ration: A	14,820	24,296	13,039	52,155
B	-	57,070	14,719	71,789
C	20,050	12,326	12,587	44,963

Source: Telplan Program Two.

Table 10. Dairy Livestock Investment Requirements.

	Building	Equipment
	---------Dollars---------	
Veal	57.50	15.00
Dairy Beef	120.00	25.00

Source: Speicher and Brown, "Costs of Raising Replacements," Michigan State University, Departments of Dairy Science and Agricultural Economics, 1971. Updated to 1975 price levels.

Estimated Cash Costs and Returns for Field Crops

The estimated cash costs and returns for field crops are presented in Table 12. These costs which are also on a 1975 price level include all cash costs with the exception of interest and property taxes.

Estimated Cash Costs and Returns for Livestock and Dairy Enterprises

Presented in Tables 13 and 14 are the estimated costs of milk production. Table 13 contains those costs which do not vary with ration and Table 14 presents those costs which do vary. Table 15 is a summary table which totals the costs of production.

Table 16 sums the costs from Table 15 with the costs of home grown feed production. As less feed is required when replacements are not raised, the cash costs of production are less. A comparison of rations A, B, and C finds Ration C (high corn silage) to be the most costly, Ration B (high haylage) to be least costly, and Ration A (haylage and

Table 11. Labor and investment requirements, strategies 1 through 37.

	STRATEGY	Labor[a]	Investment[b]	1975 Net Income[c]
1.	RA,R,D,C	3,495	481,908	74,077.95
2.	RB,R,D,C	3,777	504,919	47,555.09
3.	RC,R,D,C	3,621	471,730	76,132.98
4.	RA,BR,D,C	2,288	435,888	91,647.31
5.	RB,BR,D,C	2,583	483,272	69,301.61
6.	RC,BR,D,C	2,279	428,696	93,387.68
7.	RA,R,DB,C	4,229	490,728	80,912.38
8.	RB,R,DB,C	4,512	513,739	54,384.71
9.	RC,R,DB,C	4,160	480,550	84,567.40
10.	RA,BR,DB,C	3,354	493,405	100,304.39
11.	RB,BR,DB,C	3,591	466,486	77,958.70
12.	RC,BR,DB,C	3,288	439,660	102,044.77
13.	RA,R,V,C	3,869	485,678	72,768.35
14.	RB,R,V,C	4,151	508,689	46,245.49
15.	RC,R,V,C	3,995	475,500	74,823.38
16.	RA,BR,V,C	2,662	441,108	89,834.51
17.	RB,BR,V,C	2,957	460,742	67,488.81
18.	RC,BR,V,C	2,653	433,916	91,574.88
19.	RA,R,D,C-W	3,373	497,840	70,274.60
20.	RB,R,D,C-W	3,630	520,851	46,183.39
21.	RC,R,D,C-W	3,511	487,662	71,456.73
22.	RA,BR,D,C-W	2,186	451,550	83,758.81
23.	RB,BR,D,C-W	2,446	471,454	65,872.36
24.	RC,BR,D,C-W	2,108	444,628	86,466.83
25.	RA,R,DB,C-W	4,108	505,148	77,296.08
26.	RB,R,DB,C-W	4,412	528,159	52,888.31
27.	RC,R,DB,C-W	4,029	496,482	79,953.50
28.	RA,BR,DB,C-W	3,194	458,720	94,992.29
29.	RB,BR,DB,C-W	3,453	482,418	74,778.85
30.	RC,BR,DB,C-W	3,146	455,592	95,747.42
31.	RA,R,V,C-W	3,740	501,610	68,965.00
32.	RB,R,V,C-W	4,049	524,621	42,442.14
33.	RC,R,V,C-W	3,851	491,432	70,197.13
34.	RA,BR,V,C-W	2,463	457,040	84,223.01
35.	RB,BR,V,C-W	2,819	476,674	64,059.56
36.	RC,BR,V,C-W	2,474	449,848	84,654.03
37.	C-C-S-W	-	241,267	46,842.48

[a]Above 2,500 operator hours.

[b]1975 new price levels.

[c]1975 prices, costs, and average yields.

Key to Abbreviations in Table 11.

The abbreviations used in the table are interpreted as follows:

RA: Feed Ration A (50% forage dry matter from haylage, 50% from corn silage)

RB: Feed Ration B (100% forage dry matter from haylage)

RC: Feed Ration C (7 lbs. hay equivalent per cow per day, remainder is corn silage)

R: Raise Replacement Stock on Farm

BR: Buy Replacement Stock

D: Sell Excess Calves as Deacons

DB: Sell Excess Calves As Dairy Beef

V: Sell Excess Calves as Veal

C: All Corn grown on Excess Crop Acres

C-W: A 50-50 Corn-Wheat Combination Grown on Excess Crop Acres

C-C-S-W: A Corn-Corn-Soybeans-Wheat Rotation on Excess Crop Acres

Table 12. Estimated cash costs and returns per acre for field crops.

	Corn Grain (Fed)	Corn Grain (Sold)	Corn Silage	Haylage	Wheat	Soybeans
Yield Target	100 bu.	100 bu.	13 T.	10 T.	45 bu.	30 bu.
Gross Income	--	250.00	--	--	153.00	150.00
Cash Expenses:						
Fertilizer,						
Nitrogen (lbs.)	(100) 17.00	(100)17.00	(130) 22.10	(0) 0.00	(60) 10.20	(10) 1.70
Phosphoros (lbs.)	(50) 12.50	(50)12.50	(60) 15.00	(37) 9.37	(75) 18.75	(25) 6.25
Potassium (lbs.)	(50) 6.00	(50) 6.00	(60) 9.60	(75) 9.00	(50) 6.00	(25) 3.00
Seed (bu.)	(.23) 11.00	(.23)11.00	(.23) 11.00	(216) 4.00	(1.75) 13.10	(.83) 12.90
Lime	.70	.70	.80	.80	.70	.70
Herbicide, Other Chemicals	9.00	9.00	9.00	2.00	--	9.00
Fuel & Repair	12.00	9.00	14.50	14.00	7.00	8.00
Hauling	5.00	10.00	13.00	10.00	4.50	3.00
Utilities	3.40	3.40	.70	.70	3.40	3.40
Drying & Marketing Cost	--	19.50	--	--	--	--
Miscellaneous	1.70	1.70	.80	.80	1.70	1.70
Total Cash Expenses/ Acre	78.30	99.80	96.50	50.67	65.35	49.65

Source: Enterprise Budgets, Michigan State University, Department of Agricultural Economics, Unpublished, 1975.

Table 13. Estimated costs and receipts of items unaffected by dairy ration.

Item	Dollars/Cow + R/Year	Dollars/Cow
Breeding[a]	15.00	14.00
Veterinary[b]	27.65	22.95
Supplies[b]	14.45	13.44
Taxes[b]	4.80	3.51
Milk & Livestock Marketing[b]	55.80	56.38
Machinery Repairs[b]	26.30	26.30
Improvements Repairs[b]	7.45	5.43
Fuel, Oil, and Grease[b]	4.15	4.15
Insurance[b]	5.90	5.90
Utilities[b]	22.05	16.10
Bedding[b]	12.50	12.50
Tractor Power[b]	18.10	18.10
Miscellaneous[b]	5.05	3.68
Total Cost/Year	219.20	207.44
Livestock Sales (Cull Cows & Calves)	117.25	133.50

[a]MABC Rates for 1975.

[b]Telfarm Data.

Table 14. Cash costs of purchased feed inputs.

	Dollars Per Cow Plus Replacement			Dollars Per Cow		
	Ration			Ration		
	A	B	C	A	B	C
Soybean Meal[a]	56.25	3.75	101.25	50.63	1.88	97.50
Di-Cal Phosphate[b]	7.55	4.00	9.32	7.55	4.00	9.32
Salt[c]	1.75	1.75	1.75	1.75	0.97	1.75
Limestone[d]	0	0	0.25	0	0	0.25
TOTALS	65.55	9.50	112.57	59.93	6.85	108.82

[a]Soybean Meal @ $150/T.

[b]Di-Cal @ $14.50/cwt.

[c]Salt @ $3.50/cwt.

[d]Limestone @ $4.20/cwt.

Source: Telplan Program Two.

Table 15. Total cash costs per cow of milk production (less on-farm grown feeds).

Cash Cost	80 Cows					
	With Replacements			Without Replacements		
	Ration			Ration		
	A	B	C	A	B	C
General Cost	188.60	188.60	188.60	171.84	171.84	171.84
Bedding & Tractor Power	30.60	30.60	30.60	30.60	30.60	30.60
Purchased Feed	65.55	9.50	112.57	59.93	6.85	108.82
SUBTOTAL	284.75	228.70	331.77	262.37	209.29	311.26
Livestock Sales	-117.25	-117.25	-117.25	-133.50	-133.50	-133.50
TOTAL	167.50	111.45	214.52	128.87	75.79	177.76

Table 16. Total cash cost of milk production (purchased and grown).

	80 Cows					
	With Replacement			Without Replacement		
	Ration			Ration		
	A	B	C	A	B	C
Purchased Inputs	284.75	228.70	331.77	262.37	209.29	311.26
Grown Feed	190.84	208.91	184.85	151.49	166.07	141.85
Total	475.59	437.61	516.62	413.86	375.36	453.11

corn silage) to be in between in costliness. An offsetting variable is the fact that the high corn silage ration requires less acres for producing feed for the dairy herd. Thus, crops for cash sales or additional feeds can be grown on these acres. (This will be further evaluated in Chapter V.)

Table 17 contains the estimated costs of raising dairy calves to a veal market weight and dairy beef animals to market weight.

The total cash cost of veal production (less labor costs) is $84.50 assuming all feed requirements are purchased.

Dairy beef costs of production are $57.63 for a heifer and $60.31 for a steer (plus $84.50 required to attain veal market weight). It is assumed heifers are sold at a weight of 800 pounds and steers at 880 pounds. At these weights, the animals should grade standard.

Table 17. Estimated costs of raising dairy calves.

	Birth To 6 Months	6 Months to 12 Months	12 Months To 24 Months
Cash Costs:			
Operating			
Veterinary	3.00	1.50	1.50
Electricity & Supplies	6.00	2.00	2.00
Bedding	5.00	5.00	12.00
Power & Machinery	2.00	2.00	2.00
Feed (Veal)			
Milk or Equivalent	300 lbs.	@ 7.00/cwt 21.00	
Calf Starter	250 lbs.	@12.00/cwt 30.00	
Growing Ration	285 lbs.	@ 7.00/cwt 19.95	
Hay	600 lbs.	@43.0/T 12.90	
Trace Mineral Salt	5 lbs.	.20	
Mineral	5 lbs.	.45	
Total Cost		84.50	
Feed (Dairy Beef) Basic Ration Concentrate			
44% Soybean Meal		923 lbs. 69.23	
Dical		26 lbs. 3.77	
Limestone		16 lbs. .67	
Salt		35 lbs. 1.23	
		74.89	
Heifers (To 800 lbs.)			
509.8# Concentrate		38.18	
4,031.2# 32% D.M. Corn Silage		19.45	
		57.63	
Steers (To 880 lbs.)			
520.1# Concentrate		38.95	
4,426.7# 32% D.M. Corn Silage		21.36	
		60.31	

Chapter III Footnotes

[1]Good, Darrel, "Potential Impact of Environmental Pollution Abatement Alternatives on the Michigan Dairy Farming Industry," Unpublished Ph.D. Thesis, Michigan State University, 1972. p. 119.

CHAPTER IV

RESEARCH PROCEDURE

Introduction

It is hypothesized that a difference exists in the level and variability of income between dairy business management strategies. The synthetic model of a dairy farm developed in the previous chapter is used to measure the level and variability of income for differing farm organizations, i.e. strategies.

This chapter presents an analytical model designed to quantify theoretical relationships previously discussed and to test the null hypothesis presented above. Thirty-seven business management strategies are analyzed to determine the mean income level and variability as measured by either the standard deviation of the distribution, standard error of the estimate of linear regression or standard error of the estimate of linear logarithmic regression. The model consists of two sub-models. The first sub-model, a profit maximizing linear programming model, is used to determine income levels and labor requirements, for the synthetic dairy farm in 1975. The second sub-model is a regression model with an extensive transformation routine which combines enterprise revenues and costs to yield the above mentioned measures of income variability. The results of both the linear programming

and regression analysis are presented in Chapter V.

For each firm, the amount of operator, labor, milking facilities, machinery complement, and acreage owned and rented are assumed fixed. Dairy rations, feed storage capacities, cropping system, dairy replacement procurement, and weight of marketing of dairy calves are variable. Correspondingly, investment requirements, labor requirements above operator labor, and acres required for livestock feed production are also variable from one time period to another.

The Techniques

The linear programming model was used to determine labor requirements, and 1975 income levels. This computerized technique was used rather than conventional budgeting techniques due to the large number of alternatives considered. The regression model used the labor required for the various farm organizations obtained as an input.

Time series estimates of product prices, cash costs of production (excluding property taxes) and yields for field crops were used in the regression model. (These time series estimates are located in Appendix A.) The fixed factors, pounds of milk sold, quantities of haylage, corn silage, and corn grain required to feed the dairy cows and dairy livestock, and hours of hired labor are also used as inputs into the regression model. It is from these data that a transformation sub-routine for each of the thirty-seven strategies within the regression model was developed. Thus, the final result

of this analysis is a mean income level and associated variability for each locked in business management strategy.

The Linear Programming Model

Only one linear programming model is used to generate a portion of the input for the regression model. By forcing into solution some activities while removing others, the model is capable of simulating various farm organizations.

Following is a formal description of the linear programming model to be used in analyzing alternative management strategies.

The Objective Function

The solution of the linear programming model involves maximization of an "objective value" (Z_o) within the constraints and activities available. The objective value used in this study is the return to the operator's and labor management, and equity capital before taxes or debt retirement.

The objective function of the model used is:

$$(1) \quad Z_o = C_1X_1 + C_2X_2, \ldots, C_6X_6 - \sum_{j=8}^{35} C_jX_j$$

where:

Z_o = the objective value,

C_1X_1 = the total returns from selling milk, C_1 is the price of milk and X_1 is the cwt. of milk sold.

C_2X_2 to C_4X_4 = the returns from selling grains; corn, wheat, and soybeans. C's are prices per unit and X's are number of units sold.

C_5X_5, C_6X_6 and C_7X_7 = the returns per cow from the sale of veal, dairy beef, and deacons, respectively.

C_8X_8 = the total cost (less grown feeds) of producing milk from cows with or without replacements, less returns from culls and calves. This cost figure includes operating and ownership costs of milking, caring for the dairy, waste handling, feeding and housing of the dairy herd; with the exclusion of all labor costs and the ownership cost of land, buildings and the basic machinery complement.

C_9X_9 = the total cost of buying replacement stock for the dairy herd. This activity only enters the solution when the strategy being examined requires replacement stock to be purchased.

$C_{10}X_{10}$ = the total cost of producing corn grain for use as feed. C_{10} is the cost of producing an acre of corn grain on owned land. X_{10} is the number of acres of corn grain.

$C_{11}X_{11}$ = the total cost of producing corn silage on owned land. C_{11} is the cost of producing an acre of corn silage. X_{11} is the number of acres of corn silage produced.

$C_{12}X_{12}$ = the total cost of producing alfalfa haylage on owned land. C_{12} is the cost of producing an acre of haylage including land costs. X_{12} is the number of acres of haylage produced.

$C_{13}X_{13}$ to $C_{15}X_{15}$ = the total costs of producing the products in C_2X_2 through C_4X_4 on owned land. These products are corn grain for feed (X_{13}), corn silage (X_{14}) and alfalfa haylage (X_{15}).

$C_{16}X_{16}$ to $C_{21}X_{21}$ = the total costs of producing products $C_{10}X_{10}$ through $C_{12}X_{12}$ and C_2X_2 through C_4X_4 on rented land.

$C_{22}X_{22}$ and $C_{23}X_{23}$ = the total costs of producing veal and dairy beef respectively.

$\sum_{j=24}^{35} C_jX_j$ = the total cost of labor hiring during the twelve months of the year. C_j, j = 24---35 is the acquisition price of labor, and X_j, j = 24---35 is the number of hours of labor hired by month.

The Constraints

The objective function (Equation 1) is maximized subject to the following resource restrictions:

$$(2) \quad \sum_{j=1}^{12} A_{1,j} X_j \leq L_1$$

$$\vdots$$

$$\sum_{j=1}^{12} A_{12,j} X_j \leq L_{12}$$

L_1 is the labor resource available in period 1 (January). L_2---L_{12} are the labor resources available in the remaining eleven months.

$A_{1,24}$; $A_{2,25}$; $A_{3,26}$---$A_{12,35}$ will all have a - 1 value because they are labor hiring activities which add to the labor resources.

$$(3) \quad A_{13,8} X_8 - A_{13,1} X_1 = 0$$

This is the transfer of milk produced to milk sales.

$$(4) \quad A_{14,16} X_{16} + A_{14,10} - A_{14,8} X_8 = 0$$

This is the transfer of corn grain produced on rented and owned land to milk production.

$$(5) \quad A_{15,17} X_{17} + A_{15,11} X_{11} - A_{15,8} X_8 = 0$$

This is the transfer of corn silage production on rented and owned land to milk production.

(6) $A_{16,18} X_{18} + A_{16,12} X_{12} - A_{16,8} X_8 = 0$

This is the transfer of alfalfa haylage production to milk production.

(7) $A_{17,19} X_{19} + A_{17,13} X_{13} - A_{17,2} X_2 = 0$

This is the corn grain for sale transfer.

(8) $A_{18,20} X_{20} + A_{18,14} X_{14} - A_{18,3} X_3 = 0$

This is the soybean transfer.

(9) $A_{19,21} X_{21} + A_{19,15} X_{15} - A_{19,4} X_4 = 0$

This is the wheat transfer.

(10) $A_{20,9} X_9 - A_{20,8} X_8 = 0$

This is the replacement transfer. It insures that the number of cows in the dairy herd times the cull rate must equal the number of replacements.

(11) $A_{21,8} X_8 = 0$

This constraint sets the herd size.

(12) $A_{22,10} X_{10} + A_{22,11} X_{11} \text{ --- } A_{22,21} X_{21} \leq 383$

This constrains the acreage to less than 383.

(13) $A_{23,22} X_{22} = 52 \text{ or } 72$

This constrains the number of veal sold (52 when replacements are purchased).

(14) $A_{24,22} X_{22} - A_{24,5} X_5 = 0$

This insures that the number of veal produced equals the number sold.

(15) $A_{25,23} X_{23} = 50.4$ or 70.4

This constrains the number of dairy beef sold. (50.4 when replacements are raised, 70.4 when purchased).

(16) $A_{26,23} X_{23} - A_{26,6} X_6 = 0$

This insures that the number of dairy beef produced equals the number sold.

(17) $A_{27,7} X_7 = 52$ or 72

This sets the number of deacons produced and sold (52 if replacements are raised, 72 if replacements are purchased).

The Regression Model

The Regression Subroutine

The regression model as used in this study is the major component of the empirical analysis. The statistical package used by Michigan State University has as one portion a regression routine. This routine provides minimum and maximum values, means, standard deviations, and standard errors of the estimate of the regression equation. It also has as an option, a transformation sub-routine which performs basic math computations and logarithmetic transformations. It is within the transformation sub-routine that the variables as to enterprise

costs of production, income, and labor requirements are aggregated into a whole farm organization.

Also computed by the sub-routine is the number of acres required to feed the dairy herd. This number varies from year to year depending on the yields of the feed crops. Therefore, the number of acres available for cash grain sale is the difference of the total acres in the farm and the acres required to feed the dairy herd.

With strategy 1 used as an example, the sub-routine which calculates the level and variability of income associated with that strategy is presented below.

X_1 = 904/Haylage Yield Per Acre

X_2 = 930/Corn Silage Yield Per Acre

X_3 = 5,220/Corn Grain Yield Per Acre

$X_4 = X_1 + X_2 + X_3$ (Acres Required to Feed Ration A)

$X_5 = 383 - X_4$ (Acres Available to Grow Cash Grain for Sale)

$X_6 = X_5$* Net Income Per Acre from Corn Grain Sales

X_7 = 80* Milk Gross Income - 80* Cost of Milk Production (Net Income From Sale of Milk)

X_8 = 20* Value of Cull Cow Sale

X_9 = 52* Value of Deacon Calf Sale

X_{10} = Land Rent Cost Per Acre *118 Acres

X_{11} = 3,373* Farm Wage Rate

$X_{12} = X_7 + X_6 + X_8 + X_9 - X_{10} - X_{11}$ (Net Farm Income Before Taxes and Debt Payments)

Where: the value of X_1 is the number of acres required to yield 904 tons of haylage. The haylage requirement of 904

tons is the amount required by 80 cows when fed ration A. The value of X_2 is the number of acres required to produce 930 tons of corn silage, and the value of X_3 is the number of acres required to produce 5,220 bushels of corn grain. Again, as for the haylage, 930 tons and 5,220 bushels are the corn silage and corn grain requirements for Ration A when fed to an 80 cow herd.

The acres required to produce the farm-grown portion of the total ration is the value X_4. With 383 acres in the farm organization, X_5 results in the acres available for production of cash grain for sale. The value X_6 is the net income from the sale of cash grains produced on the excess acres (X_5).

Net income from milk sales is the value of X_7. The gross income from milk sales is the quantity sold multiplied by the price. The cost of milk production includes all cash costs and the cost of farm-produced feed. Gross income from the sale of cull cows is the value of X_8. The value 20 is arrived at when a 25 percent culling rate is assumed. The value of X_9 is the gross income from the sale of excess deacon calves. The value 52 (number of deacons sold) is determined by removing 20 calves for use as future replacements and a death loss assumed rate of 10 percent.

The cost of renting 118 acres is the value of X_{10}. The hired farm labor cost is value X_{11}. Number of hours of labor required beyond those supplied by the operator are 3,373 for strategy 1.

The value of X_{12}, the combination of the enterprises and

costs into a whole farm, is the net farm income before taxes and debt payments.

The Time Periods

Three time periods are examined in the study. A stable period during the 1960s, a more volatile period in the early 1970s (1970 to 1974), and the total period 1960 to 1974.

Measures of Level and Variability of Income

The regression package at Michigan State University calculates the mean of the distribution, the standard deviation, and the standard error of the estimate of regression. Both linear and logarithmic forms of the regression equation are examined and both resultant estimates of the standard error of the estimate of regression are presented. The above-mentioned measures of level and variability of income are used extensively in the comparison of strategies. However, the minimum and maximum values of the distribution are also calculated by the package. These values are examined also in the strategy comparisons.

The Telplan Program

A third step in the analysis was the utilization of "Telplan Program Number Five." Program Five, Income Tax Management Analysis, calculates the federal and state income tax payment, self-employment tax, and the amount of job development investment credit. For four selected strategies, the above-mentioned taxes or credits plus the property tax

payments were summed and then subtracted from the before tax income to arrive at a "net" income figure. This residual income figure is the return to operator labor, management, and equity capital.

Summary

The analytical models previously described--linear programming, regression, and Telplan program five models--are used to analyze 36 dairy business management strategies and one all cash crop alternative. In total, nine computer runs are required for the regression analysis of before-tax income: four Telplan Five runs for tax calculations and four corresponding regression runs for after tax income.

The nine computer runs result from computing strategies 1 to 18 for each of three time periods, strategies 19 to 36 for each of the time periods, and strategy 37 for the three time periods.

Each of the nine computer runs results in the calculation of minimum and maximum values of net income, mean net income, standard deviation of net income, and standard error of the estimate of the regression equation. After-tax net income calculations, of which there were four, yielded the same above-mentioned statistics.

Chapter IV Footnotes

[1]The symbol "*" means multiply.

CHAPTER V

EMPIRICAL RESULTS: NET INCOME BEFORE TAXES

Introduction

In this chapter, the level and variability of net income before taxes[1] for the 37 business management strategies are examined. The statistical tests of significance of differences in selected means and variabilities and two differing graphic methods of comparing the business management strategies are discussed. The implications of the results for various categories of decision-makers and for the Michigan dairy industry are also contained in this chapter.

The minimum and maximum net income before taxes, mean income level, standard error of the estimate of regression in linear and natural log form, and the standard deviation of 37 business management strategies of three differing time periods are presented in Appendix B. While the data contained in the Appendix table is devoted to a graphic and statistical analysis of those data.

Estimated Net Income Levels for 1975

The results of the linear programming analysis are presented in Table 18. Net Income (return to operator labor, management, and equity capital) is based upon estimates of prices and costs for the year 1975. As yield estimates for

Table 18. 1975 net income levels obtained from linear programming analysis.

	Strategy[a,b]	Net Income[c]		Strategy	Net Income
1.	RA, R, D, C	74,077.95	21.	RC, R, D, C-W	71,456.73
2.	RB, R, D, C	47,555.09	22.	RA, BR, D, C-W	83,758.81
3.	RC, R, D, C	76,132.98	23.	RB, BR, D, C-W	65,872.36
4.	RA, BR, D, C	91,647.31	24.	RC, BR, D, C-W	86,466.83
5.	RB, BR, D, C	69,301.61	25.	RA, R, DB, C-W	77,296.08
6.	RC, BR, D, C	93,387.68	26.	RB, R, DB, C-W	52,888.31
7.	RA, R, DB, C	80,912.38	27.	RC, R, DB, C-W	79,935.50
8.	RB, R, DB, C	54,384.71	28.	RA, BR, DB, C-W	94,992.29
9.	RC, R, DB, C	84,567.40	29.	RB, BR, DB, C-W	74,778.85
10.	RA, BR, DB, C	100,304.39	30.	RC, BR, DB, C-W	95,747.42
11.	RB, BR, DB, C	77,958.70	31.	RA, R, V, C-W	68,965.00
12.	RC, BR, DB, C	102.044.77	32.	RB, R, V, C-W	42,442.14
13.	RA, R, V, C	72,768.35	33.	RC, R, V, C-W	70,147.13
14.	RB, R, V, C	46,245.49	34.	RA, BR, V, C-W	84,223.01
15.	RC, R, V, C	74,823.38	35.	RB, BR, V, C-W	64,059.56
16.	RA, BR, V, C	89,834.51	36.	RC, BR, V, C-W	84,654.03
17.	RB, BR, V, C	67,438.81	37.	GG, S-W	46,342.43
18.	RC, BR, V, C	91,574.88			
19.	RA, R, D, C-W	70,274.60			
20.	RB, R, D, C-W	46,183.39			

[a]See Table 11 footnote for key to strategy abbreviations.

[b]See Table 11 for corresponding labor and investment requirements.

[c]100 percent equity assumed for this table.

the 1975 crop year were not known at the time of this writing, average yields were assumed.

The values in Table 18 can be used for comparison purposes with the average incomes in past periods presented in the next section of this chapter.

Strategies 12 and 10 are the highest expected income strategies for 1975. Feeding ration C, buying replacements, raising excess calves to a dairy beef market weight, and

growing all corn grain on excess acres are the components of strategy 12, which yields the highest income. Strategy 10 has the same components as strategy 12, with the exception of ration. Ration A replaces ration C in strategy 10.

Strategy 32, feeding ration B, raising replacements, selling veal calves, and growing a corn-wheat rotation on excess crop acres is the lowest income strategy. This strategy (32) has a lower expected income than does the all-cash crop strategy, strategy 37.

Income Opportunity Framework Comparison of Level and Variability of Net Income Before Taxes

1960 to 1969 Time Period

Figures 2 and 3 examine in an income opportunity framework the relationships among the business management strategies during the 1960 to 1969 period.[2] Two differences appear through presentation of the data in this form. When using the standard deviation as the measure of variability, the strategies are relatively dispersed in the quadrant space (Figure 2). And, when the standard error of the estimate is used, the strategies are relatively bunched in the quadrant space (Figure 3). Second, the standard deviation is much larger than the standard error of the estimates measure of variability. This reduction in variability is attributable to the regression equations removal of the upward trend from the variability calculation. Decision makers who view the future as an increasing trend in incomes should use the standard error of the

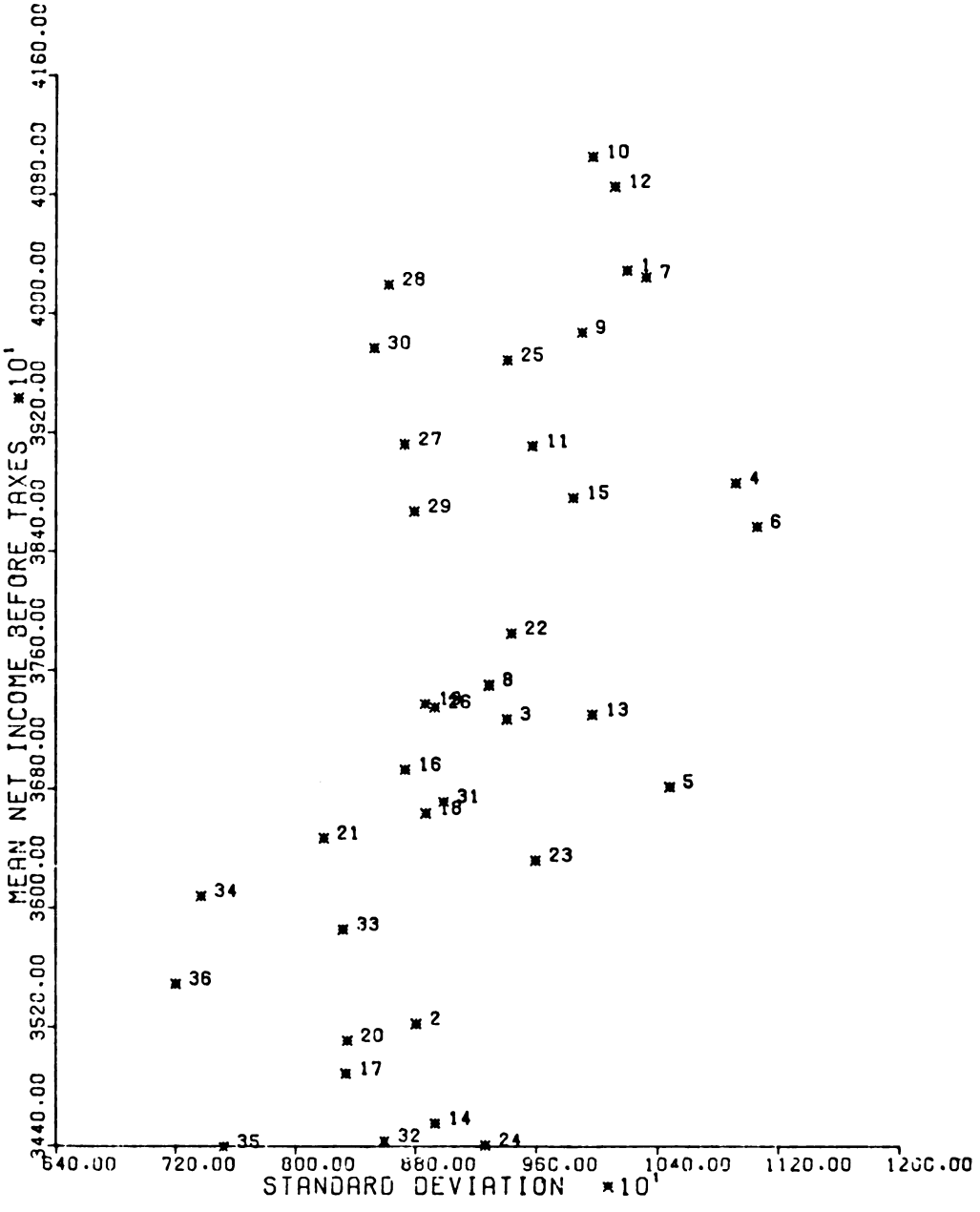

Figure 2. Level and varibility of net income before taxes. Time Period: 1960 to 1969. Measure of variability: Standard Deviation.

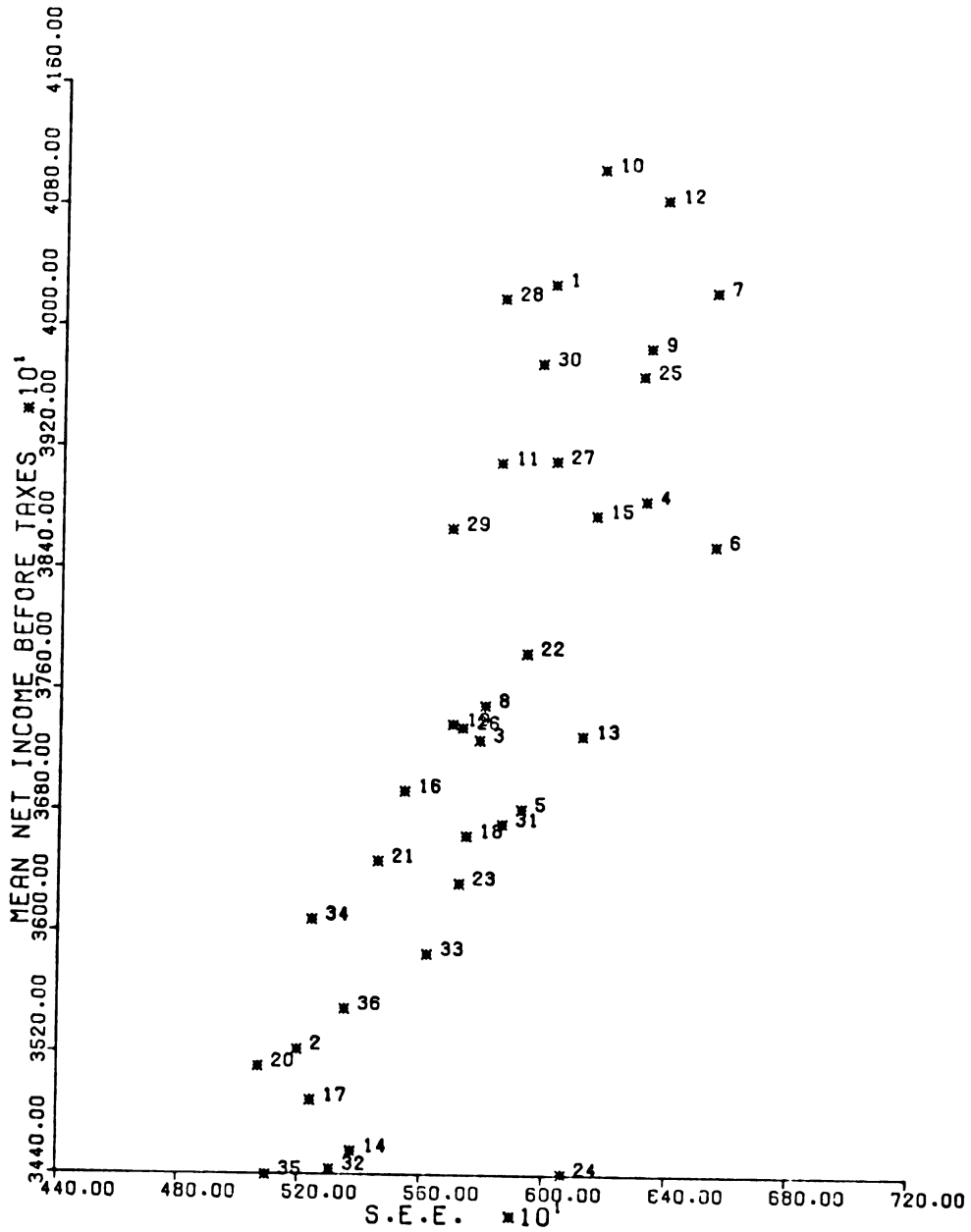

Figure 3. Level and variability of net income before taxes. Time period: 1960 to 1969. Measure of variability: S.E.E.

estimate as the measure of variability for selecting a strategy. Those who view the future as varying around a mean of a past period should use the standard deviation.

In the 1960 to 1969 period, the strategies which exhibit the lowest variability of income within $1600 income intervals beginning at $34,400 are: 10,27, 30, 34, and 36 when using the standard deviation as the measure of variability. When using the standard error of the estimate, strategies 10, 20, 28, 29 and 34 have the lowest variability within $1600 income intervals from the same starting point.

Conversely, strategies 4, 10, 25, 28, 34 and 36 exhibit the highest level of income within $800 variability of income intervals as measured by the standard deviation. When using the standard error of the estimate, strategies 1, 2, 7, 10 and 16 have the highest level of income within $400 income variability intervals.

Thus, those managers who wish to minimize variability within an income interval would be most interested in locating that income level on the Y-axis and following the income level to the first strategy point when moving from left to right. For those managers who wish to maximize income within a given level of variability, the opposite procedure would be followed. That is, locate the level of variability on the X-axis and then move up to the strategy point which has the highest income level. However, the income intervals used above may be too large or too small for a manager selecting a strategy. And as such, it would be necessary for the decision maker to

determine a minimum income level or maximum variability and then select a strategy which meets those restraints. For example, if the decision maker desired an income level greater than $38,400 with less year to year variability than $9,600 he would be limited to strategies 11, 25, 27, 28, 29, and 30. (Using the 1960 to 1969 time period and standard deviation measure of variability.)

1970 to 1974 Time Period

The strategies which have low variability for their income level or high income for their level of variability are again quite similar. Using the standard deviation during the 1970 to 1974 period, strategies 9, 12, 16, 17, 18, 34 and 36 exhibit the lowest variability within $2,000 income intervals beginning at $60,000. When the standard error of the estimate is used, strategies 1, 10, 19, 25, 28, 34 and 36 exhibit the lowest variability within $2,000 income intervals, beginning at the same starting point. (See Figures 4 and 5.)

The strategies which exhibit the highest income within $2,000 income intervals are: 1, 4, 10, 16, and 34 when using the standard deviation and 1, 4, 10 and 25 when using the standard error of the estimate.

1960 to 1974 Time Period

For the time period 1960 to 1974, one again observes greater spread and range of variability for the strategies with the standard deviation measure of variability (Figures 6 and 7). The strategies which exhibit the lowest variability

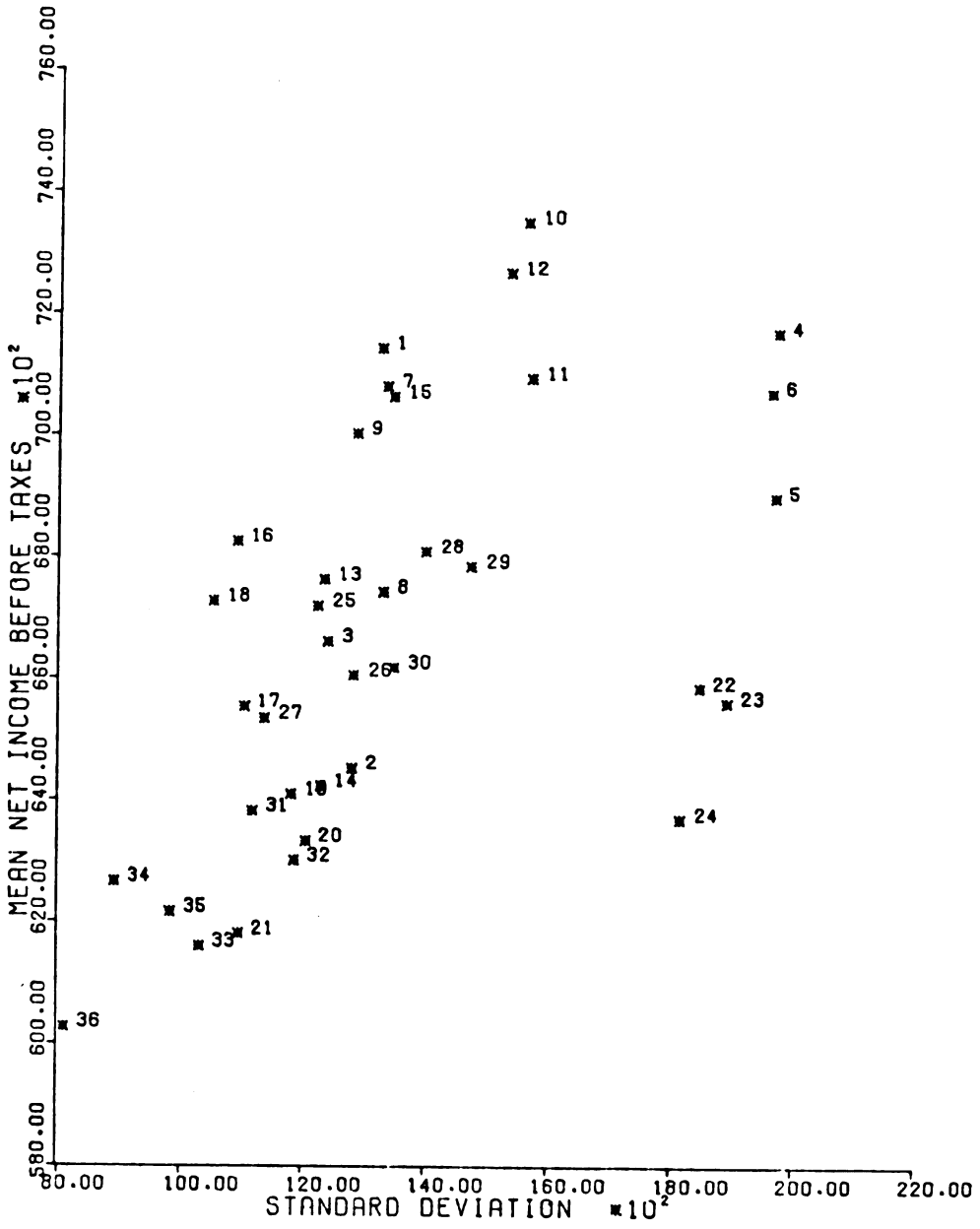

Figure 4. Level and variability of net income before taxes. Time period: 1970 to 1974. Measure of Variability: Standard Deviation.

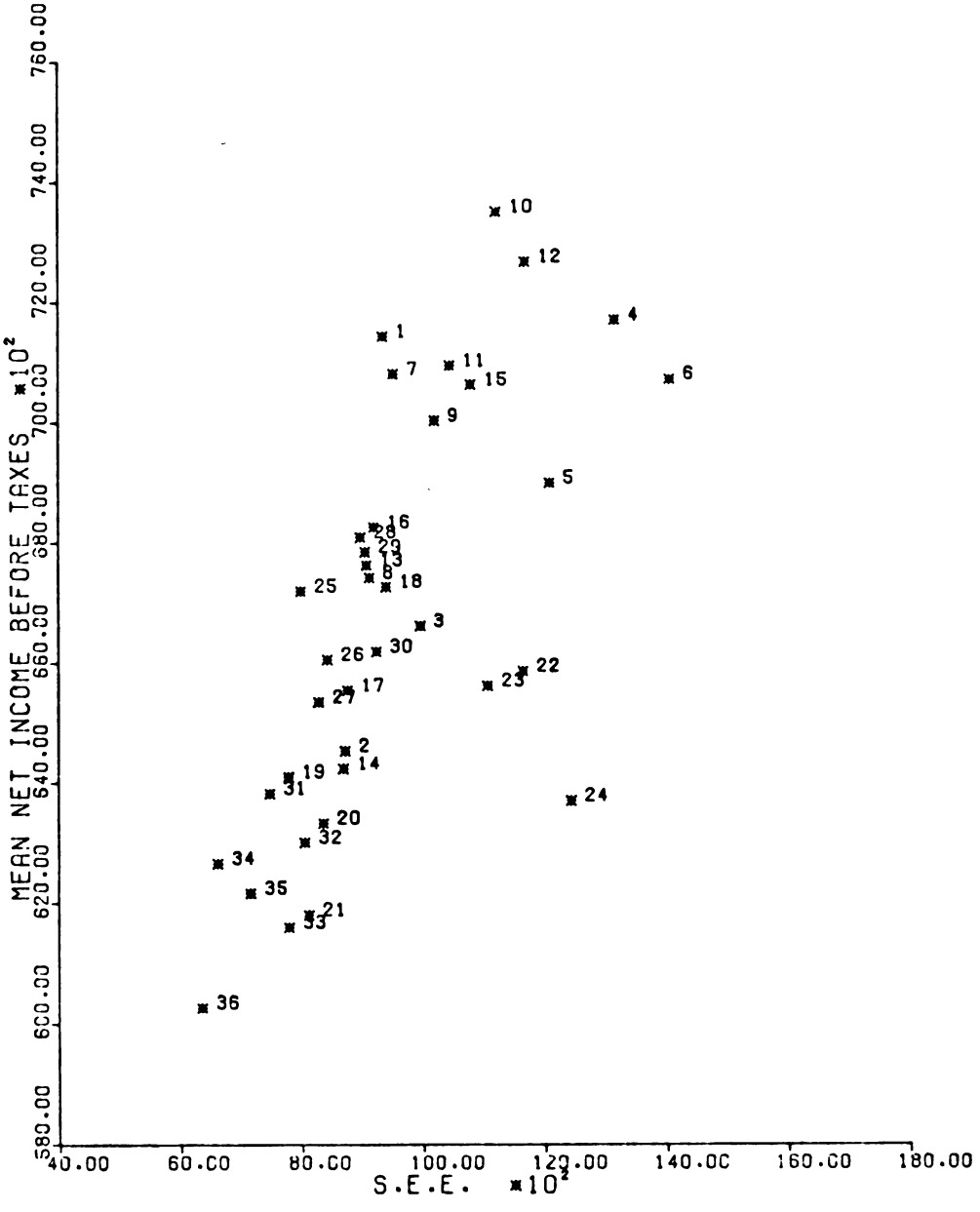

Figure 5. Level and variability of net income before taxes. Time period: 1970 to 1974. Measure of variability: S.E.E.

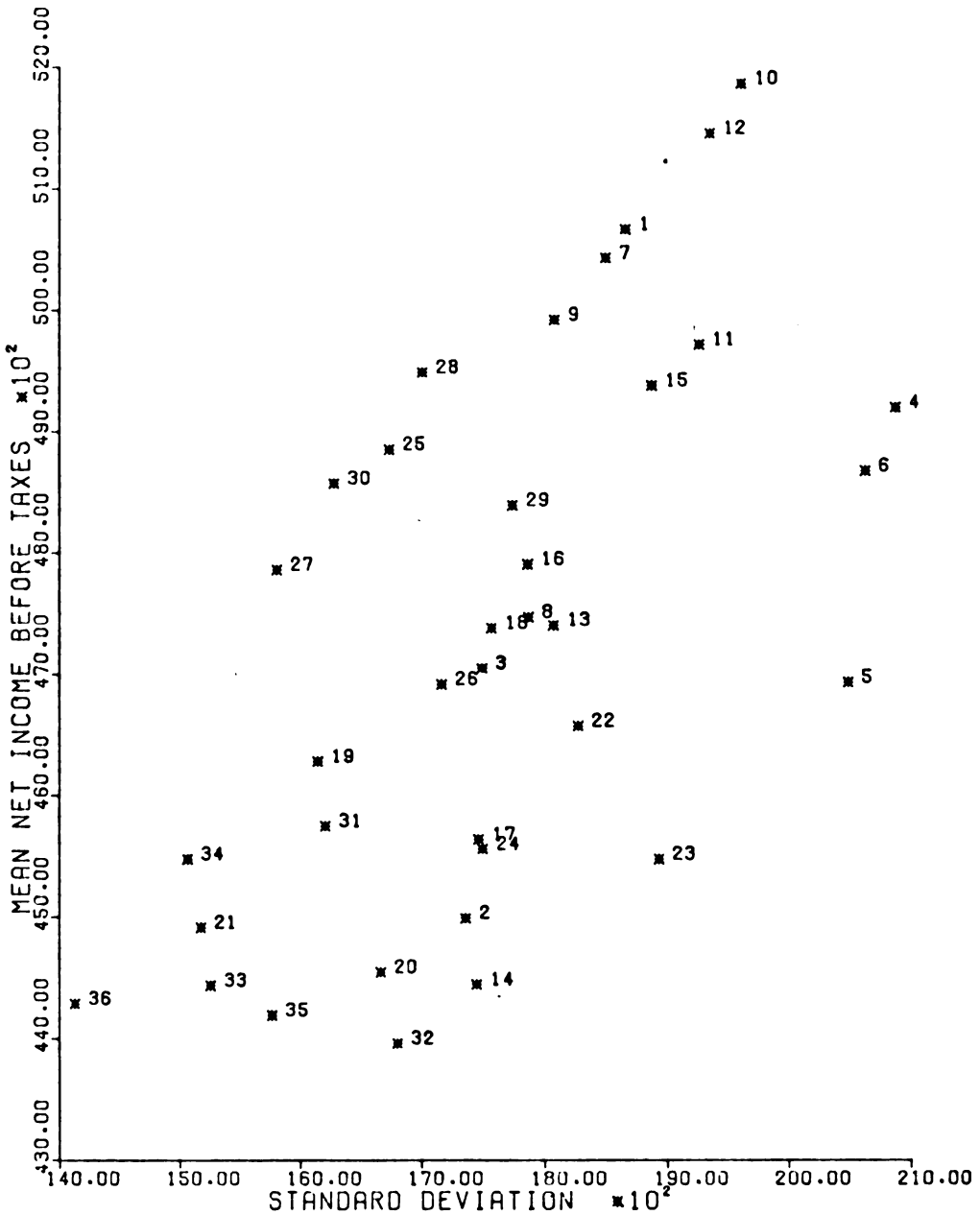

Figure 6. Level and variability of net income before taxes. Time period: 1960 to 1974. Measure of variability: Standard Deviation.

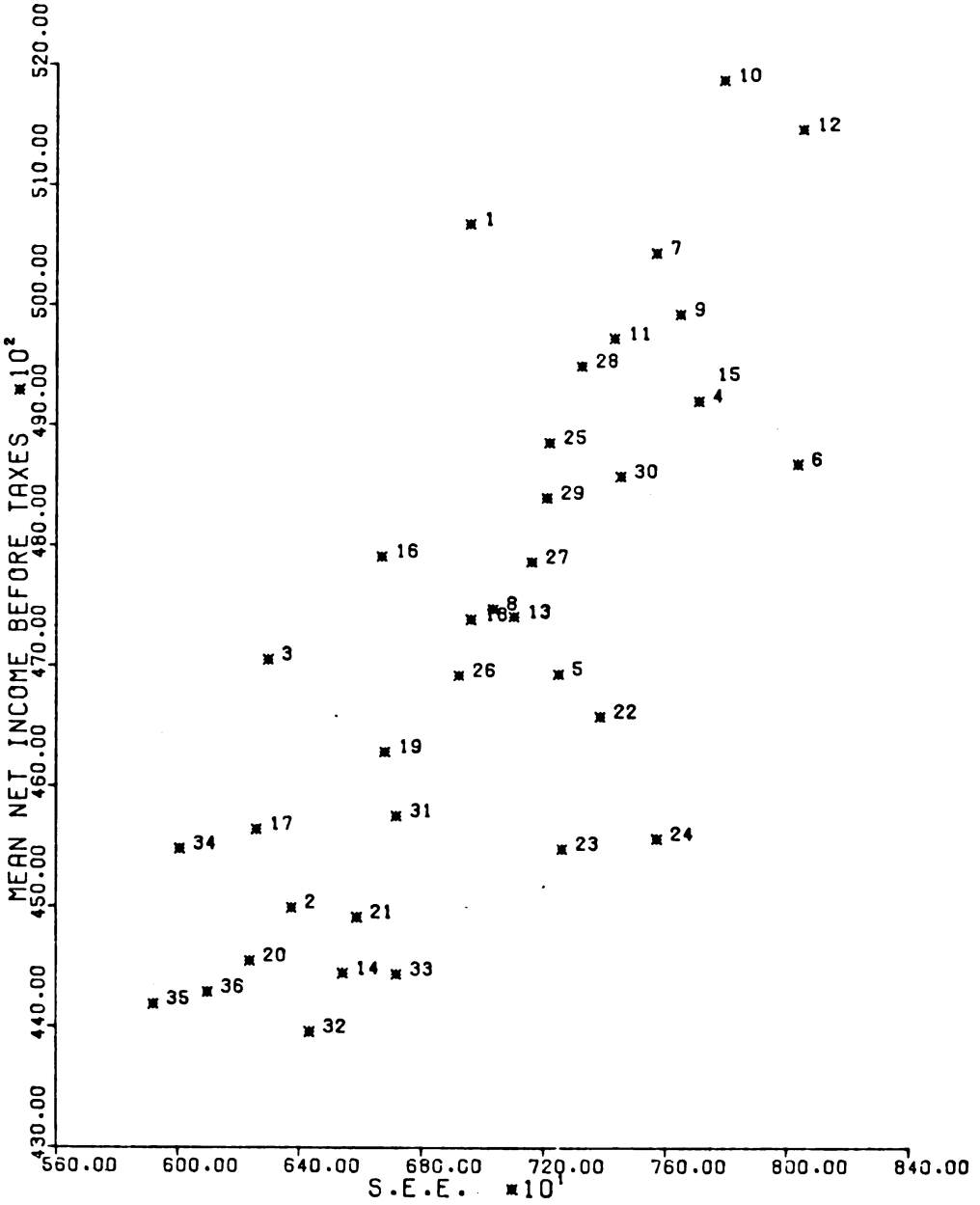

Figure 7. Level and variability of net income before taxes. Time Period: 1960 to 1974. Measure of variabilith: S.E.E.

of income within $1,000 net income intervals starting at $43,000 in the 1960 to 1974 time period are 9, 12, 19, 27, 28, 30, 34 and 36 when using the standard deviation as the measure of variability. The standard error of the estimate measure of variability has strategies 1, 3, 10, 19, 28, 29, 34 and 35 as low variability strategies within a $1,000 income interval starting at $43,000.

Strategies which have the highest income levels within $1,000 income intervals are: 1, 4, 9, 10, 27, 28 and 36 when using the standard deviation and 1, 3, 7, 10, 16, and 34 when using the standard error of the estimate.

The strategy rankings with respect to mean income level and variability can be found in Appendix B, Tables 4-6. From these tables, one can see how each strategy compared to all others in terms of mean level and variability of income.

Selection of Time Period and Measure of Variability

The selection of time period and measure of variability to be used by the decision maker is dependent upon his view of the future. Will there be variability comparable to the 1960 to 1969 period or 1970 to 1974 period? Is the future trend in incomes to be increasing or constant? The answers to these questions will determine the appropriate time period and measure of variability to be used by the decision maker.

Statistical Tests of Significance

Before proceeding further in the presentation and analysis of results, the statistical tests of significance between means and variabilities are examined. Table 19 presents these statistics for those strategies which have the largest absolute difference in mean income and variability. Thus, the values presented in Table 19 are the extreme values, and all other strategy combinations would exhibit lower significance levels.

Two differences in the statistics merit closer examination. First, it should be noted that the F-Test level of significance for the 1970 to 1974 period is greater than the other two time periods. Second, the most significant difference in mean incomes was found in the 1960 to 1969 time period. The F-Test's greater significance in the 1970 to 1974 period can be explained by greater variability in prices and costs during the period. Therefore, when comparing two strategies with large differences in variability the resultant squaring of the standard deviations for the test statistic calculation results in larger F statistics. The t-statistics were more significant in the 1960 to 1969 period because of the lower incomes and much lower variabilities. When comparing means, the t-statistic will be larger for those distributions with smaller variances. And, the variances in 1960 to 1969 time period were relatively small compared to the later time period.

Strategy thirty seven, the corn-corn-soybeans-wheat

Table 19. Statistical tests of significance of strategies with largest absolute differences[a]

Time Period and Strategy	Variance		Mean
	S.E.E.	S.D.	
	F-Statistic[b,c]		t-Statistic[b]
1960 to 1969			
(20) vs. (6)	1.68 (0.47)		
(36) vs. (6)		2.36 (0.23)	
(35) vs. (10)			1.69 (0.12)
1970 to 1974			
(36) vs. (6)	4.88 (0.17)		
(36) vs. (4)		5.90 (0.12)	
(36) vs. (10)			1.68 (0.13)
1960 to 1974			
(35) vs. (12)	1.85 (0.29)		
(36) vs. (6)		2.13 (0.18)	
(35) vs. (10)			1.18 (0.25)

[a]First, determine if the variances of the two samples are equal.[1] Second, compare the means of the two independent samples. If the variances are equal, calculate the t-statistic using the following formula: $t' = (\bar{X} - \bar{X}_2)/S_{\bar{X}_1 - \bar{X}_2}$.[2] Where: $\bar{X}_1$ and $\bar{X}_2$ are the sample means and $S_{\bar{X}_1 - \bar{X}_2}$ is the variance of the difference of $(\bar{X}_1 - \bar{X}_2)$. If the variances are unequal, the following formulation of the t-statistic is used:

$$t' = (\bar{X}_1 - \bar{X}_2) / \sqrt{s_1^2/n_1 + s_2^2/n_2}.^2$$

[b]Numbers in parentheses below the statistics are the associated levels of significance for the two-tailed test.

[c]The linear form of the equation provided the best fit in terms of the larger R and the standard error of the estimate for the time periods 1960 to 1969 and 1970 to 1974. The linear form is therefore the one discussed for those time periods. For the 1960 to 1974 time period, however, the natural log form provided the best fit. The resultant standard error of the estimate from the log form will therefore be used for comparison in the 1960 to 1974 period.

[1]Optimal significance levels vary somewhat, but are very close to .5 for most degrees of freedom. See Toyoda, T. and Wallace, T. Dudley. "Estimation of Variance After a Preliminary Test of Homogenity and Optimal Levels of Significance for the Pre-Test," Journal of Econometrics, Vol 3, (1975), pp. 395-404.

[2]Snedecor, George W. and Cochran, Willard. Statistical Methods (Ames, Iowa: Iowa State University Press, 1969), pp. 102, 103, 114, and 115.

rotation, is compared to the dairy farm strategies for variability and level of income in Table 20. The most important factor in the comparison is that the mean income from the cash crop farm is significantly different (<.01) from the dairy organizations in all time periods. However, the comparison of variabilities is more complicated. With the exception of the stable price period of 1960 to 1969 the variability was not significantly different for the dairy and crop farms.

A Bar Graph Comparison of Net Income Before Taxes

The income opportunity framework is presented in Figures 2 through 7 provide an effective method for comparison of strategies. However, additional information on which to base a decision of choice among strategies can be obtained from a bar graph. Through the bar graph, one can not only examine the mean income level and variability but also the range and shape of the distribution. This mode of presentation also allows easier comparison of strategy components.

Figures 8, 10, 10 compare strategies for not only mean and variability of income, but also range and shape of the distribution. In this study, the strategy rankings are very sensitive to changes in proportion of enterprises in the whole farm organization and the covariance term in the variability formula. Thus, to make general statements as to differences in strategy components (replacements, rations, excess calves,

Table 20. Statistical tests of significance: strategy 37 compared to those dairy strategies with largest absolute differences.

Time Period and Strategy	Variance		Mean
	F Statistic		t Statistic
	S.E.E.	S.D.	
1960 to 1969			
(37) vs (36)		3.55 (<.10)	
(37) vs (4)		8.16 (<.005)	
(37) vs (20)	1.67 (.47)		
(37) vs (6)	2.80 (.17)		
(37) vs (35)			7.81 (<.001)
1970 to 1974			
(37) vs (4)		1.59 (≈.80)	
(37) vs (36)		3.71 (.26)	
(37) vs (36)	2.18 (.48)		
(37) vs (6)	2.24 (.45)		
(37) vs (36)			3.49 (<.01)
1960 to 1974			
(37) vs (4)		2.60 (≈.90)	
(37) vs (36)		1.19 (.09)	
(37) vs (12)	1.19 (≈.90)		
(37) vs (35)	1.55 (.45)		
(37) vs (32)			4.39 (<.001)

[a]Values in parentheses are associated levels of significance for the F and t values.

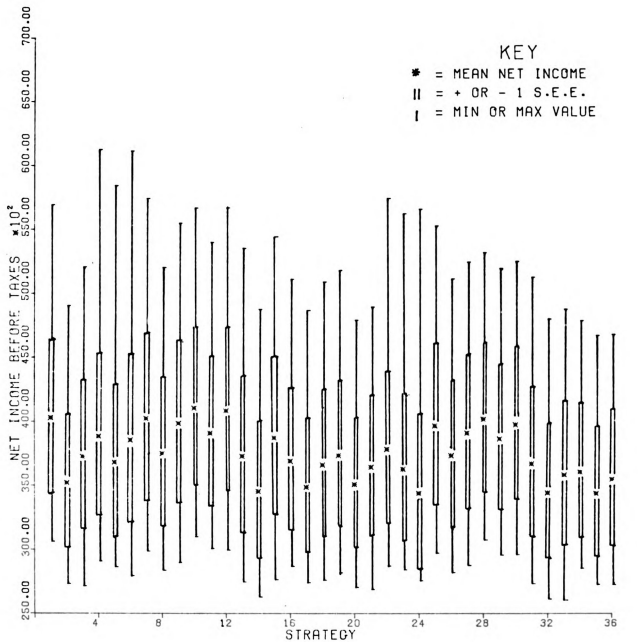

Figure 8. Bar graph comparison of net income before taxes. Time period: 1960 to 1969. Measure of variability: S.E.E.

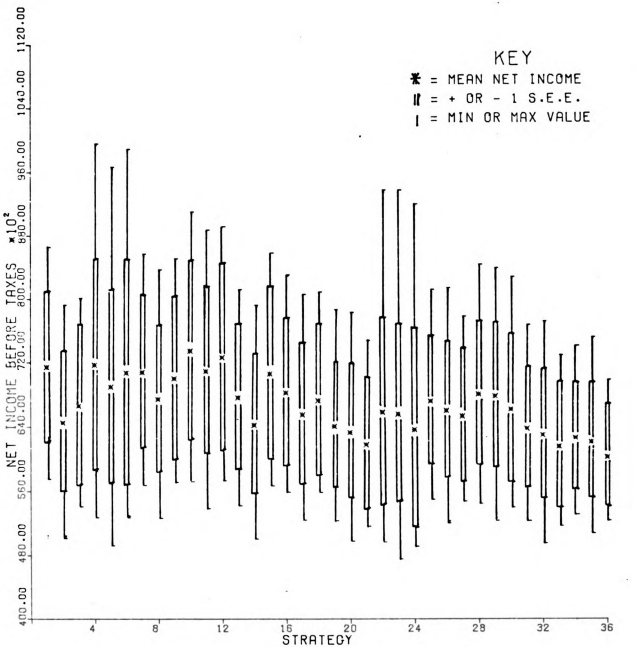

Figure 9. Bar graph comparison of net income before taxes. Time period: 1970 to 1974. Measure of variability: S.E.E.

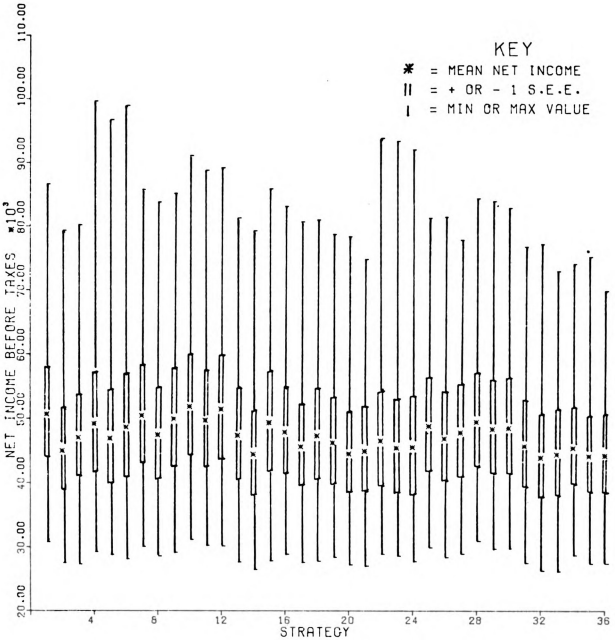

Figure 10. Bar graph comparison of net income before taxes. Time period: 1960 to 1974. Measure of variability: S.E.E.

crop rotations) is impossible. Therefore, a statement must be made for a specific strategy compared to another specific strategy or small groups of like strategies.[3]

Replacement Stock

In the 1960 to 1969 time period, as in the other periods, when replacement stock are purchased rather than farm raised and deacons are the mode of sale for excess calves the range in total farm income is much larger [Strategies (1, 2, 3) versus (4, 5, 6) and (19, 20, 21, 22, 23, 24)]. This is attributable to an increase in acres of crop land available for production of crops for cash sale and the larger variability in grain prices. However, this relationship is offset in the 1960 to 1969 period when the excess calves are sold as veal or dairy beef and in the other two periods when the excess calves are sold as veal.

For mean income levels when raising replacements versus purchasing replacements, the results must again be based on a strategy by strategy comparison. For example, strategy 1 versus strategy 4 in the 1960 to 1969 period results in a decrease in mean income as a result of purchasing replacements, and strategy 2 versus strategy 5 results in an increase in mean income when replacements are purchased.

In Michigan a serious restriction on purchasing replacements is the availability and quality of the replacement. For some dairymen, purchasing replacements as an alternative is not available.

Rations

When rations are compared, ration A results in the highest mean income level, ration B the lowest, and ration C the median income level. Again there is a contradiction to the above general statement. In the 1970 to 1974 period, ration B and C reverse positions for strategies 19 to 36. Ration C is the lowest mean income ration and ration B is the median income level ration for these strategies.

Rations high in corn silage are becoming popular in Michigan. This research does not support that trend. However, if limited availability of land and a limited labor supply were found on a dairy farm, then corn silage production would allow more cows to be fed on fewer acres, a reduction in land base, and a small reduction in labor requirements. These factors are not considered in this research and may be the reason behind the trend to corn silage rations.

Selling Dairy Livestock

The decision of selling excess dairy calves as deacons dairy beef or veal has a more consistent pattern from strategy to strategy. The decision to sell the excess calves as dairy beef produced the highest mean income level, deacons the median, and veal calves the lowest. The above stated ranking holds true over all three time periods.

Again these results are not consistent with recent trends. Raising dairy beef requires additional labor facilities and crop acres on dairy farms which have existing

high labor, capital and crop acre requirements. Agains, the assumptions of this research must be remembered when applying the results.

Cropping on Excess Acres

Strategies which have an all corn cropping program on excess acres result in higher income and higher variability than the 50-50 corn-wheat rotation over all time periods.

Summary of Strategy Comparisons

The business management strategies examined can be grouped into three categories: high, medium, and low net income and variability. Table 21 presents the groupings.

Table 21. High, medium, and low income and variability strategies.[a]

High Income And Variability	Medium Income And Variability	Low Income And Variability
1, 4, 5, 6, 7, 9, 10, 11, 12, 15	3, 8, 13, 16, 17, 18, 22, 23, 24, 25, 26, 27, 28, 29, 30	21, 33, 34, 35, 36

[a]These groupings hold for most time periods and methods of variability calculations. However, some strategies could shift from one category to another but as presented are the predominant location of the strategy.

The strategy component contained in all the high income and variability strategies is an all corn grain rotation on excess crop acres. The remaining strategy components all appear in at least one of the strategies. However, five of the ten high income and variability strategies have a dairy

beef enterprise as one component, four contained deacon calf selling and only one veal. Six of the ten strategies called for buying rather than raising replacements. Rations A and C appear four times and ration B only twice in the high income and variability strategy group.

Low income and variability strategies contain a corn-wheat rotation and in four of the five cases a veal enterprise. Ration C appears most frequently in these strategies as does buying replacements the middle income and variability group which contains the largest number of strategies has no one strategy component which dominates. Approximately equal numbers of strategies contained each ration replacement option, dairy livestock and crop rotation.

Implications for Managers

Dividing the income opportunity space into four quadrants, as shown in Figure 11, provides a mode for categorizing strategies. The first quadrant contains high income-high variability strategies, the second high income-low variability, the third low income-high variability, and the fourth low income-low variability. Ceteris paribus, any manager would prefer those strategies in quadrant two. However, the results of this study do not fall neatly in block-like clusters but rather are diagonal, falling mostly in quadrants I and IV. Thus, a trade-off between income and variability exists between the strategies which lie in these quadrants. While a decision as to which specific strategy

to pursue also depends on factors other than income and variability, the analysis does provide the basic information required. Labor and investment requirements, present financial position and farm organization, and age of the operator are important factors beyond income level and variability.

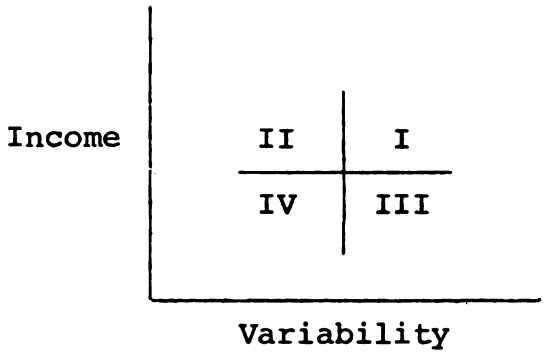

Figure 11. Income and variability compared in four quadrant space.

Labor Requirements

Labor requirements of the various strategies are important in determining which strategy a decision maker will follow. Strategy ten has a higher mean income than strategy sixteen, yet it requires 692 more hours of labor per year. An individual who is concerned with labor availability may prefer that strategy which requires less labor input. Decision makers who have excess labor available may choose that strategy which can utilize his additional labor and increase his income.

Dairy farms require a large labor input. For those farmers who are restricted in their labor supply, the labor requirements of the strategy become an important determinant for selection.

Investment Requirements

A strategy with a higher investment requirement as well as a higher income may not be preferred to a lower income-lower investment strategy by someone just getting started in dairy farming or someone with very limited capital. Conversely, those individuals with sound existing farm businesses are more likely to have access to the necessary capital to follow the higher investment strategies.

Strategies which feed ration B, raise the replacement stock, sell the excess calves as dairy beef or veal, and have a corn-wheat rotation as components will be high investment strategies. The investment requirements will become an important consideration in selecting a management strategy when the necessary facilities or equipment are not owned at present and must be acquired.

Financial Position

The financial position of the decision maker also plays an important role in the selection of an appropriate strategy.

A dairy farmer with a large fixed cost commitment would likely choose a strategy with lower variability even though the strategy had a lower mean income level. By doing so, he is reducing the probability that he would not be able to meet his cost commitments.

Conversely, a farmer with low fixed cost commitments (high equity) would be more likely to choose a high income strategy even though it has a high variability. Given a high equity financial position, the farmer is better able to

"weather the storm" should bad income years prevail.

Thus, decision makers with low equity are more likely to select strategies which exhibit low variability. Such strategies are found in quadrants two and four.

Age of Operator

Age of operator is possibly correlated with financial position and investment capital. As a farmer moves up the ladder of success and owns more assets with lower debt retirement requirements, it is hypothesized that he is more likely to follow strategies, although more variable, present the opportunity for a large gain. However, as one nears retirement age, the safe or low variability strategies may again be selected.

Again as was the case with the young operator with high debt retirement obligations, the decision as to which strategy to follow could well be based on the variability of income criterion. That is a strategy which reduces the fluctuation of year to year income.

For a decision maker to combat the great variability found in today's markets he must choose a strategy to follow wisely. But also he must continue to modernize and become more efficient in use of labor, feed, and land resources. It is not enough to follow a strategy which is a higher income strategy if the dairy farmer is not able to attain high efficiency levels in his use of resources.

Implications for Michigan Dairy Industry

The implications of this study for the Michigan dairy industry are not precisely quantifiable. The impact on the total industry of one dairy farmer changing from growing replacements to purchasing from off-farm sources or selling calves at a veal weight rather than as deacons would be very small. However, if large numbers of farmers were to do so the appropriate market reactions would likely occur in those commodity areas.

Thus, while it is difficult to foresee possible changes in the strategies of dairy farmers, it is improbable that all dairy farmers will switch to like strategies. This is primarily due to the previously mentioned factors beyond level and variability of income which play an important role in selection of a strategy. These factors are investment requirements, labor requirements, financial position, and age of the operator. Also, within each category of dairy farmer, the same strategy choice is not likely. For within each category the decision maker may be a minimax, maximax, or any other decision rule user and thereby result in the selection of different strategies within the same general category. Yet, there are factors which will have an influence on dairy farms and the Michigan dairy industry. These factors are: the changing structure, equity levels, marginal farm numbers, milk pricing and dairy farm organization.

The Marginal Dairy Farms

The marginal dairy farm (high production cost per unit of output or low return per unit of input) may be facing difficult times if the variability conditions of the recent past continues. Dairy farming, while one of the more stable agricultural enterprises, has become more volatile. The greatest yearly income variation can be a factor which would cause the marginal dairy farms to exit. As increasing risk is associated with milk production; farmers with lower equity levels will likely be faced with more years in which fixed cost commitments cannot be met. Those operations which do not have the necessary liquidity to withstand these years will likely be forced from dairy farming.

Equity Levels

Not only are those dairy farms which are marginal in the physical production sense in danger of discontinuing dairy production, but also those farms which are heavily debt financed. When a marginal dairy farm is mentioned, one may think of the smaller unit in a poorer agricultural area. However, the more heavily externally financed dairy farms are more likely to be the 50 cow or larger farms in good agricultural areas. As will be discussed in detail in the next chapter, those dairy farms with high debt repayment commitments may also be in danger of discontinuing dairy production. This is partially due to the greater variability now associated with dairy farming which results in more years which dairy farm incomes may fall below cost commitments.

Dairy Farm Organization

Dairy farm organization may also undergo change in the future. With more revenue variability dairy farmers may choose strategies which utilize the principle of diversification to reduce variability in income. Thus the decision as to ration, crop rotation, replacement acquisition, weight of sale for excess calves will be very important in the success of the dairy farm. And the decision as to the organization of the dairy farm will evolve more around variability considerations than in prior years.

Chapter V Footnotes

[1]Net income before taxes as used in this research is gross receipts minus cash expenses (not including property taxes).

[2]Due to the difference in investment and labor requirements, strategy thirty seven will be discussed independently of the thirty six dairy business management strategies.

[3]Note these comparisons are made on the basis of a whole farm organization and are sensitive to proportion and covariance relationships which do change from one strategy to another. This gives rise to the varying magnitudes of many pairs of strategies which are seemingly comparing only one variable. In fact the comparison involves much more than the specific variable examined in a whole farm framework.

CHAPTER VI

EMPIRICAL RESULTS AND CONCLUSIONS: NET INCOME AFTER TAXES

Introduction

While before tax income is important for making managerial decisions, the after tax income[1] may provide additional information for the decision maker who is choosing a strategy. Appendix C presents the after tax income minimum and maximum values, mean income, standard error of the estimate in linear and log N form, and standard deviation of four selected business management strategies over all three time periods. The four strategies selected are 10, 16, 36, and 37. Strategy 10 was selected for being the one high income strategy which, regardless of time period or measure of variability calculation, always had the lowest variability for the high income group. Strategy 36, a low income strategy, was selected because of its consistency in being a low variability strategy. Strategy 16, a middle income-variability strategy, while not showing the same degree of consistency in having the lowest variability for a middle income strategy, was always very close and not significantly different from the strategy which was lowest. The all cash crop strategy, strategy 37, was included to give an indication for the level and stability of a dairy farm versus a cash crop farm.

Only the above mentioned four strategies are analyzed for level and variability of after tax income. They were selected because of their consistent low variability, for their income level, and the ease with which results could be transferred to the other strategies. Also, only four were selected due to the time required to perform this analysis.

Reduction in Level and Variability of Income After Removal of Taxes

From the before tax incomes for each of the four selected strategies are deducted the state and federal income taxes, self-employment taxes and property taxes.

After taxes were deducted the mean net incomes were lowered 18.3 to 33.4 percent (see Table 22). The highest reductions in mean income occurred in the 1970 to 1974 period. This is attributable to the larger incomes in this period, the self-employment taxes and graduated federal income tax. Variability was also decreased after deduction of taxes. Reductions in variability ranged from 28.3 to 54.2 percent when using the standard error of the estimate and from 29.2 to 50.3 percent when using the standard deviation.

However, to conclude from Table 22 that the variability of income streams after taxes was reduced in the magnitude of 20 to 40 percent would be erroneous.

Coefficients of variation are presented in Table 22. Here one finds the reduction in variability attributable to removal of taxes to be approximately 2.7 to 4.4 percent.

Table 22. Decrease in mean income level and variability after removal of selected taxes.

Time Period and Strategy	Mean	Variability	
		S.E.E.	S.D.
	----------Percent----------		
1960 to 1969			
10	24.2	39.7	40.7
16	21.3	35.4	29.5
36	19.6	33.6	26.2
37	18.3	28.3	29.2
1970 to 1974			
10	33.4	48.2	48.6
16	31.9	54.2	50.3
36	28.7	50.6	46.9
37	29.0	36.2	38.6
1960 to 1974			
10	28.6	40.2	44.8
16	27.3	44.3	42.7
36	24.7	39.4	39.5
37	24.2	32.4	36.9

These estimates of reduction in variability include the lowering of the mean income level.

The removal of taxes from the incomes of each of the four strategies did not, however, change the ranking of the strategies with regard to mean income level or variability. Strategy 10 has the highest income level and variability; strategy 16, the next highest mean income level and variability; strategy 36, the lowest income and variability for dairy strategies, and strategy 37, the cash crops strategy has the lowest income of all strategies but the largest variability in the 1970 to 1974 period. For the actual values of mean net income, minimum and maximum net incomes see the

first three columns of Table 23.

Table 23. Comparison of variability of selected strategies: before and after tax income.

Strategy	Coefficient of Variation[a]		
	1960 to 1969	1970 to 1974	1960 to 1974
10			
Before Taxes	.150	.152	.150
After Taxes	.119	.118	.118
16			
Before Taxes	.149	.134	.139
After Taxes	.123	.090	.109
36			
Before Taxes	.150	.105	.137
After Taxes	.124	.073	.110
37			
Before Taxes	.288	.286	.369
After Taxes	.253	.257	.329

[a]The coefficient of variation is the square root of the variance expressed as a percentage of the mean of the distribution.

Residual Income

To more fully examine the differences in income level of selected strategies; family living expenses and debt retirement payments are deducted from the net income after taxes. In Table 24 the maximum, mean, and minimum values of net income after taxes for the 1970 to 1974 time period are presented. For this analysis, it is assumed that the future expected net income after taxes is the mean of the 1970 to 1974 period.

Table 24. Residual income assuming constant family living expenditure: 1970 to 1974.

Strategy	Net Income After Taxes[1]			Family Living Expenses[2]	Residual Income[3]		
	Maximum	Mean	Minimum		Maximum	Mean	Minimum
	Dollars						
10	59,085.00	48,950.00	40,517.00	12,877.29	46,207.71	36,072.71	27,639.71
16	53,517.00	46,438.00	40,062.00	12,877.29	40,639.71	33,560.71	27,184.71
36	47,962.00	42,944.00	38,472.00	12,877.29	35,084.71	30.066.71	25,394.71
37	35,616.00	23,243.00	13,526.00	12,877.29	22,738.71	10,366.11	648.71

[1]100 percent equity.

[2]Obtained from the Farm Family Living Survey in 1973 as reported in Food and Home Notes, December 1, 1975, Statistical Reporting Services, U.S. Department of Agriculture. The consumer price index was then used to bring the costs to the 1975 level. For the purpose of strategy comparison, the family living expenses are assumed constant for all income levels.

[3]Residual income is the amount available for debt retirement, new capital purchases, and retained earnings.

Family living expenses are calculated by two different methods and deducted from the after tax mean, maximum, and minimum net income values (Tables 24 and 25). The result of this calculation is a residual income. From the residual income must come any debt retirement payments, any new capital purchases, and retained earnings.

The residual income shows the greatest absolute difference in strategies when examining the maximum values and the least with minimum values. Strategies 10, 16, and 36 have very similar minimum values of income, but quite different maximum values. This can be attributed to the all corn grain production and dairy beef production for the high income strategy.

An examination of the differences in the level of residual income from calculating family living expenditures as an average and on the basis of a consumption function results in a narrowing of the range in residual incomes for each strategy (Tables 24 and 25). If one is concerned in the amount that could be available for debt retirement, new capital purchases, and retained earnings when the family has a fixed consumption pattern, at this average level use the figures in Table 24. If the family tends to spend money if they have it available use Table 25.

A comparison of strategies residual incomes after the deduction of debt retirement payments at the fifty percent equity level reveals that all three strategies (10, 16, and 36) are able to adequately cover this requirement at all

Table 25. Residual income assuming a consumption function, 1970 to 1974.[1]

Strategy	Family Living Expenses At			Residual Income[2]		
	Maximum Net Income	Mean Net Income	Minimum Net Income	Maximum	Mean	Minimum
	Dollars					
10	17,664.47	14,507.66	11,424.82	41,420.53	34,442.34	29,092.00
16	16,564.64	14,163.82	11,984.69	36,952.36	32,279.18	28,077.31
36	14,579.67	12,643.75	10,810.23	33,382.33	30.300.25	27,611.77
37	13,724.68	8,757.12	-----[3]	21,891.32	14,485.88	------[4]

[1]A consumption function of the form;

$$\text{Consumption} = 22.96\ P^{0.410}{}_I{}^{0.590}{}_S{}^{0.163}$$

was used to estimate family living expenditures. Where P equals the ratio of current prices to 1961 prices, I equals after tax income, and S equals the number of members in the family. This was taken from Brake, John R., "Firm Growth Models Often Neglect Important Cash Withdrawals," American Journal of Agricultural Economics, Vol. 50, No. 3 (August 1968), pp. 769-772.

[2]Assumes 100 percent equity.

[3]Too low an income level for use of the consumption function.

[4]Negative values.

Table 26. Residual income minus debt retirement payments.[1]

Strategy	Maximum Value	Mean Value	Minimum Value
	----------Dollars----------		
	50 Percent Equity		
10	24,718.02	14,049.53	5,083.05
16	20,834.85	12,976.94	6,600.94
36	14,276.13	8,451.64	3,477.20
37	11,632.85	-1,432.46	-11,842.58
	40 Percent Equity		
10	20,420.07	9,388.82	571.72
16	16,873.90	8,860.21	2,484.21
36	10,114.42	4,491.54	- 906.30
37	9,411.81	-4,111.81	-1,325.91

[1]Debt retirement payments at 8.5 percent interest. Long term debt is repaid over 30 years and short term 10 years in equal annuity payments. Long term debt is approximately 2.5 times short term debt.

instances (Table 26). The all cash crop strategy with a fifty percent equity has a residual income which does cover the debt retirement commitment at only the maximum value. At the 40 percent equity level, one of the dairy strategies (36) is not able to cover the debt retirement payments. This suggests that at the 40 percent equity level only the very best of strategies will cover all commitments. For other strategies, this may range upwards of 50 to 60 percent equity required. Even at the seventy-five percent equity level, the all cash crop strategy still falls very short of covering debt retirement payments. Even at the

ninety percent equity level.

Table 27 shows the average return on investment over the 1970 to 1974 period. Strategy 16 has the highest return, yet less than one percentage point separates any of the strategies.

Table 27. Return on investment.[1]

Strategy	Return on Investment
	Percent
10	9.92
16	10.52
36	9.55
37	9.63

[1]At mean after tax income level before debt retirement payments, 1970 to 1974 period. Assets are value at 1975 new price levels. However, most farms do not have all new machinery, equipment and buildings in any one year. And therefore, the return on investment presented above underestimates the situation in which a combinaiton of new and used equipment and buildings are present.

Conclusions

The four strategies examined in the prior sections of this chapter all exhibited relatively high minimum income points when compared to the other strategies (see Figures 8 through 10). These four strategies also have the lowest variabilities for their income levels (see Figures 2 through 7). As a result, other strategies whose income opportunity points lie to the right of those examined in this chapter

will have a greater variability and therefore a larger probability for years occurring in which cost commitments cannot be met. Thus, it can be assumed that strategies having lower minimum income levels than 10, 16, and 36 will have a greater probability of not meeting debt retirement payments.

At the 50 percent equity level, the dairy strategies covering fixed cost commitments in all instances. The other dairy strategies not examined in this chapter, may well require minimum equity levels of 60 percent or higher to reduce the likelihood of not meeting cost commitments in low income years.

The all cash crop farm required much higher equity levels to avoid falling short on debt repayment. Even at the 90 percent equity level, the minimum income point did not cover all fixed cost commitments.

Chapter VI Footnotes

[1]After tax income as used in this research is the before tax income minus federal and state income taxes, self-employment taxes, and property taxes.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary of Research Procedure

The purpose of this study was to examine the level and variability of dairy farm income for Michigan dairy operations. Specifically, the objectives of the study were:

1. to describe the present economic environment in which Michigan dairy farmers must function,
2. to identify those Michigan dairy farms which are potentially most affected by recent changes in prices of inputs and outputs,
3. to analyze selected business management strategies for controlling the effects of price and cost changes on the level and variability of net dairy farm income,
4. to appraise the implications of adopting alternative strategies on the Michigan dairy farming industry.

Relevant Theory

A theoretical basis for analyzing the dairy business management strategies was deduced from decision theory and the theory of utility functions. Diversification and flexibility principles were also used in the process of management strategy formulation.

Representative Firm Analysis

An empirical analysis of the level and variability of net income for dairy business management strategies was accomplished by developing a synthetic dairy farm. Linear programming techniques were employed to determine net farm incomes and labor requirements for selected business management strategies for the year 1975.

A linear and logarithmic regression line were then fitted to the net income estimates for each of the thirty six dairy business management strategies and one cash grain strategy. This was done for each of three time periods: 1960 to 1969, 1970 to 1974, and 1960 to 1974.

Thus, for each business management strategy the 1975 income level and mean, maximum and minimum income values, standard deviation, and standard error of the estimate of regression were calculated for each of the three time periods.

Empirical Results

Limitations of the Study

A recognition of the following limitations of this study is necessary for correct interpretation of the empirical results:

1. The representative firm developed in this study does not depict all the dairy farms in Michigan. Many differing herd sizes and technologies are in existence within the state, however, the results are assumed to be applicable to the other milk

producing firms.

2. The assumptions concerning labor availability may be unrealistic for some Michigan milk producers. Some may substitute family labor for hired labor and others may find it difficult to hire the quantity of labor required.
3. The empirical analysis assumed a constant technology, herd and farm size over time. This also may be unrealistic, for most farms have not remained static. Therefore, this research must be referred to as static in the sense that a strategy with its corresponding technology and resource base, once selected, is adherred to through the time period analyzed. Yet, by following that strategy through time the research does have a dynamic aspect.
4. The estimates of costs of production and field crop yields were created using averages. Therefore, some firms will have higher and some lower costs of production and yields.
5. The assumption that the past is a good representation of the future is also crucial in the interpretation of the results. The view of the future that one holds will determine his actions and choice of strategy.

Major Findings

The empirical analysis of the thirty seven business management strategies resulted in the following major findings:

1. The current economic environment (1970 to 1974) was found to:
   a. Contain greater yearly variability in selected farm product prices than in past years (1960 to 1969). The coefficient of variation increased from 8.9 to 31.5 for corn grain, from 14.3 to 28.5 for wheat from 6.6 to 20.5 for oats, and from 10.7 to 22.1 for soybeans in 1970 to 1974 over 1960 to 1969.
   b. Contain greater yearly variability in selected farm input costs with the exception of farm wages and 6-24-24 mixed fertilizer than in past years (1960 to 1969). The coefficient of variation increased from 9.4 to 59.6 for soybean oil meal, from 4.9 to 33.1 for annhydrous ammonia, from 2.3 to 31.1 for gasoline, and from 2.5 to 21.9 for diesel fuel in 1970 to 1974 over 1960 to 1969.
   c. The prices received index increased in variability during the 1970 to 1974 period. An increase in the coefficient of variation from 3.04 to 10.47 was recorded. A like increase in

in the index of production cost items occurred. The coefficient of variation rose from 1.52 in 1.52 in 1960 to 1969 to 10.67 in 1970 to 1974.

2. In 1975, it was found through the use of linear programming that:
   a. Strategy 10 [feeding ration A (a ration containing 50 percent forage dry matter from haylage and 50 percent from corn silage) buying replacement stock, raising excess calves to dairy beef market weight, and selling corn grain from excess crop acres] was the highest income generating strategy. A before tax and debt retirement income of $100,304.39 resulted.
   b. Strategy 32 [feeding ration B (a ration containing 100 percent forage dry matter from hay crops) raising replacements, raising veal from excess calves, and growing a 50-50 corn grain-wheat rotation] was the lowest income strategy. A before tax and debt retirement net income of $42,942.14 resulted.
3. When comparing net income before taxes for business management strategies over three time periods, it was found that:
   a. Strategy 10 was the high income strategy which consistently exhibited the lowest variability for the high income range.

b. Strategy 34 (feeding ration A, buying replacements, selling excess dairy calves as veal, and growing a corn-wheat rotation on excess crop acres) was the low income strategy which consistently exhibited the lowest variability for the low income range.

c. Many strategies were in the center of the income opportunity graph, all exhibiting middle income and variability net incomes. Nonsignificant differences in mean and variability of income existed for this group.

d. Cash crop net income is lower than dairy farm net income in all time periods, but variability was equally as large as the dairy farm in the later time period.

4. A comparison of business management strategy components resulted in:

a. An all corn grain rotation on excess crop acres providing the highest income and the highest variability for many strategies.

b. A corn-wheat rotation reducing the variability over those strategies which contained an all corn rotation.

c. The decision to sell excess dairy calves as dairy beef producing the highest mean income level, deacons the median, and veal calves the

lowest. However, this is not consistent with what Michigan dairy farmers actually do. The additional labor, feed and facilities required to raise dairy beef may offset the additional income for many farmers.

d. Ration A (50 percent forage dry matter from haylage and 50 percent from corn silage) was the highest mean income level ration, ration B (100 percent forage dry matter from haylage) was the lowest, and ration C (7 pounds hay equivalent per day-remainder corn silage) the median. This was reversed, however in the 1970 to 1974 period when B and C exchanged rankings for strategies 19 through 36. This also is not consistent with what Michigan dairy farmers are doing. A limited availability of land and labor could reverse these results for many farmers.

e. Replacement stock being purchased from off farm sources versus raising herd replacements changed rankings from strategy to strategy.

5. When comparing selected business management strategies on the basis of net income after taxes it was found:

   a. The rankings for mean net income level remain unchanged from the before tax ranking.

b. The rankings for variability of net income also remain unchanged before and after taxes.

c. Of the dairy strategies examined, only the strategies with the lowest variabilities for their income level were able to always meet debt retirement commitments and family living expenses at the 50 percent equity level. The cash crop strategy was able to cover all expenses only at the maximum value with 50 percent equity.

Conclusions

The present economic environment has as a characteristic, variability. Higher price levels and greater fluctuations in agricultural prices have occurred as a result of many factors. The large volumes of grain exported in the face of low storage levels has both increased prices and made the market more sensitive to small changes in supply or demand. The energy situation with the associated price increases has pushed up the cost of production for grain and livestock products through fertilizer, gasoline, diesel fuel, and herbicide prices. Also, the general inflationary period of the national economy during the early 1970s increased the costs of many purchased inputs.

Dairy farms which are potentially most affected by the recent cost and price changes are those which are not as efficient in the production of grain, livestock, or milk and

those farms which have relatively low equity levels. The farms with high production costs may find small or even negative incomes in years when price-cost margins are low. Also, the farm with high debt retirement payments may find small or negative incomes not unlike those experienced by the inefficient operation.

However, many factors other than level and variability of net income are important in the decision process of selecting a strategy. Such factors as labor and investment requirements of the strategy, present financial position of the operator, current farm organization, and the age of the operator are all very important in the selection of a strategy.

The recent years, 1970 to 1974, have resulted in more yearly variability of net dairy farm income. It is for this reason that dairymen must choose strategies which limit variability within bounds that permit repayment of debt commitments and meet with their risk avoidance levels.

Yet, one should not be led to believe that by following a given strategy which has acceptable level and variability of income, no further management is necessary. The tactical decisions still remain and are also very important. Marketing decisions, the timing of the sale of grains and livestock as well as the purchase of inputs are crucial in the operation of a dairy farm. Purchases of needed inputs in volume or in off-season may be a desirable tactic in following the

chosen strategy. The use of futures markets may also be a tool applicable to both purchasing and selling farm items. Through the use of futures markets, a dairy farmer would be able to "lock in" the cost of some of the major feed inputs (soybean meal, corn grain). Also the price of grain commodities and livestock may be "locked in" at profitable levels.

The decisions in regard to modernizing or increasing the efficiency of the dairy farm are also important. Ways in which production costs per unit of output can be decreased or a reduction in labor requirements should be carefully examined and implemented when profitable.

Wise purchases or rental of machinery and income tax management are other areas of tactical decision making so important in today's economic environment.

The Michigan dairy farming industry will likely undergo changes in both the organization of dairy farms and in the structure of the industry. In an economic environment which has great variability in prices and costs, the dairy farmer will want to combine enterprises in such a manner so as to reduce variability while maintaining satisfactory income levels. This can be accomplished on a dairy farm with various components of the dairy enterprise or in combination with other crop and livestock enterprises.

The structure of the Michigan dairy industry will continue to change toward larger but fewer dairy farms. The more efficient dairy farm will be better able to withstand

the price and cost fluctuations. The inefficient and heavily financed dairy farms may experience financial difficulties in low price years.

Suggestions for Further Research

Additional research to more fully assist dairy farmers in their decision making under risk and uncertainty is needed. Researchable topics include:

1. To what extent will Michigan dairy farm organization adjust to the new economic environment?
2. How do dairy farmers react to a new price and cost environment and how are those decisions made?
3. To what degree will the greater variability in dairy farm income effect the structure of the Michigan dairy farming industry?

APPENDICES

APPENDIX A

Table A1: Prices of agricultural commodities

YEAR	Corn Grain[a] ($/bu.)	Wheat[a] ($/bu.)	Soybeans[a] ($/bu.)	Deacons[b] ($/head)	Veal[b] ($/cwt)	Dairy Beef[b] ($/cwt)	Slaughter Cows[b] ($/cwt)	Base Milk[b] ($/cwt)
1974	3.29	3.84	7.59	50.84	49.29	37.54	28.69	8.79
1973	2.16	2.66	5.34	66.10	64.08	39.85	35.57	7.28
1972	1.22	1.30	3.13	56.87	55.14	30.20	34.57	6.25
1971	0.94	1.30	3.02	47.80	46.34	27.30	25.75	6.11
1970	1.29	1.26	2.67	46.20	44.79	25.85	22.92	6.07
1969	1.06	1.11	2.20	40.12	38.90	26.14	21.54	5.80
1968	0.94	1.09	2.28	34.80	33.75	25.75	20.79	5.74
1967	0.96	1.27	2.44	32.66	31.67	23.06	18.89	5.52
1966	1.23	1.73	2.89	32.23	31.25	22.76	18.23	5.08
1965	1.02	1.27	2.28	28.90	28.02	20.31	18.94	4.40
1964	1.04	1.29	2.50	26.36	25.57	18.80	15.29	4.33
1963	1.05	1.65	2.47	29.13	28.25	20.70	14.34	4.29
1962	0.93	1.95	2.18	31.69	30.72	22.59	15.28	4.30
1961	0.92	1.71	2.14	30.29	29.37	21.60	15.84	4.48
1960	0.92	1.66	1.93	30.96	30.02	22.08	16.20	4.50

Source:Michigan Crop Reporting Service and Michigan Milk Messenger

[a]Price at the time of harvest. [b]Yearly Average.

Table A2: Cost of production for field crops[a]

Year	Field Crops					
	Corn Grain Sold	Corn Fed	Corn Silage	Soybeans	Wheat	Haylage
1975	99.80	78.30	96.50	44.65	65.35	50.67
1974	93.60	72.04	92.10	47.36	62.79	48.36
1973	68.96	51.09	64.23	34.58	41.95	34.89
1972	59.74	45.01	56.30	31.65	37.19	30.87
1971	57.19	43.47	54.31	30.53	36.05	29.80
1970	54.45	41.49	51.75	29.22	34.44	28.44
1969	52.25	39.80	49.78	28.35	33.27	27.42
1968	51.31	39.77	49.52	28.05	33.54	27.02
1967	50.64	39.66	49.49	27.63	33.60	26.78
1966	49.75	38.85	48.49	27.27	33.23	26.30
1965	48.82	38.59	47.99	27.32	33.29	25.67
1964	48.73	38.48	47.60	26.96	33.13	25.54
1963	49.71	39.57	47.83	26.99	34.17	25.67
1962	49.11	39.18	47.92	26.64	33.90	25.44
1961	48.36	38.68	47.28	26.27	33.51	25.41
1960	47.93	38.35	46.86	26.24	33.24	25.20

Source: Enterprise Budgets, Michigan State University, Department of Agricultural Economics, and Agricultural Product Prices, Crop Reporting Service, U.S.D.A.

[a]Variable costs, excluding property taxes or a land charge.

Table A3: Cost of milk and livestock production

Year	80 Cows with Replacement Ration			80 Cows without Replacement Ration			Dairy Livestock	
	A	B	C	A	B	C	Veal	Dairy Beef
1974	464.84	417.47	544.18	421.99	355.40	476.44	73.50	157.74
1973	395.70	297.65	454.80	335.15	255.80	409.91	62.70	129.26
1972	340.24	273.81	398.88	298.44	236.41	359.89	41.30	94.83
1971	293.87	271.50	318.90	258.04	236.13	284.71	40.40	92.11
1970	277.14	249.59	302.25	242.49	217.09	268.95	38.90	89.02
1969	278.47	252.80	302.72	243.14	219.41	268.79	36.90	85.63
1968	227.26	249.20	291.94	237.49	216.12	261.52	36.60	84.33
1967	280.58	253.71	305.10	243.80	218.66	269.69	38.20	86.80
1966	278.17	250.09	303.17	241.61	215.44	267.97	39.10	87.86
1965	294.39	263.07	319.12	253.46	225.05	279.42	37.30	86.24
1964	281.09	261.11	301.47	243.39	224.36	265.11	36.90	84.57
1963	278.97	258.97	299.82	241.63	222.52	263.83	37.30	84.74
1962	278.90	255.01	301.15	241.32	218.99	264.88	35.70	82.43
1961	270.40	255.59	288.02	234.50	219.96	253.43	35.30	81.41
1960	280.32	255.86	300.55	241.56	219.26	262.90	34.90	81.63

Sources: Nott, S.B., Telplan Program Two: Dairy Herd Management, Michigan State University, Dept. of Agricultural Economics and Agricultural Product Prices, Crop Reporting Service, U.S.D.A.

Table A4: Yields for field crops

Year	Corn Grain (bu)	Wheat (bu)	Soybeans (bu)	Corn Silage (T)	Haylage (T)
1974	80	43	28	10.4	11.4
1973	107	37	30	13.9	12.2
1972	116	51	35	15.1	11.4
1971	125	46	35	16.3	9.8
1970	120	45	38	15.6	11.9
1969	110	48	32	14.3	10.5
1968	112	43	31	14.6	10.3
1967	99	44	28	12.9	9.8
1966	97	49	29	12.6	9.9
1965	77	45	23	10.0	9.1
1964	92	51	30	11.9	8.3
1963	95	45	31	12.4	8.5
1962	91	45	25	11.8	8.9
1961	101	45	32	13.1	8.3
1960	81	40	24	10.5	9.0

Source: Michigan Crop Reporting Service Estimates increased to above average management levels.

Table A5: Estimated costs of basic machinery complement

Item	Spec.	New Prices[a] Herd Size 80
Tractor (Used)[a]	50 H.P.	3895
Tractor[a]	38 H.P.	6407
Tractor[a]	53 H.P.	7790
Tractor[a]	70 H.P.	8358
Plow	3-16"	2336
Plow	4-16"	2920
Disc	12'	1898
Corn Planter	4-Row	2190
Spray Attachment	4-Row	440
Seeder		1315
Field Chopper[a]	2-R PTO	4797
Corn Harvester[a](Corn grain only)	2-R Mounted	6240
Corn and Grain Harvester[a] (Corn, wheat, soybeans)	Self-Propelled	22,172
Sprayer	32'	1460
Silage Wagons	S.U.	4960
Grain Wagons		850
Corn Head[a]	2-Row	923
Forage Head[a]	2-Row	1751
Harrow	16'	657
Cultivator	4-Row	1240
Windrower[a]	9' PTO	3580
Truck	3/4 T.	3650
Total Cost: Corn only		$66,234
Corn and Wheat		82,166

[a]Source: Official Guide: Tractors and Farm Equipment, National Farm and Power Equipment and Dealers Association, Spring 1975.
Those not labeled were taken from Darrel Good thesis and increased to 1975 price levels.

APPENDIX B

Table B1. Net income minimum and maximum values, mean, standard error of the estimate, and standard deviation of thirty seven business management strategies, 1960 to 1969.[a]

Strategy	Minimum Value	Maximum Value	Mean	Standard Error	Standard Deviation
(1)RA,R,D,C	30,479.74	56,769.00	40,292.96	6,013.44	10,198.89
(2)RB,R,D,C	27,151.25	48,882.93	35,224.03	5,195.63	8,808.56
(3)RC,R,D,C	26,956.70	51,924.64	37,271.45	5,783.96	9,405.87
(4)RA,BR,D,C	28,905.75	61,118.33	38,361.01	6,317.36	10,915.04
(5)RB,BR,D,C	28,465.36	58,290.65	36,315.24	5,922.31	10,477.99
(6)RC,BR,D,C	27,765.81	61,021.97	38,566.33	6,566.33	11,056.86
(7)RA,R,DB,C	29,714.27	57,293.87	40,248.12	6,545.47	10,325.58
(8)RB,R,DB,C	28,212.39	51,900.82	37,500.26	5,800.33	9,288.02
(9)RC,R,DB,C	28,799.86	55,360.04	39,874.47	6,331.33	9,898.89
(10)RA,BR,DB,C	30,855.19	56,557.49	41,057.44	6,170.40	9,971.05
(11)RB,BR,DB,C	29,918.25	53,854.37	39,109.16	5,843.99	9,575.42
(12)RC,BR,DB,C	29,808.00	56,582.91	40,858.08	6,378.69	10,117.98
(13)RA,R,V,C	27,301.78	53,390.58	37,300.58	6,121.51	9,966.88
(14)RB,R,V,C	26,114.25	48,625.99	34,551.78	5,374.65	8,931.30
(15)RC,R,V,C	27,480.41	54,316.10	38,761.98	6,156.49	9,840.57
(16)RA,BR,V,C	28,514.96	51,004.73	36,931.94	5,539.38	8,733.85
(17)RB,BR,V,C	27,242.02	48,553.18	34,886.17	5,240.45	8,340.75
(18)RC,BR,V,C	27,433.83	50,785.36	36,637.27	5,742.84	8,869.84
(19)RA,R,D,C-W	28,030.36	51,711.64	37,374.41	5,695.56	8,865.54
(20)RB,R,D,C-W	26,877.00	47,781.81	35,108.18	5,069.15	8,351.20
(21)RC,R,D,C-W	26,695.36	48,833.04	36,468.87	5,454.78	8,193.29
(22)RA,BR,D,C-W	28,544.61	57,346.01	37,849.08	5,935.10	9,435.49
(23)RB,BR,D,C-W	28,260.71	56,145.13	36,321.90	5,721.36	9,596.55
(24)RC,BR,D,C-W	27,399.94	56,510.51	37,407.14	6,064.56	9,264.02
(25)RA,R,DB,C-W	29,572.76	55,177.72	39,689.73	6,306.73	9,409.92
(26)RB,R,DB,C-W	28,027.79	51,049.81	37,351.68	5,728.00	8,929.52
(27)RC,R,DB,C-W	28,579.75	52,359.22	39,121.39	6,023.95	8,732.78
(28)RA,BR,DB,C-W	30,612.36	53,087.08	40,195.56	5,849.41	8,862.55
(29)RB,BR,DB,C-W	29,407.45	51,886.42	38,668.56	5,685.42	8,794.49
(30)RC,BR,DB,C-W	29,447.11	52,407.81	39,768.08	5,975.25	8,529.39
(31)RA,R,V,C-W	27,154.59	51,166.96	36,714.55	5,859.94	8,988.24
(32)RB,R,V,C-W	25,961.90	47,868.58	34,433.33	5,305.66	8,598.83
(33)RC,R,V,C-W	25,864.74	48,651.22	35,855.41	5,619.46	8,324.03
(34)RA,BR,V,C-W	28,370.09	47,740.36	36,081.82	5,240.99	7,374.08
(35)RB,BR,V,C-W	27,049.92	46,591.22	34,394.51	5,096.74	7,524.93
(36)RC,BR,V,C-W	27,081.00	46,669.38	35,491.48	5,349.39	7,204.32
(37)C-C-S-W	8,080.22	21,209.10	13,550.04	3,913.17	3,818.89

[a]Net income before taxes, debt retirement payments, return to operator labor, management, and equity capital.

Table B2. Net income minimum and maximum values, mean, standard error of the estimate, and standard deviation of thirty seven business management strategies, 1970 to 1974.[a]

Strategy	Minimum Value	Maximum Value	Mean	Standard Error	Standard Deviation
(1)RA,R,D,C	57,283.93	86,315.46	71,436.77	9,338.71	13,255.02
(2)RB,R,D,C	49,854.21	79,027.74	64,530.69	8,719.78	12,815.62
(3)RC,R,D,C	53,855.26	79,883.01	66,615.97	9,958.25	12,415.07
(4)RA,BR,D,C	52,476.49	99,352.21	71,712.54	13,145.91	19,725.94
(5)RB,BR,D,C	48,969.02	96,439.93	68,995.25	12,075.20	19,686.81
(6)RC,BR,D,C	52,467.32	98,697.73	70,729.75	14,045.46	19,626.70
(7)RA,R,DB,C	56,553.06	85,451.30	70,813.91	9,512.97	13,352.76
(8)RB,R,DB,C	52,400.72	83,470.46	67,419.84	9,115.57	13,312.66
(9)RC,R,DB,C	56,897.32	84,875.91	70,030.33	10,196.85	12,860.13
(10)RA,BR,DB,C	56,974.55	90,822.14	73,511.54	11,214.37	15,640.60
(11)RB,BR,DB,C	53,613.90	88,547.94	70,950.93	10,450.26	15,714.25
(12)RC,BR,DB,C	57,109.90	88,966.17	72,681.92	11,677.72	15,366.41
(13)RA,R,V,C	53,960.09	81,002.06	67,629.76	9,071.55	12,357.86
(14)RB,R,V,C	49,806.99	79,020.38	64,234.88	8,687.52	12,315.59
(15)RC,R,V,C	56,467.62	85,618.83	70,635.15	10,800.42	13,471.23
(16)RA,BR,V,C	55,662.69	82,843.16	68,256.01	9,193.10	10,907.51
(17)RB,BR,V,C	52,154.22	80,404.82	65,538.72	8,757.36	11,042.76
(18)RC,BR,V,C	55,653.52	80,723.11	67,273.22	9,394.57	10,541.32
(19)RA,R,D,C-W	52,086.01	78,473.35	64,101.49	7,783.77	11,827.38
(20)RB,R,D,C-W	49,541.19	78,126.02	63.331.24	8,359.13	12,061.78
(21)RC,R,D,C-W	51,390.88	74,543.11	61,806.00	8,120.16	10,952.99
(22)RA,BR,D,C-W	49,445.17	93,612.07	65,862.08	11,641.37	18,457.61
(23)RB,BR,D,C-W	47,305.19	93,162.04	65,620.98	11,058.56	18,913.08
(24)RC,BR,D,C-W	48,880.06	91,824.71	63,703.92	12,427.67	18,157.13
(25)RA,R,DB,C-W	54,741.70	81,008.33	67,194.70	7,991.43	12,248.28
(26)RB,R,DB,C-W	51,776.27	81,214.77	66,054.62	8,429.79	12,843.03
(27)RC,R,DB,C-W	54,524.63	77,611.91	65,346.83	8,288.29	11,378.49
(28)RA,BR,DB,C-W	54,237.30	84,153.60	68,089.98	8,970.79	14,009.28
(29)RB,BR,DB,C-W	52,097.58	83,703.87	67,849.14	9,047.01	14,753.18
(30)RC,BR,DB,C-W	53,777.26	82,608.34	66,189.73	9,234.01	13,478.19
(31)RA,R,V,C-W	52,057.59	76,560.85	63,825.61	7,478.24	11,182.56
(32)RB,R,V,C-W	49,261.50	76,982.55	63,011.97	8,058.59	11,879.08
(33)RC,R,V,C-W	51,432.82	72,715.93	61,604.69	7,796.97	10,318.82
(34)RA,BR,V,C-W	52,876.73	73,891.11	62,665.60	6,620.13	8,920.39
(35)RB,BR,V,C-W	50,493.94	74,981.04	62,167.14	7,160.87	9,848.68
(36)RC,BR,V,C-W	52,086.58	69,601.99	60,268.93	6,358.12	8,123.36
(37)C-C-S-W	17,711.06	53,842.57	32,757.91	9,385.19	15,656.40

[a]Net income before taxes, debt retirement payments, return to operator labor, management, and equity capital.

Table B3. Net income minimum and maximum values, mean, standard error of the estimate, and standard deviation of thirty seven business management strategies, 1960 to 1974.[a]

Strategy	Minimum Value	Maximum Value	Mean	Standard Error	Standard Deviation
(1)RA,R,D,C	30,479.74	86,315.46	50,674.23	6,958.73	18,654.88
(2)RB,R,D,C	27,151.25	79,027.74	44,992.92	6,375.13	17,358.02
(3)RC,R,D,C	26,956.70	79,883.01	47,052.95	7,298.02	17,491.03
(4)RA,BR,D,C	28,905.75	99,352.21	49,203.52	7,703.83	20,869.49
(5)RB,BR,D,C	28,465.36	96,439.93	46,933.91	7,246.69	20,479.59
(6)RC,BR,D,C	27,765.81	98,697.73	48,679.48	8,030.72	20,620.71
(7)RA,R,DB,C	29,714.27	85,451.30	50,436.72	7,564.90	18,491.25
(8)RB,R,DB,C	28,212.39	83,470.46	47,473.45	7,032.61	17,867.06
(9)RC,R,DB,C	28,799.86	84,875.91	49,926.42	7,644.36	18,076.58
(10)RA,BR,DB,C	30,855.19	90,822.15	51,875.47	7,787.73	19,610.87
(11)RB,BR,DB,C	29,918.25	88,547.94	49,723.08	7,428.82	19,258.78
(12)RC,BR,DB,C	29,808.00	88,966.17	51,466.03	8,046.10	19,349.65
(13)RA,R,V,C	27,301.78	81,002.06	47,410.01	7,101.80	18,069.71
(14)RB,R,V,C	26,114.25	79,020.38	44,446.15	6,542.14	17,446.99
(15)RC,R,V,C	27,480.41	85,618.83	49,386.37	7,719.73	18,867.51
(16)RA,BR,V,C	28,514.96	82,843.16	47,910.78	6,668.72	17,859.82
(17)RB,BR,V,C	27,242.02	80,404.83	45,641.17	6,259.47	17,462.95
(18)RC,BR,V,C	27,433.83	80,723.11	47,386.74	6,961.63	17,567.28
(19)RA,R,D,C-W	28,030.36	78,473.35	46,283.44	6,680.02	16,142.34
(20)RB,R,D,C-W	26,877.00	78,126.02	44,548.51	6,237.88	16,622.25
(21)RC,R,D,C-W	26,695.36	74,543.11	44,914.58	6,588.69	15,175.03
(22)RA,BR,D,C-W	28,544.61	93,612.07	46,578.75	7,383.57	18,267.99
(23)RB,BR,D,C-W	28,260.71	93,162.04	45,480.26	7,259.44	18,927.13
(24)RC,BR,D,C-W	27,399.94	91,824.71	45,564.74	7,596.97	17,496.43
(25)RA,R,DB,C-W	29,572.76	81,008.33	48,857.91	7,216.97	16,730.40
(26)RB,R,DB,C-W	28,027.79	81,214.77	46,919.33	6,922.43	17,162.24
(27)RC,R,DB,C-W	28,579.75	77,611.91	47,863.20	7,159.32	15,804.19
(28)RA,BR,DB,C-W	30,612.36	84,153.60	49,493.70	7,321.90	17,004.84
(29)RB,BR,DB,C-W	29,407.45	83,703.87	48,395.42	7,208.42	17,738.42
(30)RC,BR,DB,C-W	29,447.11	82,608.34	48,575.30	7,449.12	16,275.34
(31)RA,R,V,C-W	27,154.59	76,560.85	45,751.57	6,717.80	16,206.98
(32)RB,R,V,C-W	25,961.90	76,982.55	43,959.55	6,435.08	16,802.15
(33)RC,R,V,C-W	25,864.74	72,715.93	44,438.50	6,719.36	15,258.73
(34)RA,BR,V,C-W	28,370.09	73,891.11	45,480.56	6,007.08	15,065.54
(35)RB,BR,V,C-W	27,049.92	74,981.04	44,189.54	5,919.83	15,768.57
(36)RC,BR,V,C-W	27,081.00	69,601.99	44,288.11	6,099.64	14,128.05
(37)C-C-S-W	8,080.22	53,842.57	19,952.67	9,161.66	12,932.67

[a]Net income before taxes, debt retirement payments,return to operator labor, management, and equity capital.

Table B4: Strategy rankings 1960 to 1974

Strategy	Ranking		
	Mean Income[1]	Standard Error of Estimate[2]	Standard Deviation[2]
(1)	3	15	27
(2)	29	6	15
(3)	20	25	18
(4)	9	32	36
(5)	19	22	34
(6)	11	35	35
(7)	4	29	26
(8)	16	17	22
(9)	5	31	24
(10)	1	34	33
(11)	6	27	31
(12)	2	36	32
(13)	17	18	23
(14)	32	8	16
(15)	8	33	29
(16)	14	10	28
(17)	25	5	17
(18)	18	16	20
(19)	23	11	7
(20)	31	4	10
(21)	30	9	3
(22)	22	26	25
(23)	28	22	30
(24)	26	30	19
(25)	10	21	11
(26)	21	14	14
(27)	15	19	6
(28)	7	24	13
(29)	13	20	21
(30)	12	28	9
(31)	24	12	8
(32)	36	7	12
(33)	33	13	4
(34)	27	2	2
(35)	35	1	5
(36)	34	3	1

[1] 1 equals highest income

[2] 1 equals lowest variability

Table B5: Strategy rankings 1970 to 1974

Strategy	Ranking		
	Mean Income[1]	Standard Error of Estimate[2]	Standard Deviation[2]
(1)	4	22	21
(2)	25	14	18
(3)	18	25	17
(4)	3	35	36
(5)	9	33	35
(6)	7	36	34
(7)	6	24	23
(8)	14	19	22
(9)	8	26	20
(10)	1	30	29
(11)	5	27	30
(12)	2	32	28
(13)	13	18	16
(14)	26	13	15
(15)	7	28	24
(16)	10	20	7
(17)	23	15	8
(18)	16	23	5
(19)	27	5	11
(20)	30	11	13
(21)	34	9	6
(22)	21	31	32
(23)	22	29	33
(24)	29	34	31
(25)	17	7	14
(26)	20	12	19
(27)	23	10	10
(28)	11	16	26
(29)	12	17	27
(30)	19	21	25
(31)	28	4	9
(32)	31	8	12
(33)	35	6	4
(34)	32	2	2
(35)	33	3	3
(36)	36	1	1

(1) 1 equals highest income

(2) 1 equals lowest variability

Table B6. Strategy rankings 1960 to 1969

Strategy	Ranking		
	Mean Income[1]	Standard Error of Estimate[2]	Standard Deviation[2]
(1)	3	25	32
(2)	31	3	14
(3)	21	17	22
(4)	12	31	35
(5)	24	22	34
(6)	15	36	36
(7)	4	35	33
(8)	17	18	21
(9)	6	33	28
(10)	1	30	30
(11)	11	19	25
(12)	2	34	31
(13)	20	28	29
(14)	34	8	17
(15)	13	29	27
(16)	22	10	12
(17)	33	5	5
(18)	25	16	16
(19)	19	13	15
(20)	32	1	7
(21)	26	9	4
(22)	16	23	24
(23)	27	14	26
(24)	18	27	20
(25)	8	32	23
(26)	9	15	18
(27)	10	26	11
(28)	5	20	10
(29)	14	12	13
(30)	7	24	8
(31)	23	21	19
(32)	35	6	9
(33)	29	1	6
(34)	28	4	2
(35)	36	2	3
(36)	30	7	1

(1) 1 equals largest mean income

(2) 1 equals lowest variability

APPENDIX C

Table C1. Level and variability of after tax income for selected strategies[a,b]

Strategy	Minimum Value	Maximum Value	Mean	SEE	S.D.
		1960 to 1969			
10	25,040.00	39,836.00	31,081.10	3,718.21	5,916.05
16	22,985.00	38,447.00	29,052.10	3,580.01	6,156.03
36	22,609.00	36,346.00	28,508.50	3,554.09	5,318.67
37	7,291.00	16,652.00	11,063.70	2,805.60	2,703.07
		1970 to 1974			
10	40,517.00	59.085.00	48,950.00	5,813.02	8,036.36
16	40,062.00	53,517.00	46,438.80	4,214.90	5,414.79
36	38,472.00	47,962.00	42,944.80	3,138.86	4,308.59
37	13,526.00	35,616.00	23,243.40	5,992.37	9,607.88
		1960 to 1974			
10	25,040.00	59.085.00	37,037.40	4,373.25	10,815.51
16	22,985.00	53,517.00	34,847.67	3,828.38	10,233.03
36	22,609.00	47,962.00	33,320.60	3,698.43	8,550.44
37	7,291.00	35,616.00	15,123.60	4,990.21	8,148.13

[a]After tax income is the before tax income minus property taxes, state and federal income taxes, and self-employment taxes. It is therefore the return to operator labor, management, and equity capital plus the amount available for debt retirement purposes.

[b]Income averaging was not used. If income averaging had been used, a reduction in variability would likely occur. However, it is not believed the reduction would be large or would change the rankings.

Table C2. Yearly taxes for selected strategies

Year	Strategy 10				Strategy 16			
	Federal Income Tax	State Income Tax	Self-Employment Tax	Property Tax	Federal Income Tax	State Income Tax	Self-Employment Tax	Property Tax
1974	25,507	2,081	1,043	6,011	17,917	1,525	1,043	5,739
1973	29,972	2,398	1,043	5,226	22,329	1,850	1,043	5,000
1972	12,782	1,120	1,043	4,529	12,116	1,066	1,043	4,451
1971	11,061	974	1,043	4,135	10,342	912	1,043	4,080
1970	16,709	1,430	1,043	3,838	15,565	1,341	1,043	3,899
1969	11,680	1,028	1,043	3,642	10,280	906	1,043	3,701
1968	11,197	986	1,043	3,179	9,398	824	1,043	3,231
1967	8,447	734	1,043	2,678	7,072	597	1,043	2,716
1966	9,225	808	1,043	2,403	7,772	677	1,043	2,443
1965	3,059	101	1,043	2,172	2,436	3	1,043	2,210
1964	3,743	199	1,043	2,210	3,139	113	1,043	2,249
1963	4,203	263	1,043	2,287	3,152	115	1,043	2,328
1962	3,907	222	1,043	2,257	2,684	42	1,043	2,249
1961	5,349	406	1,043	2,090	4,214	265	1,043	2,130
1960	4,286	275	1,043	1,970	3,128	111	1,043	2,008

Table C2. Continued

Year	Strategy 36				Strategy 37			
	Federal Income Tax	State Income Tax	Self-Employment Tax	Property Tax	Federal Income Tax	State Income Tax	Self-Employment Tax	Property Tax
1974	13,880	1,209	1,043	5,918	13,365	1,167	1,043	3,092
1973	15,213	1,314	1,043	5,000	9,421	827	1,043	2,621
1972	8,467	736	1,043	4,339	2,366	-8	1,043	2,420
1971	8,656	755	1,043	3,965	1,395	-179	1,029	2,269
1970	11,671	1,027	1,043	3,684	3,173	118	1,043	2,129
1969	8,222	712	1,043	3,492	1,074	-256	873	1,982
1968	7,511	641	1,043	3,049	725	-341	702	1,734
1967	5,957	476	1,043	2,568	587	-371	640	1,450
1966	7,016	591	1,043	2,301	2,408	88	1,043	1,270
1965	2,015	-68	1,043	2,077	41	-500	363	1,123
1964	2,764	54	1,043	2,111	1,091	-178	881	1,117
1963	2,090	77	1,043	2,184	1,342	-85	1,004	1,147
1962	3,023	95	1,043	2,154	790	-290	734	1,115
1961	4,251	270	1,043	1,991	1,166	-90	918	989
1960	3,091	105	1,043	1,874	130	-413	413	907

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