THE RELATIONSHIP BETWEEN BUSINESS SUCCESS AND SELECTED DAIRY BUSINESS ANALYSIS FACTORS ON LARGE SOUTHWESTERN U. S. DRYLOT DAIRIES

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ABSTRACT

THE RELATIONSHIP BETWEEN BUSINESS SUCCESS AND SELECTED DAIRY BUSINESS ANALYSIS FACTORS ON LARGE SOUTHWESTERN U.S. DRYLOT DAIRIES

By

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Records from Southwestern U.S. drylot dairies were studied to determine the management factors most useful for monitoring the dairy operation and to suggest a predictive model for relating the financial, marketing, and production facets of the business to business success.

All information was obtained anonymously through an accounting agency. Raw data was converted to 25 specified ratios measuring the various aspects of the dairy business. The relationship of these ratios to business success was then investigated by means of multiple regression analysis.

Ten factors resulted in a coefficient of determination, R^2, of .69. Milk revenue per cow contributed 98% of the explained variation in percent return to net worth. The relationship suggests that the genetic potential of cows to produce milk, as well as those management practices which contribute to high milk production, should be a top priority item to dairymen.

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DEDICATION

This study is dedicated to my wife, Donna, as a thank you for the patience, encouragement and love she has given me throughout my graduate education.

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I. INTRODUCTION

Modern dairy enterprises are characterized by increased cows per farm, increased production per cow, increased use of capital, technology, and managerial skills, and narrow profit margins. These characteristics are most applicable to large specialized drylot operations as found in the southwestern states. Dairy managers intending to create, maintain, or improve profitability under such circumstances must efficiently monitor the financial, marketing, and production facets of the business in order to quickly pinpoint problem areas where improvements should be made. A tool which can be used to monitor the business without requiring the dairyman to have knowledge of the underlying economic theory is the dairy business analysis. A dairy business analysis consists of comparing a set of predetermined performance factors developed from the dairyman's record system to historical and industry norms. To date, few such norms, or guidelines, are available for large specialized drylot dairies, nor are sufficient studies available indicating the most suitable performance factors to use in an analysis. This is particularly true when considering measures dealing with acquisition and use of capital.

The objectives of this study are:

1) To determine which management factors are most useful for monitoring:
   a) the financial facet of the dairy enterprise (acquisition and use of capital),
   b) the marketing facet of the dairy enterprise (procurement of inputs, pricing, and distribution of outputs), and
   c) the production facet of the dairy enterprise (physical inputs and outputs, quantities, and technologies).
2) To suggest a predictive model for relating the financial, marketing, and production facets of the business to business success.
3) To determine the relative value of financial, marketing, and production factors when used simultaneously in a dairy business analysis.

To accomplish these objectives literature was first reviewed concerning 1) factors to be used in business analysis, 2) currently available business analysis tools, and 3) the relationship between specified factors and business success. A set of factors to be studied was then selected and data obtained from an established southwestern U.S. accounting firm specializing in dairy accounts. Descriptive statistics were then developed from the data set and multiple regression analysis was used to accomplish the remaining objectives. The following pages detail this procedure and present the results obtained from the study.

It is expected that results of this study will be useful to dairy managers, extension dairy management specialists, financial institutions, and related agencies interested in dairy business analysis.

II. REVIEW OF LITERATURE

This review is concerned with the changing nature of the dairy business; factors and methods used in dairy business analysis; and the association between dairy business analysis factors and measures of success.

Changing Nature of the Dairy Business

Changes in the dairy industry during the last few decades help explain the increased need for use of business analysis as a management tool. Farm numbers have decreased with a corresponding increase in farm size. In 1959 U.S. farms numbered over 4 million and averaged 288 acres per farm. In 1975 these values were under 3 million and over 385, respectively (11). Within the dairy sector herds of 10 or more cows were reduced by 33% during the 1954-1964 era and 49% during the 1964-1974 era. During the entire 1954-1974 period total milk cow numbers declined 30%; milk production per cow increased 30%; and average cows per farm increased by 26 cows (4). Increased use of capital, technology, and managerial skills is indicated by changes in labor and capital as percents of agricultural input values. From 1940 to 1972 labor use decreased 35 percentage points while use of capital increased 35 percentage points (34). Production costs have risen at a faster rate than gross income. Since 1972 feed and interest costs have increased by more than 70%. Building and machinery costs have increased by more than 50% while fertilizer and energy costs have gone up 100%. The price received for milk since 1972 has gone up by only 39% (3). The result of such cost-price changes is narrower profit margins. Hoglund (4), during a 12-month study of the U.S. dairy industry today, reported that modern dairies are larger, more highly mechanized, and better managed than ever before.

Through this veil of change has emerged the enigmatic phrase large herd management. This study deals with business analysis of large dairies and it is therefore appropriate to expand upon the definition and nature of large herd management. Albright (1) attempts to define large herd in a manner applicable, within reason, to most of the U.S. dairies, by stating that a dairy herd is large when the owner-operator: 1) manages resources such as feed, labor, and capital; 2) handles and thinks of cows in terms of groups rather than individuals; 3) no longer milks his own cows; 4) raises most of the feed for his herd and owns at least twice the average number of cows enrolled in his state D.H.I.A. program; and 5) has 100 or more cows in milk at one location. Speicher (8) indicates that not only herd size, but size of investment can be used in classifying the size of a herd as large. Pelissier (6) states that to define a herd as large is a relative matter affected by location, environment, custom, market, and a variety of economic factors. Consequently, discussion of large herd management is facilitated by relating management practices to specific geographical areas and situations.

The author concurs with Pellisier in that geographic location facilitates understanding the nature of large herd management. Although Longo (5) does not define large herds by size, he describes successful large herd management systems in New England has having:

1) efficient records and accounting systems,
2) sufficient time for the manager to plan and organize,
3) use of sophisticated investment analysis tools,
4) ration balancing and forage analysis programs,
5) group feeding methods,
6) planned breeding programs,
7) planned herd health programs,
8) free stall milking systems,
9) bunker silos.

Speicher (8) states that 50 or more cows is a reasonable approximation of a large herd in the Midwest and he outlines those aspects which have a major effect on profits from large dairy farms:

1) adequate herd size,
2) high level of output per cow,
3) controlled feed costs,
4) investment to accomplish desired goals at least cost,
5) high output per man,

6) maintenance and use of adequate records,

7) sound youngstock management program,

8) milk price,

9) balance of operations.

From data supplied by Pelissier (6), it is reasonable to define a Southwest herd as 400 or more cows. Such herds, radical departures from more traditional dairying, are characterized by small acreage drylots, purchasing of all feed and replacements, high investments, a high degree of mechanization, and narrow profit margins (2,7,9,10).

The changing nature of the dairy industry accents the increased need for accurate business monitoring and analysis particularly in larger dairy herds.

Methods and Factors Used in Dairy Business Analysis

For a complete business analysis researchers in the field of farm management science have developed selected measures to evaluate the success and efficiency of the whole farm, to describe organization of the farm, to measure the level of farm inputs and outputs, and to evaluate the efficiency of individual farm enterprises. Black et al. (13), Boss and Pond (14), Case et al. (18), Chastain et al. (19), and Heady and Hopkins (25) outlined a variety of such measures. A composite outline developed from the above references is printed below to provide the reader with adequate perspective:

I. Measures of whole-farm earnings and efficiency

A. Aggregate measures

1. Net cash income is the difference between cash input and cash output.

2. Gross income is gross cash receipts adjusted for inventory change, livestock purchases, and feed purchases.

3. Net operating income is gross income less operating expenses.

4. Net farm income is gross income less both operating and fixed expenses.

5. Return to management is net farm income less arbitrary charges for a) operator's labor, b) family labor, c) interest on net worth, and d) rental value of all land with improvements.

6. Return to total investment is net farm income less arbitrary charges for operator and family labor plus interest on borrowed capital.

7. Return to net worth is net farm income less arbitrary charge for operator and family labor.

B. Ratio measures

1. Rate of return on investment is return to total investment divided by total investment.

2. Rate of return to net worth is return to net worth divided by net worth.

3. Operating ratio is operating expenses divided by gross income.
4. Fixed ratio is fixed expenses divided by gross income.
5. Gross ratio is total expenses divided by gross income.
6. Capital turnover is gross income divided by average capital investment.

II. Kind of organization

A. Percent of returns from livestock.

B. Percent of returns from crops.

C. Percent of land in different crops.

D. Diversity index is a simple index which shows the number of enterprises contributing significantly to the whole farm income.

E. Feed fed per acre.

F. Animal units per acre.

III. Size of business

A. Capital input

1. Total investment.
2. Size of important livestock enterprises.

B. Land input

1. Total acres.
2. Total acres tillable.

C. Labor input

1. Number of men.

2. Productive man-work-units is total labor input required for whole farm at normal regional labor efficiencies.

D. Combined inputs of land, labor, and capital

1. Total farm inputs.

2. Total nonfeed inputs.

IV. Labor efficiency

A. Work units per man is number of productive man-work-units divided by number of men.

B. Enterprise units per man.

C. Gross income per man.

V. Power and machinery efficiency

A. Power and machinery cost per acre.

B. Power and machinery investment per acre.

VI. Capital ratios

A. Capital per $100 gross income is total investment divided by gross income X 100.

B. Capital per man.

VII. Enterprise efficiency: dairy[1]

A. Milk sold per cow.

B. Butterfat sold per cow.

C. Total dairy income per cow.

D. Number cows per man.

E. Milk price per 100 pounds of milk.

F. Improvements per cow.

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[1]Only efficiency factors for the dairy enterprise were considered appropriate for this discussion. Nondairy enterprises were eliminated.

G. Replacements per cow.

H. Cattle income per cow.

I. Feed cost per cow.

J. Return per dollar of feed expense.

K. Percent cows in milk.

L. Grain fed per cow per day.

M. TDN fed per cow per day.

N. Hay equivalent per cow per day.

O. Pounds of milk per pound of grain fed.

Additional measures of financial soundness have been suggested more recently by Nelson, Lee, and Murray (29) and Hopkin, Barry, and Baker (26) as follows:

Current ratio is total current assets divided by total current debt. The current ratio is a measure of the ability of liquidated current assets to cover current outstanding debts.

Intermediate ratio is total current and intermediate assets divided by total current and intermediate debts.

Net capital ratio is total assets divided by total debt. The net capital ratio describes the long-run liquidity or solvency position of the business in that it reflects the ability of the sale of all assets to cover the entire business debt.

Leverage or debt: equity ratio is total debts divided by owner's equity or net worth. This ratio indicates how dependent the business entity is on nonequity capital.

Equity: value ratio is owner's equity divided by value of assets.

In reviewing the above measures, two observations should be made: 1) An almost infinite number of measures and ratios can be used to monitor a business. Only those considered significant for field use are listed. 2) Several measures can be used to measure the same characteristic of the business. The type of analysis and the most readily available information often determine which measure will be used to describe a given characteristic.

Farm management researchers have historically suggested two methods of business analysis (15,26,29). Trend analysis is used to analyze changes in finance, production, and marketing aspects of an individual farm business over a period of time. Comparative analysis is used to compare an individual farm with similar farms within a region through the use of various ratio measures. Ratios facilitate analysis of all farm businesses on the same basis. The usefulness of comparative analysis depends heavily on the availability of reliable standards for comparison.

Extension personnel throughout the U.S. have promoted state or regional comparative analysis and individual trend analysis with varying degrees of intensity.[2] The literature made available by these workers can be crudely

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[2] In view of the pragmatic nature of this study and the potential benefits to future researchers, the author considers it appropriate to briefly describe such work. The author requested information from 26 land-grant schools on dairy business analysis, categorized the material received, and included the material in the bibliography. The list is not necessarily all-inclusive.

classified into 3 categories: 1) Dairy Business Analysis Guides (17,24,33,34,37). These include specific instruction on the theory and use of business analysis. Some contain a set of standards developed from field data or a synthetic planning cost guide. Only two of the guides examined by the author contained specific information on financial management and standards which included short and long term liquidity (34,37). 2) Dairy Business Summaries (16,20,21,22,27,28,30,31,33,35,36,38). These are the most common type of business analysis tools available. The summaries contain cost standards et al. developed from land-grant university based record keeping systems. The data are accompanied by various explanations, but contain significantly less instructional material than the business analysis guides. The summaries vary greatly in thoroughness. 3) Synthetic Budget and Cost Guides (12,32,39). These are cost estimates developed from means other than those used for the business summaries. The guides are primarily designed for budget and planning purposes.

Association Between Dairy Business Analysis Factors and Measures of Business Success

In his Ph.D. dissertation Speicher (46) provides a thorough review of literature prior to 1963 describing the association between farm incomes and farm management factors. The present review will therefore concern literature developed during and after 1963.

Speicher (46,47) conducted an investigation to determine the amount of variation in net income that could be explained by selected farm management factors and to determine the relative importance of those factors in explaining this variation. To do so the author used Michigan D.H.I.A. and Michigan Mail-In Account Project records from 340 dairies for the period 1958 through 1962. All dairies received 70% or more of their gross income from dairy product sales. Thirty-eight factors were developed from the data source to reflect the effect of size of operation, livestock program, cropping program, and organization and intensity on net income. Prior to the use of multiple regression analysis, simple correlations between net income and each of the farm management factors were computed to establish the degree of curvilinearity. Sets of factors from within the groups of size, livestock and crop programs, and organization and intensity were developed since various combinations of factors within a group could be of equal value in explaining variation in net income. All sets were then combined in all possible combinations to produce 12 prediction equations. The largest coefficient of determination, .7531, resulted from the equation: $Y = F(X_3, X_3^2; X_6, X_6^2; X_9, X_9^2; X_{12}, X_{12}^2; X_{12}^3; X_{13}, X_{13}^2; X_{15}, X_{15}^2; X_{16}; X_{18}; X_{21}; X_{26}, X_{26}^2; X_{30}, X_{30}^2; X_{31}, X_{31}^2; X_{32}, X_{32}^2)$ where:

X_3, X_3^2 represents number of cows

X_4 represents number of tillable acres

X_6, X_6^2 represents crop value/tillable acres

X_9, X_9^2 represents soil value rating

$X_{12}, X_{12}^2, X_{12}^3$ represents percent cash crops

X_{13}, X_{13}^2 represents machinery expense/tillable acre

X_{15}, X_{15}^2 represents percent rented land

X_{16} represents tillable acres/cow

X_{18} represents milk sold/man

X_{21} represents milk sold/cow

X_{26}, X_{26}^2 represents milk price/cwt

X_{30}, X_{30}^2 represents base milk

X_{31}, X_{31}^2 represents dairy cattle income/cow

X_{32}, X_{32}^2 represents livestock income/\$100 feed expense

Path coefficients were used to measure the relative value of the farm management factors in the explanation of variation in net income. The path coefficients and conversion of the path coefficients to percents of explained variation are shown in Table II-1. It should be noted that the 3 groups, size of operation, livestock program, and cropping program, explained 28%, 25%, and 29% of the variation, respectively. The remaining 18% was accounted for by machinery expense and organization and intensity. Within the two groups, livestock and cropping program factors, livestock income/$100 feed expense ($X_{32}$) and crop value/tillable acre (X_6) accounted for 86% and 88% of total variation attributed to the respective group.

Results of the entire investigation indicated size of operation, cropping program, and livestock operation

Table II-1. Explanation of variation in net income with 14 farm management factors. Coefficient of determination (R^2) = .75

Farm management factors		Path Coef. (P^2)	% of Explained variation: Individual factors	Area totals
X_3	Number of cows	.038	5.2	27.7
X_4	Number of tillable acres	.163	22.5	
X_6	Crop value/tillable acre	.163	22.5	
X_9	Soil value rating	.002	.3	25.4
X_{12}	Percent cash crops	.019	2.6	
X_{13}	Machinery expense/ tillable acre	.086	11.9	11.9
X_{15}	Percent rented land	.008	1.1	1.1
X_{16}	Tillable acres/cow	.032	4.4	4.8
X_{18}	Milk sold/man	.003	.4	
X_{21}	Milk sold/cow	.006	.8	
X_{26}	Milk price/CWT	.002	.3	
X_{30}	Milk production distribution	.002	.3	29.1
X_{31}	Dairy cattle sales/cow	.019	2.6	
X_{32}	Livestock income/$100 feed	.182	25.1	

to be of equal importance in determination of net income. In addition it was shown that farm management factors within a factor group exhibit a primacy of order in explaining variation in net income.

LaDue and Bratton (44) continued an ongoing study of the relationship of various dairy farm business factors to labor income. Labor income was defined as return to operator's labor and management. The data source used was 731 farm business records of New York dairy farmers cooperating in extension farm management projects. The sample was considered slightly above average. Records were summarized, put on electronic data processing cards, and sorted in various ways to provide relationship data. Beyond this sorting no statistical procedures were performed. Factors were first considered one at a time and the following observations were made: 1) Size was strongly related to labor income. Larger farms made higher labor incomes and had greater labor, livestock, crop, and machinery efficiencies. No relationship appeared to exist between size and capital efficiency. 2) Higher rates of production were associated with higher labor incomes. 3) Labor incomes rose sharply with increased labor efficiency. 4) Investments which increased labor efficiency were associated with higher labor incomes. 5) Optimum cost levels for increased labor income fell between maximum and minimum cost levels. 6) Sole proprietorships made significantly higher incomes than equal size partnerships. When combinations of size, rate of production, labor efficiency, and cost control factors were examined it was concluded that labor efficiency was most consistently important.

Currin et al. (42) used multiple discriminant analysis to assign dairy farms to income groups on the basis of selected business analysis factors. One hundred seventy-eight records taken from the V.P.I. Farm Account System during 1968 and 1969 served as the data base. The 8 business analysis factors studied were 1) number of dairy cows, 2) pounds of milk sold per cow, 3) price received per hundredweight of milk, 4) estimated feed cost per hundredweight, 5) investment per cow, 6) percent of total investment in dairy cows, 7) percent cow turnover, and 8) pounds of milk sold per man. These factors were related to 4 labor income groups ranging from less than $1 to greater than $10,000. Feed cost per hundredweight of milk sold proved to have the greatest power to discriminate farms into the income groups. The analysis indicated that farms earning a negative income would have a .96 probability of receiving a positive income if feed costs per hundredweight were reduced 30%. The authors considered discriminant analysis a valuable tool for farm business analysis in that the method can indicate probability of increasing income if certain adjustments are made.

The objectives of a study by Brown and White (41) were to characterize relationships among selected herd management variables and to determine the curvilinearity of these variables when associated with average milk yield and income over feed costs in Jersey, Guernsey, and Holstein herds. The data source included average yearly D.H.I.A. records completed from 1965 to 1970 from 2,269 Holstein, 230 Guernsey, and 134 Jersey herds in 8 southeastern states. Twelve independent variables were related to income over feed costs: 1) milk yield, 2) milk price, 3) milk fat percent, 4) percent days in milk, 5) feed costs per 45.4 kg milk, 6) other feed costs, 7) concentrates fed, 8) succulents fed, 9) dry forage fed, 10) days on pasture, 11) grain price, and 12) herd size. Variables were also related to milk production. Correlations between herd size and income over feed cost were significant and positive. Results of multiple regression analysis when income over feed cost was the dependent variable indicated that the 12 variables included in the model accounted for 99% of the variation in income over feed costs. The full model included both linear and quadratic effects. Milk price, milk production per cow, concentrate feeding, grain price, and other feed costs were relatively more important than other variables in determining income over feed cost. This is in accordance with earlier studies (46,47).

Literature concerning the relationship between financial ratios and dairy business success measures is rare. This is to be expected in light of the reluctance of the average dairyman to divulge financial information and in light of the limited and frequently unreliable financial information available from land-grant university record programs. Asset and liability valuation is perhaps the most difficult farm record to incorporate into such record programs since it is often based on the dairyman's judgment each year. Gordon (43) surmounted these difficulties in an effort to determine which financial ratios are associated with business success on Virginia Grade A dairy farms as measured by net operating cash income divided by net worth. The data source used was 95 anonymous financial statements furnished by various production credit associations located in Virginia. Multiple discriminant analysis was used to develop classification functions to assign previously unclassified dairy farms to profitability groups based on a selected set of financial ratios. The ratios were ranked according to their ability to assign observations to the correct profitability grouping. In order to do so the data were broken into subsamples using one subsample to develop discriminant functions and the remaining group to test the ability of the functions to correctly assign dairies to income groups. The five most useful ratios, in order of importance, were: total operating expenses/total operating income, total debt/total assets, total operating expenses/cow, current liabilities/current assets, and total liabilities/number of cows. These ratios assigned a significant number of dairies to correct income groups.

Literature concerning the relationship between financial ratios and non-dairy business success measures is more plentiful than dairy-related literature. Two studies merit comment. Altman (40) used financial records of bankrupt and non-bankrupt firms to test the ability of various financial ratios to discriminate between these two groups. A discriminant ratio model using the ratios working capital/total assets, retained earnings/total assets, earnings before interest and taxes/total assets, market value equity/book value of total debt, and sales/total assets proved to be very accurate in predicting bankruptcy with 95% of all firms in the bankrupt and non-bankrupt groups assigned to their correct classifications.

O'Connor (45) analyzed various models relating financial ratios to rate of return on investment in common stocks and concluded that usefulness of ratios to predict rates of return was doubtful.

It should be observed that none of the studies reviewed by the author investigated the relationship between all three economic facets of the business (financial, marketing, and production) and business success simultaneously. It was felt that a study doing so would be of benefit to future dairyman and associated accounting agencies.

III. CONCEPTUAL FRAMEWORK AND DATA SOURCE

The economic facets of a dairy business may be classified as financial, marketing, and production activities. A dairy manager is responsible for decisions in each of these areas. Financial decisions concern the acquisition and use of capital. Financial decisions have become increasingly important to dairy managers. Marketing decisions concern procurement of inputs, pricing, and distribution of outputs. Some aspects of marketing are little affected by a dairy manager's decisions. Milk price is an example. Production decisions concern physical inputs and outputs, quantities, and technologies. Traditionally, production decisions have been the dairyman's chief concern.

Various tools are available to aid economic decision-making. Economic theory states that maximum profits are obtained when marginal costs equal marginal returns. It is difficult for a dairy manager to put this theory into practice via marginal analysis since in reality it is difficult to accurately associate marginal costs and returns associated with additional units of production. Joint cost allocation is an example of one of the difficulties encountered when applying economic theory. From a practical standpoint a dairy business analysis presents a more reasonable tool to aid decision-making in each economic facet of the business. A business analysis is a tool to aid the dairy manager in monitoring his present status; relating this status to his objectives; and making changes necessary to achieve these objectives. The analysis consists of comparing performance measures of the economic facets of the business to historical measures, or factors, taken from past records of the individual dairy. This is referred to as trend analysis. The current performance measures can also be compared to norms established for similar dairies operating within the region. This method of analysis is referred to as comparative analysis. In order to conduct a comparative analysis it is necessary to have reliable industry norms. As outlined in the introduction, this study attempts to determine such norms and suggest which norms are most useful in analyzing the economic facets of the business. Prior studies, as noted earlier, have not dealt with financial, marketing, and production factors simultaneously. Dairymen balk at individually releasing financial information and land-grant university record systems cannot generally obtain reliable financial information. Production and marketing information is more easily obtained.

To overcome these difficulties cooperation from an old and well-established southwestern accounting firm was sought and granted.[3] The firm offers all accounting

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[3]The firm has requested its name be kept anonymous.

services to its clients. This includes bookkeeping on a cash basis and presentation of financial statements on an accrual basis. Such matters as asset evaluation and inventories are handled by the firm leaving little room for input and recording error on the part of the dairyman. This offers a marked advantage over land-grant university record systems in that the data provided are consistent and accurate. Data on dairies having 500 or more total cows which purchase 85% or more of their feed were requested. Data for 1974 and 1975 on each of 46 dairies located in California and 4 located in Arizona were provided. The sample is considered to be slightly above average by virtue of the fact that all dairies make use of an accounting service. The information obtained for each dairy is listed below with a brief explanation, as provided by the firm, for each item. All valuations and costs are historical and according to A.I.C.P.A. accepted accounting principles.

1) Total assets. Total assets includes current assets, dairy herd, dairy fixed assets and other assets such as partnership and stock investments, long-term notes receivable, rental properties, and others.

2) Total liabilities. Total liabilities includes current and long-term liabilities applicable to both the dairy operation and other investments.

3) Current assets. Current assets are primarily cash, receivables and inventories easily liquidated

within 12 months. Feed inventory is included whether feed is located on the dairy or in the hands of the seller.

4) Current liabilities. Current liabilities are all debts due within 12 months including 100% of bank feed loans, but excluding current portion of long-term debt.

5) Milk sales. Milk sales are gross receipts from sale of milk. Hauling and state and association charges are classified as expenses.

6) Cattle sales. Cattle sales are gross receipts from sale of cattle, primarily cull cows. Sale of calves is excluded.

7) Other revenue. These revenues are primarily calf sales and patronage dividends but can include heifer feeding for other dairymen, sale of feed, and sale of steers.

8) Total expenses. Total expenses includes feed, labor, herd replacement, and other operating costs.

9) Feed costs. Feed costs include cost of consumed hay, grain, and other feeds for milking and dry animals and heifers less an average allowance of $50 per heifer per quarter for expenses attributable to raising.

10) Labor costs. Labor costs include salaries for milkers and other farm workers and a provision

for partners' salaries where the business entity is a partnership.

11) Herd replacement cost. This includes a provision for depreciation on mature cows plus loss or less gain on mature cows sold.[4]

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[4]An explanation of accounting practice is required here. Dairymen have the option to either purchase a bred heifer as a replacement animal or raise their own replacement animals or to do both. For statement purposes only valuations for animals in these two situations are handled by the accounting firm in the following manners:

Purchased replacements: Purchased animals are valued at cost when purchased and a salvage value of 50% of cost is established. Animals are depreciated at cull rate per year. For example, a herd having an average cull rate of 33.3% would depreciate cost less salvage value by 33.3% for each of 3 years if kept the full 3 years. This depreciation is included in herd replacement cost along with depreciation of self-raised replacements. If the animal is sold for either a gain or loss on the statement book value, this gain or loss is included in herd replacement cost.

Self-raised replacements: For statement purposes self-raised replacements are valued at $60 per quarter from birth until entrance into the milking herd up to a maximum of $480. This value is then depreciated down to an arbitrary $250 in the same manner as purchased replacements. For example, depreciation on a self-raised animal in a milking herd having a 25% cull rate would be $57.50 per year (480-250)/4. For most dairymen a first-in - first-out basis is used in valuing the herd. Depreciation on self-raised animals is also included in herd replacement cost along with gain or loss on cow sold.

Tax implications: Statements used for this study are accrual based statements for use by the dairyman. It should be understood that depreciation of a self-raised animal is meaningless for tax purposes. Self-raised animals are subject only to deductions for immediate expenses while raising and a capital gain tax rate if the animal is sold for gain. Depreciation of purchased animals is tax deductible, but gains on sale are not normally subject to special tax privileges unless the animal is held for 24 months and sold for a gain.

12) Other operating expenses. This includes all operation costs except for feed, labor, and herd replacement expenses.

13) Partner's salaries. This is self-explanatory. In a few instances, a provision may not be made as profits are simply split equally.

14) Personal withdrawals. This is self-explanatory. It does not include income taxes of proprietorships but would for partners of partnerships.

15) Milk cows and dry cows. The cow numbers are averages per year.

16) Heifers. Heifers being raised except for those under 3 months of age.

17) Percentage replacements. Percentage replacements equals the total mature head sold plus dead cows divided by the average total mature herd size for the year.

18) Grain and hay fed. This includes amount fed to mature cows and heifers if they are raised on the dairy.

19) Silage fed. Silage fed was estimated by dividing total silage cost by the average cost per ton for the region and converting to dry matter tons. The item is only an approximation.

20) Greenfeed and other feeds. This item was converted to dry matter tons in the same manner as item 19.

21) Net income. Net income was calculated by the author as milk revenues plus other revenues less total expenses. Cattle sales were not included as a revenue since herd replacement cost takes cattle sales into account.

22) Net worth. Net worth is total assets less total liabilities.

23) Age of record. Age of record refers to the number of years a dairy has utilized services of the accounting firm. Since balance sheet items are based on historical values it is logical to assume that the date of asset and liability valuation is an important factor.

After careful consideration of the literature cited earlier, a list of ratios was compiled to facilitate analyzing all sizes of the business on the same basis. The raw data described above were used to calculate values for these ratios on each dairy in the sample. The resulting set of ratio-values served as the data base for the analysis described in Section IV. Table III-1 lists the ratios which were calculated and the abbreviated ratio names which will be used throughout the remainder of the text.

In reviewing the ratio list, the following observations should be made:

1) An attempt was made to include those ratios most frequently recommended in the literature for use in a dairy business analysis.

Table III-1. List of performance ratios to be used for data base

Ratio	Abbreviated ratio name
1. (net income/net worth)100	NI/NW
2. current assets/current liabilities	CA/CL
3. total assets/total liabilities	TA/TL
4. total liabilities/net worth	TL/NW
5. net worth/total assets	NW/TA
6. gross income/total assets*	GI/TA
7. feed expense/gross income**	FE/GI
8. labor expense/gross income***	LE/GI
9. herd replacement expense/gross income	HRE/GI
10. other operating expense/gross income	OOE/GI
11. withdrawals/gross income	W/GI
12. other revenue/gross income	OR/GI
13. feed expense/cow equivalent†	FE/CE
14. labor expense/cow equivalent	LE/CE
15. herd replacement expense/cow equivalent	HRE/CE
16. other operating expenses/cow equivalent	OOE/CE
17. milk revenue/milking cow	MR/MC
18. cattle revenue/milking cow	CR/MC
19. other revenue/cow equivalent	OR/CE
20. milk production/milking cow	MP/MC
21. milk fat/milking cow	MF/MC
22. raised heifers/total mature cows	RH/TC
23. grain/cow equivalent	G/CE
24. roughage/cow equivalent	R/CE
25. replacements/total mature cows	CSD/TC

*Gross income = milk sales + cattle sales + other revenue.

**In order to evaluate those dairies which raise their own heifers on an equal basis with those dairies which do not, feed expense was adjusted by adding ($50 x 4) (number of heifers raised) to the feed expense value given in the raw data. The raw data value did not include the $50 allotment per quarter per raised heifer.

***In order to evaluate sole proprietorships and partnerships on an equal basis, labor expense was adjusted by subtracting partners' salaries from the labor expense value provided in the raw data. The raw data value included partners' salaries.

†Cow equivalent = milking cows + dry cows + .5 (number of heifers raised). Cow equivalents were used in order to evaluate those dairies which raise their own heifers on equal basis with those that do not. Two heifers were arbitrarily considered equivalent to a mature cow.

2) An attempt was made to include ratios which describe the financial, marketing, and production facets of the dairy business.

3) The raw data set imposed some limitations on the ratios which could be calculated. The primary limitation was inability to calculate a ratio describing labor efficiency. Data on actual labor hours worked were unavailable.

Descriptive statistics for these ratios can be found in Tables A-1 and A-2 in the Appendix.

IV. ANALYTICAL METHOD

It was decided that the six functions described in Table IV-1 were logical functions to analyze in order to accomplish the objectives of the study. This decision was made after reviewing the literature, consulting with extension personnel, and considering the data source. The

Table IV-1. A listing of functions analyzed

Name of Function	Function*
Financial Function	$Y = f(X_i, YR, AOR)$, where $i = 1, \ldots, 5$
Marketing Functions:	
Income Generating Efficiency	$Y = g(X_i, YR, AOR)$, where $i = 6, \ldots, 11$
Input Marketing Efficiency	$Y = g'(X_i, YR, AOR)$, where $i = 12, \ldots, 15$
Output Marketing Efficiency	$Y = g''(X_i, YR, AOR)$, where $i = 16, 17, 18$
Production Function	$Y = h(X_i, YR, AOR)$, where $i = 19, \ldots, 24$
Complete Function	$Y = k(X_i, YR, AOR)$, where $i = 1, \ldots, 24$

*For all functions: YR = year of record; AOR = age of record (time since individual began keeping records).

variables used in these functions are described in Table IV-2. Several observations concerning the selected functions should be made, as follows: 1) The assumption was made that most dairy managers desire to maximize profitability. Therefore, the profitability measure, percent return to net worth was used as a measure of business success. 2) The financial function expected to adequately cover the financial facet of the business included measures of short-term liquidity (X_1), solvency (X_2), leverage (X_3), portion of ownership (X_4) and capital turnover (X_5). 3) The marketing functions covered 3 aspects of marketing: use of monetary inputs and diversification to generate income (X_6 through X_{11}), cost of inputs (X_{12} through X_{15}), and price of outputs (X_{16} through X_{18}). 4) The production function included measures of technical efficiency which were measured by physical factors only (X_{19} through X_{24}). This function was expected to adequately cover the production facet of the business with the exception of labor efficiency. It will be recalled that a measure of labor hours was not available. 5) The complete function included all the variables used in the financial, marketing, and production functions. It was expected that the complete function would adequately cover all measurable facets of the business related to profitability.

Multiple regression analysis was used to approximate the functional relationships under investigation. Use of multiple regression analysis involves the assumption that the functional relationships are linear in unknown

Table IV-2. A listing of variables used in functions

Number	Name	Symbol	Number	Name	Symbol
Y =	$\frac{\text{net income}}{\text{net worth}} \times 100$	= (NI/NW)100	X_9 =	$\frac{\text{other operating expense}}{\text{gross income}}$	= OOE/GI
X_1 =	$\frac{\text{current assets}}{\text{current liabilities}}$	= CA/CL	X_{10} =	$\frac{\text{withdrawals}}{\text{gross income}}$	= W/GI
X_2 =	$\frac{\text{total assets}}{\text{total liabilities}}$	= TA/TL	X_{11} =	$\frac{\text{other revenue}}{\text{gross income}}$	= OR/GI
X_3 =	$\frac{\text{total liabilities}}{\text{net worth}}$	= TL/NW	X_{12} =	$\frac{\text{feed expense}}{\text{cow equivalent}}$	= FE/CE
X_4 =	$\frac{\text{net worth}}{\text{total assets}}$	= NW/TA	X_{13} =	$\frac{\text{labor expense}}{\text{cow equivalent}}$	= LE/CE
X_5 =	$\frac{\text{gross income}}{\text{total assets}}$	= GI/TA	X_{14} =	$\frac{\text{herd replacement expense}}{\text{cow equivalent}}$	= HRE/CE
X_6 =	$\frac{\text{feed expense}}{\text{gross income}}$	= FE/GI	X_{15} =	$\frac{\text{other operating expense}}{\text{cow equivalent}}$	= OOE/CE
X_7 =	$\frac{\text{labor expense}}{\text{gross income}}$	= LE/GI	X_{16} =	$\frac{\text{milk revenue}}{\text{milking cows}}$	= MR/MC
X_8	$\frac{\text{herd replacement expense}}{\text{gross income}}$	= HRE/GI	X_{17} =	$\frac{\text{cattle revenue}}{\text{milking cows}}$	= CR/MC

Table IV-2 (continued)

Number	Name	Symbol	Number	Name	Symbol
X_{18} =	$\frac{\text{other revenue}}{\text{milking cows}}$	= OR/CE	X_{22} =	$\frac{\text{grain}}{\text{cow equivalent}}$	= G/CE
X_{19} =	$\frac{\text{milk production}}{\text{milking cows}}$	= MP/MC	X_{23} =	$\frac{\text{roughage}}{\text{cow equivalent}}$	= R/CE
X_{20} =	$\frac{\text{milk fat}}{\text{milking cows}}$	= MF/MC	X_{24} =	$\frac{\text{replacements}}{\text{total mature cows}}$	= CSD/TC
X_{21} =	$\frac{\text{raised heifers}}{\text{total mature cows}}$	= RR/TC		year of record	= YR
				age of record	= AOR

parameters. This assumption was justified in the literature reviewed prior to the analysis. Through this technique values for the unknown parameters are estimated and a model is developed which describes the functional relationship. The validity of the model and underlying assumptions pertaining to the data can be checked by statistical tests. Various procedures can be used to select the "best" regression equation for approximating a functional relationship. In this study a stepwise selection procedure was used to select the "best" regression equation for approximating each of the 6 functions of interest. Four aspects of the analysis merit explanations. These are 1) the underlying assumptions, 2) examination of the regression equation, 3) the stepwise procedure, and 4) examination of residuals. Explanations are as follows:

1) Underlying Assumptions. Certain underlying assumptions must be made before the regression equation can be examined. Draper and Smith (49) list these assumptions:

> "...in the model $Y_i = \beta_o + \beta_1 X \rightarrow \varepsilon_i$, i = 1,2,.....,n,
>
> a) ε_i is a random variable with mean zero and variance σ^2 (unknown), that is, $E(\sigma_i) = 0$, $V(\sigma_i) = \sigma^2$.
>
> b) ε_i and ε_j are uncorrelated, $i \neq j$, so that $cov(E_i, \varepsilon_j) = 0$. Thus $E(Y_i) = \beta_o + \beta_1 X_i$, $V(Y_i) = \sigma^2$ and Y_i and Y_j, $i \neq j$ are uncorrelated. A further assumption, which is not immediately necessary...is that

c) ε_i is a normally distributed random variable, with mean zero and variance σ^2 by (a), that is $\varepsilon_i \sim N(0,\sigma^2)$."

In brief, it is assumed that the errors have a zero mean, a constant variance, are independent, and follow a normal distribution. The assumptions were dealt with by examination of the residuals as outlined below.

2) Examination of the Regression Equation. In developing a regression equation to approximate a functional relationship, the additional variation accounted for by inclusion of more than one variable in the equation is of prime importance. Four criteria are suggested by Draper and Smith to assess what is accomplished by inclusion of one or more additional variables in the equation. These are as follows:

a) The square of the multiple correlation coefficient R^2. R^2 is defined as the sum of squares due to regression after fitting b_o divided by the total corrected sum of squares. The larger the R^2 value, the better the model explains variation. R^2 values can be examined at each stage of the regression for substantial increases. Caution in using the R^2 criterion should be exerted when the number of parameters in the model approaches the saturation point and when repeat observations are used. It should also be observed that addition of a new variable will increase R^2 but will not necessarily decrease the residual mean square.

b) The standard error of the estimate, s. s is the square root of the residual mean square. The residual mean square is an estimate of the variance about the regression. The smaller the standard error of the estimate the better the model explains variation. Caution should be exerted when the model approaches the saturation point and when repeated observations are made.

c) The sequential F-test criterion. This criterion assesses the value of adding a new variable after one or more other variables have been included in the model by examining the calculated F values after addition of each new variable. The F value is calculated by dividing the mean square due to addition of the new variable above and beyond that due to variables already included in the model by the residual mean square. The calculated F-value is compared to a tabulated F-value, F_{α, r_1, v_2}, where α is a preset desired level for the probability of a Type I error (rejection of a hypothesis which is in fact true).

d) The partial F-test criterion. The partial F-test criterion is used when the order of variable entry into the equation is of interest. For example, X_1 may be entered into an equation before or after X_2. If entered before, it may be of interest to know what contribution X_2 would have made if it had been entered first. Also of interest might be the contribution of X_1 above and beyond the contribution of a first-entry X_2.

In this study the R^2 value criterion, the standard error of the estimate, and partial F-tests were used when examining regression equations produced by the stepwise procedure. The SPSS (Version 6.0) regression program (50) used in this study provided overall F-values and F-values to enter or remove a variable. These F-values are calculated as $F = \frac{SS_{reg/K}}{SS_{res/(N-k-1)}}$ and $F = \frac{\text{incremental SS due to } X_i/1}{SS_{res(N-k-1)}}$ respectively, where k is the number of independent variables in the equation and N is the sample size.

Users of the SPSS regression program have the option of specifying three statistical criteria for inclusion of a variable in a model. These are n, the maximum number of independent variables to be entered into the equation, F, the minimum F-value to be accepted, and T, a tolerance index ranging from 0 to 1 indicating the degree of correlation between the variable to be entered and those already included. If the user does not specify n, F, and T the SPSS program has minimum default values of 80, .01, and .001, respectively. The author wished to examine the addition of variables which would not have been included in the regression equation if stringent default levels had been set and therefore set no specific levels for n, F, and T.

In addition to the criteria for excepting or rejecting additional X's, the standard error of the B's and associated confidence intervals are of interest in describing models. These statistics were available from the SPSS Regression program.

3) The stepwise procedure. To build a useful predictive model the researcher should attempt to include as many X's as possible in order to insure a reliable prediction model (without saturating the model) yet the cost of information and problems in monitoring variables often induce the modeler to reduce the equation to include as few X's as possible. In selecting the "best" regression equation a compromise between these opposing criteria must be made. Procedures used for selecting the "best" regression equation include a) all possible regressions, b) backward elimination, c) forward selection, and d) stepwise regression. The stepwise procedure was selected for use in this study for two reasons: a) the procedure eliminates wasteful computer time and laborious examination of cumbersome computer printouts, and b) the procedure reexamines all variables included in the model at each stage of the regression. A CDC 6500 was used to run the SPSS stepwise regression program. The procedure is as follows:

a) The variable most correlated with the response is entered into the regression equation.

b) Again, using partial correlation coefficients, the next most highly correlated variable is entered into the regression equation.

c) The contribution of the first variable if it had been entered second in the equation is examined. If the contribution is insignificant, the variable is rejected.

d) The process is continued until all variables have been examined.

The stepwise procedure was used in developing models of the six functions of interest. The models examined are shown in Table IV-3. Inclusion of first and second order terms for each independent variable includcd in the model was decided upon as means of incorporating the effects of diminishing returns into the model. Economic theory holds that as the quantity of one factor of production is held constant, the additional output derived from unit increases of a variable factor declines after a certain level of that factor has been obtained. The principle of diminishing returns can be applied to both physical and monetary data. The inclusion of second order terms served as a means of investigating possible curvilinear relationships which the principle of diminishing returns suggests.

It should be observed that discrete classification variables accounting for farm effects were not included in any model. It was felt that to include such variables in the models would sacrifice too many degrees of freedom. In an effort to make an objective statement about variation due to a repeated observation on each dairy, correlation of the two residuals produced from each repeated observation was studied.

Table IV-3. A listing of models examined

Name of Model	Model
Financial Model	$Y = \beta_o + \beta_i X_i + \beta_{i'} X_i^2 + AOR + YR + e$, where $i = 1,\ldots,5$; $i' = 6,\ldots,10$
Marketing Models:	
Income Generating Efficiency	$Y = \beta_o + \beta_i X_i + \beta_{i'} X_i^2 + AOR + YR + e$, where $i = 6,\ldots,11$; $i' = 12,\ldots,17$
Input Marketing Efficiency	$Y = \beta_o + \beta_i X_i + \beta_{i'} X_i^2 + AOR + YR + e$, where $i = 12,13,14,15$; $i' = 16,17,18,19$
Output Marketing Efficiency	$Y = \beta_o + \beta_i X_i + \beta_{i'} X_i^2 + AOR + YR + e$, where $i = 16,17,18$; $i' = 19,20,21$
Production Model	$Y = \beta_o + \beta_i X_i + \beta_{i'} X_i^2 + AOR + YR + e$, where $i = 19,\ldots,24$; $i' = 25,\ldots,30$
Complete Model	$Y = \beta_o + \beta_i X_i + \beta_{i'} X_i^2 + AOR + YR + e$, where $i = 1,\ldots,24$; $i' = 25,\ldots,48$

4) Examination of residuals. A residual is the difference between the observed response and the predicted response. If the fitted model is correct, the residuals should exhibit tendencies which indicate whether or not the underlying assumptions described above appear to be violated.

Residuals may be examined by one or more of the five suggested graphical means: a) overall plotting, b) plotting in time sequence, c) plotting against the predicted responses, d) plotting against the independent variables, and e) plotting in any way that is appropos for the problem under examination. In this study residuals were first plotted against the predicted Y's. According to Draper and Smith (48), the shape of this plot can indicate whether or not the regression analysis appears to be valid. Typically, one of four plots may appear as follows:

a) A horizontal band. This would indicate no abnormality and the underlying assumptions would not appear to be violated.

b) A horizontal band which expands in width as the magnitude of predicted Y's increases. This would indicate that the variance of the errors is not constant. Perhaps weighted least squares or transformations on the Y_i observations should be used.

c) A band which slopes negatively or positively. This would indicate that there is a systematic departure from the fitted equation. The analysis should be reconsidered.

d) A band in the shape of a parabola. This would indicate an inadequate model. Additional terms on transformations of the Y_i observations should be considered.

Residuals from 1974 observations were then plotted against residuals from 1975 observations in an effort to determine the degree of correlation between observations taken from the same farm.

Residuals were also standardized and plotted casewise in an effort to spot outliers. Suspected outliers were those falling outside of the range of standard deviation suggested by use of the Mean Ranges of Samples from a Normal Distribution table (Table 2) found in Sokal and Rohlf (51). Acceptance or rejection of outliers was by use of the method suggested by David, Hartley, and Pearson (48). Borderline cases were also investigated by rerunning the stepwise regression without the suspected outlier. If significant changes in the regression occurred, the borderline case was deleted from the study and the second-run models were examined.

Finally, in an effort to determine how much of the explained variation in each model was accounted for by the variables in the model, path coefficients were used in the manner suggested by Wright (52). According to this method, the direct contribution of a single variable (uncorrelated with remaining variables) is the square of the standardized partial regression coefficient, or "path" coefficient, denoted as $(b_{j'})^2 = [b_j(\frac{\hat{\sigma}_{xj}}{\hat{\sigma}_y})]^2$. $(b_{j'})^2$ is called the coefficient of determination. The indirect contribution of two correlated variables, X_i and X_j, is $2(b'_i)(b'_j)r_{ij}$. This term is referred to as the joint coefficient of determination. The total sum of these two types of contribution should approach unity and may be used as the denominator in determining the percent of explained variation accounted for by each variable.

V. RESULTS AND DISCUSSION

Results of the statistical analysis are described in this section. Any conclusions drawn from the analysis are withheld until Section VI.

The results are divided into six parts. Each part describes one of the six models of interest. Included in each part are three tables used to present results and facilitate discussion. The types of tables and appropriate descriptions are as follows:

Stepwise Regression Summary. The summary table includes the following statistics for each new variable entered into the equation: F to enter or remove the variable, R^2, overall F, and standard error of the estimate. Significance levels are also provided.

Coefficients and Confidence Intervals. The table of coefficients includes the regression coefficients, standard errors of the coefficients, and a 95% confidence interval for each coefficient.

Contribution of Variables to Explained Variation. The explanation of variation table includes path coefficients and a percent figure indicating the percent of explained variation attributable to each variable.

General discussion of each model will include selection of the "best" regression equation to approximate the function of interest utilizing the R^2, partial F test, and change in standard error of the estimate criteria. Discussion of the complete model includes examination of the residuals for that model.

Financial Model

The summary table for the financial model is Table V-1. The overall model in which all variables were fitted accounted for 24.6% of the variation in Y. This suggests little potential as a predictive model. However, examination of the regression to find the "best" model is of use. In doing so the following practical question can be answered: If a dairyman wishes to monitor his financial status (i.e., his acquisition and use of capital), which financial ratios are of most use?

The R^2 criterion for the "best" regression equation suggests inclusion of the first 4 variables. These variables account for 19.2% of the variation. Addition of the remaining variables increases the explained variation by less than 2% for each new variable. The author considers the less than 2% increase to be negligible.

The partial F-test criterion substantiates the R^2 criterion. Probability of a type 1 error is less than or equal to 9.1% each for entrance of the first 4 variables. For additional variables this probability is equal to or greater than 14.1%.

Table V-1. Stepwise regression summary: financial model

Step	Variable Entered	Variable Symbol	F to Enter	Significance	R^2	Overall F	Significance	Standard Error of Estimate
1	X_3	TL/NW	6.22	.014	.061	6.22	.014	39.7
2	XX_3	$(TL/NW)^2$	3.86	.052	.098	5.14	.008	39.2
3	X_4	NW/TA	2.92	.091	.125	4.47	.006	38.8
4	X_5	GI/TA	7.46	.008	.191	5.45	.001	37.5
5	YR		2.22	.141	.212	4.86	.001	37.2
6	XX_4	$(NW/TA)^2$	1.91	.171	.227	4.41	.001	37.1
7	XX_5	$(GI/TA)^2$	.57	.451	.232	3.84	.001	37.1
8	X_1	CA/CL	.33	.563	.235	3.38	.002	37.3
9	XX_2	$(TA/TL)^2$	.29	.589	.237	3.01	.004	37.4
10	XX_1	$(CA/CL)^2$	.33	.562	.240	2.72	.006	37.6
11	AOR		.52	.446	.246	2.52	.009	37.7
12	X_2	TA/TL	.01	.906	.246	2.28	.015	37.9

The change in the standard error of the estimate was considered negligible for variables entered after the first 4 steps of the stepwise analysis.

Consideration of the 3 criteria suggest the following model as the model which best approximates the relationship between the financial ratios and return to net worth:

$$Y = 39.67 - 12.42X_3 + .38X_3^2 - 80.93X_4 + 35.81X_5$$

This model has an overall significance level of .001. It suggests that when measures of financial status alone are considered in relation to return to net worth, the amount of leverage (X_3, total liabilities/net worth), the equity to value ratio (X_4, net worth/total assets), and the asset turnover (X_5, gross income/total assets) are the most important factors. Furthermore, it suggests that the amount of leverage employed has a curvilinear relationship to the percent return on net worth. Statistics on the regression coefficients are found in Table V-2.

Use of path coefficients for determining direct and indirect contribution of variables included in the "best" model to Y is shown in Table V-3. Table V-3 suggests that almost all of the explained variation in Y for this model is attributable to the direct and indirect effects of leverage (X_3, total liabilities/net worth) if this model was considered as a closed system. Examination of the correlation matrix for the entire set of variables suggests that net worth/total assets (X_4) is correlated to a number of other variables as is X_3. Thus, considering

Table V-2. Coefficients and confidence intervals: financial model

Variable	B	Standard Error B	95% Confidence Interval		
Overall Model					
X_3	-21.91	6.79	-35.4	,	-8.4
XX_3	.63	.19	.2	,	1.0
X_4	-392.93	197.64	-786.0	,	1.0
X_5	107.40	84.96	-61.6	,	276.3
YR	9.94	8.06	-6.1	,	26.0
XX_4	245.91	167.22	-86.6	,	578.5
XX_5	-36.50	42.47	-121.1	,	47.9
X_1	3.72	4.45	-4.3	,	11.8
XX_2	-.27	.64	-1.5	,	1.1
XX_1	-.11	.14	.4	,	.2
AOR	.75	.90	-1.1	,	2.4
X_2	1.70	13.44	-25.0	,	28.4
Constant	84.82	58.91	-32.3	,	202.0
"Best" Model					
X_3	-12.42	3.18			
XX_3	.38	.11			
X_4	-80.93	29.58			
X_5	35.81	13.11			
Constant	39.67	18.01			

Table V-3. Contribution of variables to explained variation: financial model

Variable(s)	Path Coefficient	Correlation Coefficient	% Explained Variation Direct Contrib.	% Explained Variation Indirect Contrib.
X_3	-1.51		29.6	
XX_3	1.05		14.3	
X_4	-.49		3.1	
X_5	.28		1.0	
X_3, XX_3		.92		37.3
X_3, X_4		-.67		8.9
XX_3, X_4		-.43		5.8

the financial model as a closed system may mask the overall contribution of these variables. This means that when financial variables are considered alone the leverage ratio is the most important variable, but examination of the complete model may or may not suggest that leverage is important when non-financial variables from other models are considered.

Income Generating Efficiency Model

The summary table for the income generating efficiency model is Table V-4. The overall model in which all variables are fitted accounted for 47.4% of the variation in Y. This too suggests little potential as a predictive model. However, examination of the regression to find the "best" model will help answer the question: If a dairyman wishes

Table V-4. Stepwise regression summary: income generating efficiency model

Step	Variable Entered	Variable Symbol	F to Enter	Significance	R^2	Overall F	Significance	Standard Error of Estimate
1	XX_8	$(HRE/GI)^2$	27.20	.000	.223	27.20	.000	36.2
2	XX_6	$(FE/GI)^2$	28.46	.000	.403	31.76	.000	31.9
3	YR		4.15	.044	.429	23.27	.000	31.3
4	XX_9	$(OOE/GI)^2$	4.27	.042	.454	19.13	.000	30.8
5	AOR		.82	.367	.459	15.44	.000	30.8
6	X_9	OOE/GI	.92	.341	.464	13.01	.000	30.8
7	X_8	HRE/GI	.75	.389	.469	11.23	.000	30.9
8	XX_{11}	$(OR/GI)^2$	.07	.806	.469	9.73	.000	31.1
9	X_{11}	OR/GI	.27	.608	.471	8.60	.000	31.2
10	XX_{10}	$(W/GI)^2$	.06	.813	.471	7.66	.000	31.3

to use ratios measuring income generating efficiency, which ratios are most useful? It is to be remembered that the author uses the phrase "income generating efficiency ratios" to mean ratios involving monetary inputs or monetary diversifications as numerators and gross income as a denominator.

The R^2 criterion for the "best" regression equation suggests inclusion of the first 2 variables. These variables account for 40.3% of the total variation in Y. Addition of the remaining variables increases the explained variation by less than 3% for each new variable entered.

The partial F-test criterion substantiates the R^2 criterion in that the probability of a type 1 error is less than .1% each for entrance of the first 2 variables and greater than 4% each for entrance of the remaining variables.

Change in the standard error of the estimate appears negligible for variables beyond the first 2 accepted in the equation.

Consideration of these criteria suggests the following model as the model which best approximates the relationship between income generating efficiency ratios and return to net worth:

$$Y = 101.97 - 210.16X_6{}^2 - 3578.15X_8{}^2$$

The overall significance level of this model is less than .001. The model suggests that when income generating efficiency ratios are related to return to net worth, herd replacement expense/gross income (X_8) and feed expense/gross income (X_6) are the most important factors. Curvilinear relationships are suggested between X_8 and Y and X_9 and Y. It should be observed that labor expense/ gross income (X_7) explained an insignificant amount of variation in Y. This is perhaps attributable in part to the fact that most California dairies hire unionized milkers and generally run high through-put parlors suggesting the po-sibility of little labor efficiency variation between dairies. Labor expense/gross income had a relatively low correlation with Y ($r_{X_{7},Y} = -.17622$). Statistics on regression coefficients are found in Table V-5.

The contribution of each variable accepted in the "best" model is shown in Table V-6. Table V-6 indicates that feed expense/gross income (X_6) and herd replacement expense/gross income (X_8) directly contribute an almost equal amount to the explained variation if the model is considered as a closed system. However, high correlations between X_6, X_8, and variables outside of the model again suggest these effects may be masked by other variables when the complete model is examined.

Input Marketing Efficiency Model

The summary table for the input marketing efficiency model is Table V-7. The overall model accounts for only 20.9% of the variation in Y. It too is of little use as a predictive model, but it can be examined to help answer

Table V-5. Coefficients and confidence intervals: income generating efficiency model

Variable	B	Standard Error B	95% Confidence Interval		
Overall Model					
XX_8	-2202.68	2023.74	-6228.5	,	1823.1
XX_6	-249.66	594.79	-1432.9	,	933.5
YR	15.54	7.14	1.3	,	29.7
XX_9	-2125.24	1737.98	-5582.6	,	1332.1
AOR	-.46	.84	-1.7	,	.8
X_9	761.72	738.73	-707.8	,	2231.3
X_8	-306.17	322.56	--947.8	,	335.5
XX_{11}	2581.46	5872.29	-9100.3	,	14263.3
X_{11}	-210.72	536.30	-1277.6	,	856.1
XX_{10}	1297.32	2683.26	-404.5	,	6635.1
X_{10}	-158.20	389.67	-933.3	,	616.9
X_7	-484.30	1232.13	-3034.8	,	2066.2
XX_7	3170.08	8716.11	-14169.4	,	21509.2
X_6	76.56	728.51	-1372.6	,	1525.8
Constant	35.72	228.42	-418.6	,	490.1
Best Model					
XX_8	-3578.15	605.48			
XX_6	-210.16	39.40			
Constant	101.97	15.13			

Table V-6. Contribution of variables to explained variations: income generating efficiency model

Variable	Path Coefficient	% of Explained Variation Direct
XX_8	-.47	55.1
XX_6	-.43	44.9
		100.0%

the question: If a dairyman wishes to monitor cost of inputs, which cost ratios are most useful?

The R^2 criterion for the "best" regression equation suggests inclusion of the first 2 variables. These variables account for 18.6% of the variation in Y. Addition of the remaining variables increases the explained variation by less than 3% for each new variable entered.

The partial F-test criterion substantiates the R^2 criterion in that the probability of a type 1 error is less than 1% each for entrance of the first 2 variables and greater than 15% each for entrance of the remaining variables.

Change in the standard error of the estimate is negligible after entrance of the first 2 variables.

Consideration of these criteria suggests the following model as the model which best approximates the relationship between cost ratios and percent return to net worth:

$$Y = 12.77 - .0025X_{14}^{2} + 22.27YR$$

Table V-7. Stepwise regression summary: input marketing efficiency model

Step	Variable Entered	Variable Symbol	F to Enter	Significance	R^2	Overall F	Significance	Standard Error of Estimate
1	XX_{14}	$(HRE/CE)^2$	12.51	.001	.116	12.51	.001	38.6
2	YR		8.05	.006	.186	10.75	.000	37.2
3	X_{12}	FE/CE	.31	.581	.189	7.22	.000	37.3
4	XX_{12}	$(FE/CE)^2$	2.05	.156	.206	5.99	.000	37.1
5	XX_{15}	$(OOE/CE)^2$	.12	.741	.207	4.76	.001	37.3
6	X_{15}	OOE/CE	.08	.779	.208	3.94	.002	37.5
7	X_{14}	HRE/CE	.03	.862	.208	3.35	.003	37.7
8	AOR		.01	.911	.209	2.90	.006	37.9

The overall significance level of this model is less than .001. The model suggests that herd replacement expense/cow equivalent (X_{14}) and the effect of time on the market are the most important factors. It is of interest to note that feed expense/cow equivalent (X_{12}) was not included in the model, nor was labor expense/cow equivalent (X_{13}).[5] Correlation between X_{12} and Y was low ($r_{X_{12},Y}$ = -.068) as was true for X_{13} and Y ($r_{X_{13},Y}$ = -.031), perhaps indicating that consideration of input costs without considering prices received is of little benefit. Statistics on regression coefficients are shown in Table V-8.

The contribution of each variable accepted in the "best" model is shown in Table V-9.

Output Marketing Efficiency Model

The summary table for the output marketing efficiency model is Table V-10. The overall model accounted for 36.8% of the variation in Y. Little predictive value for the model is indicated here. However, as in the case of the previously reviewed models, a practical question can be dealt with: If a dairyman wishes to monitor price-control efficiency, which price ratios are most valuable?

The R^2 criterion for selecting the "best" model suggests inclusion of the first 2 variables. These variables account for 34.4% of the variation in Y. Addition of new

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[5] X_{13} was not included in the summary table due to the automatic default criteria (n,F,T) built into the SPSS program.

Table V-8. Coefficients and confidence intervals: input marketing efficiency model

Variable	B	Standard Error B	95% Confidence Interval	
Overall Model				
XX_{14}	-.30E-02	.19E-02	-.68E-02 ,	.84E-03
YR	24.45	8.38	7.78 ,	41.12
X_{12}	-.64	.46	-1.57 ,	.27
XX_{12}	.44E-03	.33E-03	-2.99E-03 ,	.11E-02
XX_{15}	-.48E-03	.17E-02	-.38E-02 ,	.29E-02
X_{15}	.21	.83	-1.45 ,	1.87
X_{14}	.56E-01	.33	-.65 ,	.72
AOR	-.76E-01	.68	-1.44 ,	1.29
Constant	218.49	172.94	-125.21 ,	562.19
"Best" Model				
XX_{14}	-.25E-02	.59E-03		
YR	22.27	7.85		
Constant	12.77	5.95		

Table V-9. Contribution of variables to explained variation: input marketing efficiency

Variable	Path Coefficient	% of Explained Variation Direct
XX_{14}	-.42	69.6
YR	.27	30.4
		100.0%

Table V-10. Stepwise regression summary: output marketing efficiency model

Step	Variable Entered	Variable Symbol	F to Enter	Significance	R^2	Overall F	Significance	Standard Error of Estimate
1	X_{16}	MR/MC	21.98	.000	.188	21.98	.000	33.7
2	XX_{16}	$(MR/MC)^2$	22.53	.000	.345	24.75	.000	33.4
3	XX_{17}	$(CR/MC)^2$	2.06	.155	.359	17.37	.000	33.2
4	X_{17}	CR/MC	.63	.430	.363	13.13	.000	33.3
5	YR		.50	.479	.367	10.55	.000	33.3
6	AOR		.12	.745	.368	8.72	.000	32.5
7	X_{18}	OR/CE	.02	.880	.368	7.40	.000	33.7
8	XX_{18}	$(OR/CE)^2$	.07	.793	.368	6.41	.000	33.9

variables would increase the explained variation by less than 2% for each new variable entered. The author considers such an increase to be negligible.

The partial F-test criterion confirms the choice made above. The probability of making a type 1 error is less than .1% each for entrance of the first 2 variables into the equation. This probability is greater than 15% each for addition of remaining variables. Changes in the standard error of the estimate appeared negligible for variables entered beyond the first 2 variables.

After consideration of the above criteria the following model was selected as the "best" model to approximate the relationship between price ratios and the percent return to net worth:

$$Y = -928.73 + 1.09X_{16} - .00031X_{16}^{2}$$

This model has an overall significance level of less than .001. The model suggests that milk revenue/milk cow (X_{16}) is the most important factor. It also suggests a curvilinear relationship between X_{16} and Y. Coefficients and confidence intervals are shown in Table V-11.

Production Model

The summary table for the production model is Table V-12. The overall model in which all variables were fitted accounted for 39.2% of the variation in Y. The model is insufficient for predictive purposes, but examination of the regression equation can help answer the

Table V-11. Coefficients and confidence intervals: output marketing efficiency model

Variable	B	Standard Error B	95% Confidence Interval	
Overall Model				
X_{16}	1.10	.21	.67 ,	1.53
XX_{16}	-.31E-03	.67E-04	-.45E-03 ,	-.18E-03
XX_{17}	-.90E-03	.71E-03	-.23E-02 ,	.50E-03
X_{17}	.23	.25	-.26 ,	.73
YR	5.49	7.68	-9.78 ,	20.77
AOR	-.16	.60	-1.36 ,	1.03
X_{18}	.16	.57	-.95 ,	1.30
XX_{18}	-.16E-02	.62E-02	-.14E-01 ,	.10E-01
Constant	-953.11	172.82	-1293.57 ,	-606.65
"Best" Model				
X_{16}	1.09	.21		
XX_{16}	-.31E-03	.65E-04		
Constant	-928.73	167.50		

question: If a dairyman wishes to monitor technical efficiency, which production ratios are most useful?

The R^2 criterion suggests inclusion of the first 6 variables. These variables account for 37.3% of the variation in Y. Addition of the remaining variables increases the explained variation by less than 1% for each new variable added. Such an increase is considered negligible.

Table V-12. Stepwise regression summary: production model

Step	Variable Entered	Variable Symbol	F to Enter	Significance	R^2	Overall F	Significance	Standard Error of Estimate
1	X_{19}	MP/MC	14.90	.000	.136	14.90	.000	38.1
2	XX_{19}	$(MP/MC)^2$	8.15	.005	.205	12.09	.000	36.8
3	XX_{22}	$(G/CE)^2$	5.07	.027	.246	10.10	.000	36.0
4	XX_{23}	$(R/CE)^2$	5.26	.024	.287	9.24	.000	35.2
5	YR		6.25	.014	.332	9.06	.000	34.2
6	X_{21}	RH/TC	5.83	.018	.373	8.92	.000	33.4
7	XX_{24}	$(CSD/TC)^2$	.82	.368	.379	7.75	.000	33.4
8	X_{24}	CSD/TC	.60	.440	.383	6.83	.000	33.5
9	X_{22}	G/CE	.47	.491	.386	6.09	.000	33.6
10	X_{20}	MF/MC	.33	.568	.389	5.47	.000	33.7
11	XX_{20}	$(MF/MC)^2$	.30	.587	.391	4.96	.000	33.8
12	AOR		.12	.729	.392	4.51	.000	34.0
13	XX_{21}	$(RH/TC)^2$	.02	.887	.392	4.11	.000	34.0

The partial F-test criterion suggests the same model. The probability of a type 1 error for entrance of the first 6 variables is less than 3% each. This probability is greater than 36% each for entrance of the remaining variables. Changes in the standard error of the estimate appear negligible beyond entrance of the first 6 variables.

Use of these criteria suggests the following model as that model which best approximates the relationship between production ratios and the percent return to net worth:

$$Y = -640.65 + .08X_{19} - .22 \times 10^{-5}X_{19}^{2} - 29.47X_{21} - 2.95X_{22}^{2} - 1.67X_{23}^{2} + 22.11YR$$

The overall significance level of this model is less than .001. The model suggests that when production ratios are considered in relation to net worth, milk production/ milk cow (X_{19}), grain/cow equivalent (X_{22}), roughage/ cow equivalent (X_{23}), raised heifers/cow equivalent (X_{21}), and the effect of time on the market are the most important factors. The model also suggests curvilinear relationships between X_{19} and Y, X_{22} and Y, and X_{23} and Y. Regression coefficients are shown in Table V-13.

The contribution of each variable accepted in the "best" model is shown in Table V-14. Table V-14 suggests that milk production/milk cow (X_{19}) directly and indirectly contributes nearly all of the explained variation in Y if this model is considered as a closed system. High correlations between X_{21}, X_{22}, X_{23}, and non-production variables

Table V-13. Coefficients and confidence intervals: production model

Variable	B	Standard Error B	95% Confidence Interval	
<u>Overall Model</u>				
X_{19}	.88E-01	.44E-01	.51E-03 ,	.17
XX_{19}	-.24E-05	.14E-05	-.53E-05 ,	.51E-05
XX_{22}	-.54	4.07	-8.65 ,	7.57
XX_{23}	-1.76	.48	-2.73 ,	-.79
YR	23.05	7.78	7.56 ,	38.54
X_{21}	-36.15	33.98	-103.74 ,	31.44
XX_{24}	-240.50	227.73	-693.45 ,	212.44
X_{24}	16.08	179.93	-197.88 ,	517.97
X_{22}	-19.22	27.76	-74.45 ,	36.01
X_{20}	-.33	.58	-1.50 ,	.83
XX_{20}	.24E-03	.48E-03	-.73E-03 ,	.12E-02
AOR	.22	.64	-1.06 ,	1.50
XX_{21}	4.67	32.84	-60.65 ,	70.00
Constant	-593.48	325.92	-1241.65 ,	54.83
<u>"Best" Model</u>				
X_{19}	.80E-01	.38E-01		
XX_{19}	-.22E-05	.12E-05		
XX_{22}	-2.95	.78		
XX_{23}	-1.67	.45		
YR	22.11	7.46		
X_{21}	-29.47	12.20		
Constant	-640.65	295.45		

Table V-14. Contribution of variables to explained variation: production model

Variable(s)	Path Coefficient	Correlation Coefficient	% Explaining Variation Direct	% Explaining Variation Indirect
X_{19}	-2.88		29.5	
XX_{19}	-2.39		20.3	
XX_{22}	-.36		.5	
XX_{23}	.35		.4	
YR	.27		.2	
X_{21}	.24		.2	
X_{19}, XX_{19}		.998		48.9

is masked by examining the production model as a closed system.

Complete Model

The summary table for the complete model is Table V-15. The overall model accounts for 81.7% of the variation in Y. This suggests predictive potential over the range and type of dairies dealt with in this study. Examination of the regression equation will help determine the "best" regression equation to use for predictive purposes and will help answer the question: Which management factors, as measured by selected ratios, are most useful in a business analysis? The information used in this study is not considered difficult for the individual dairyman who uses an accrual accounting system to obtain.

Table V-15. Stepwise regression summary: complete model

Step	Variable Entered	Variable Removed	Variable Symbol	F to Enter or Remove	Significance	R^2	Overall F	Significance	Standard Error of the Estimate
1	XX_8		HRE/GI	27.19	.000	.223	27.19	.000	36.1
2	XX_6		FE/GI	28.45	.000	.403	31.75	.000	31.8
3	XX_{17}		CR/MC	9.59	.003	.460	26.30	.000	30.4
4	X_{16}		MR/MC	10.66	.002	.515	24.44	.000	29.0
5	X_{22}		G/CE	8.93	.004	.559	23.02	.000	27.8
6	XX_{16}		MR/MC	11.94	.001	.616	23.49	.000	26.3
7	X_{14}		HRE/CE	4.36	.035	.629	21.58	.000	25.7
8	XX_{13}		LE/CE	3.05	.084	.642	19.70	.000	25.5
9	XX_9		OOE/GI	3.19	.077	.654	18.30	.000	25.1
10	X_4		NW/TA	3.47	.066	.668	17.29	.000	24.8
11	XX_{24}		RH/TC	5.48	.022	.688	17.03	.000	24.2
12	X_{17}		CR/MC	2.22	.140	.696	15.02	.000	24.0
13	XX_5		GI/TA	2.22	.139	.734	15.18	.000	23.8

Table V-15 (continued)

Step	Variable Entered	Variable Removed	Variable Symbol	F to Enter or Remove	Significance	R^2	Overall F	Significance	Standard Error of the Estimate
14	X_3		TL/NW	2.73	.102	.714	14.58	.000	23.6
15	XX_{12}		FE/CE	1.55	.216	.719	13.81	.000	23.5
16	X_{12}		FE/CE	4.95	.029	.735	13.89	.000	22.9
17	XX_{22}		G/CE	2.03	.157	.742	13.36	.000	22.8
18	X_{20}		MF/MC	1.79	.184	.748	12.84	.000	22.7
19	XX_{20}		MF/MC	2.66	.106	.756	12.57	.000	22.4
20	XX_{15}		OOE/CE	1.64	.203	.761	12.12	.000	22.3
21	X_{13}		LE/CE	1.55	.216	.766	11.79	.000	22.3
22	XX_7		LE/GI	1.80	.183	.772	11.37	.000	22.1
23	X_{21}		RH/TC	1.42	.236	.776	11.00	.000	22.1
24	X_1		CA/CL	1.10	.297	.780	11.61	.000	22.1
25	X_9		OOE/GI	1.14	.238	.783	10.25	.000	
26	XX_1		CA/CL	1.04	.311	.786	9.90	.000	

Table V-15 (continued)

Step	Variable Entered	Variable Removed	Variable Symbol	F to Enter or Remove	Significance	R^2	Overall F	Significance	Standard Error of the Estimate
27	XX_{24}		CSD/TC	.78	.378	.789	9.53	.000	
28	XX_{11}			.57	.452	.790	9.16	.000	
29		XX_9	MP/MC	.00	.972	.790	9.63	.000	
30	XX_{18}		OR/CE	2.35	.130	.797	9.56	.000	
31	XX_4		NW/TA	.71	.401	.805	9.21	.000	
32	X_{18}		OR/CE	.36	.355	.802	8.92	.000	
33	XX_{10}		W/GI	.43	.511	.804	8.57	.000	
34	XX_{14}		HRE/CE	.54	.463	.805	8.26	.000	
35	XX_3		TL/NW	.41	.521	.806	7.95	.000	
36	X_{24}		CSD/TC	.22	.635	.807	7.63	.000	
37	X_5		GI/TA	.09	.755	.807	7.30	.000	
38	XX_2		TA/TL	.07	.789	.808	7.60	.000	
39	X_2		TA/TL	1.69	.198	.813	6.93	.000	

Table V-15 (continued)

Step	Variable Entered	Variable Removed	Variable Symbol	F to Enter or Remove	Significance	R^2	Overall F	Significance	Standard Error of the Estimate
40	AOR			.147	.702	.814	6.65	.000	
41	X_{18}		W/GI	.19	.663	.814	6.40	.000	
42	X_{19}		MP/MC	.03	.849	.814	6.13	.000	
43	YR			.04	.842	.814	5.88	.000	
44	XX_{23}		R/CE	.06	.805	.815	5.65	.000	
45	X_{23}		R/CE	.59	.443	.817	5.49	.000	

Therefore the author felt justified in using a less stringent R^2 criterion in order to improve the predictive potential of the "best" model. This was not done with the first 5 models since their predictive potential was poor and the only interest was in finding the most important factors contributing to the variation. The R^2 criterion suggests inclusion of the first 11 variables. These variables contribute 1.2% or more to the total variation in Y. Addition of remaining variables would increase the explained variation by less than 1% for each addition.

The partial F-test criterion suggests that addition of variables in steps 7 through 11 is with a probability of a type 1 error of 2.2% or more up to 8.4%. The author felt that the additional 7% increase in R^2 justified this situation. Change in the standard error of the estimate was felt to be negligible after entrance of the first 5 variables.

These criteria suggest the following model as one possible choice for the "best" model:

$$\begin{aligned} Y = & -681.75 - 30.94X_4 - 300.31X_6{}^2 + 1199.36X_8{}^2 \\ & - 630.17X_9{}^2 - .90 \times 10^{-3}X_{13}{}^2 - .34X_{14} + 1.02X_{16} \\ & - .29 \times 10^{-3}X_{16}{}^2 - .66 \times 10^{-3}X_{17}{}^2 + 31.35X_{21}{}^2 \\ & - 8.43X_{22} \end{aligned}$$

This model accounts for 68.8% of the variation in Y. It is felt that this model could serve as a limited predictor for making generalizations. It would not serve for precise predictions. The author believed that inclusion of more variables in the model would begin to saturate the model. The model suggests that when ratios measuring the financial, marketing, and production facets of the business are related to return on net worth, the following ratios are most important:

herd replacement expense/gross income (X_8)
feed expense/gross income (X_6)
cattle revenue/milk cow (X_{17})
milk revenue/milk cow (X_{16})
grain/cow equivalent (X_{22})
labor expense/cow equivalent (X_{13})
other operating expenses/gross income (X_9)
net worth/total assets (X_4)
raised heifers/total cows (X_{21})

Table V-16 provides coefficients for the entire model.

Table V-17 shows the direct contribution of these variables to explained variation in Y (the contribution of X_{16} and X_{16}^2 is considered jointly).

The high contribution of X_{16} to the explained variation is indicative of the manner in which the regression procedure is run (i.e., those variables highly correlated with X_{16} are not entered into the regression equation until the final steps of the procedure). The above model therefore serves as a predictive model, but does not help indicate which variables are most useful in a dairy business analysis. To see which variables are most useful, the entire model was examined and variables with relatively high path coefficients were arbitrarily selected as those variables providing the most direct contributions to Y. These variables were:

Table V-16. Coefficients and confidence intervals: complete model

Variable	B	Standard Error B	95% Confidence Interval	
Overall Model				
XX_8	2199.84	2577.24	-2969.45 ,	7369.13
XX_6	-547.20	193.21	-934.73 ,	-159.67
XX_{17}	.111E-02	.11E-02	-.12E-02 ,	.35E-02
X_{16}	1.20	.29	.52 ,	1.79
X_{22}	31.76	32.59	-33.62 ,	97.15
XX_{16}	-.34E-03	.91E-04	-.52E-03 ,	-.16E-03
X_{14}	-.22	.29	-.82 ,	.38
XX_{13}	.35E-02	.60E-02	-.86E-02 ,	.15E-04
X_4	-223.01	192.67	-609.47 ,	163.44
XX_{21}	32.15	32.56	-33.15 ,	97.47
X_{17}	-.77	.54	-1.87 ,	.32
XX_5	22.74	37.84	-53.15 ,	98.64
X_3	-4.42	7.29	-18.67 ,	-18.59
XX_{12}	.96E-03	.33E-03	.29E-03 ,	.16E-02
X_{12}	-1.23	.53	-2.30 ,	-.16
XX_{22}	-4.96	4.51	-14.92 ,	4.18
X_{20}	-.65	.53	-1.73 ,	.41
XX_{20}	.44E-03	.43E-03	-.42E-03 ,	.13E-02
XX_{15}	.92E-04	.10E-02	-.19E-02 ,	.21E-02
X_{13}	-1.89	1.14	-4.18 ,	.39
XX_7	9549.01	5789.46	-2023.06 ,	21121.10
X_{21}	50.31	41.45	-32.83 ,	133.47
X_9	-352.83	598.52	-1553.32 ,	847.65
XX_1	.22	.16	-.10 ,	.558450
XX_{24}	234.36	332.84	-433.23 ,	901.96
XX_{11}	-23226.15	11096.99	-45483.90 ,	-968.39
XX_{18}	.28E-01	.14E-01	-.15E-02 ,	.57E-01
XX_4	80.45	166.53	-253.56 ,	414.48
X_{18}	-.70	.60	-1.91 ,	.50

Table V-16 (continued)

Variable	B	Standard Error B	95% Confidence Interval	
XX_{10}	1325.23	2723.47	-4137.37	6787.83
XX_{14}	-.19E-02	.20E-02	-.61E-02	.22E-02
XX_3	.27E-01	.20	-.38	.43
X_{24}	-150.31	320.03	-792.22	491.58
X_5	-25.36	76.52	-178.85	128.11
XX_2	-.72	.55	-1.83	.38
X_2	15.39	11.78	-8.23	39.02
AOR	-.12	.77	-1.69	1.43
X_{10}	-118.97	392.63	-906.50	668.54
X_{19}	-.21E-02	.91E-02	-.20E-01	.16E-01
YR	-2.56	13.38	-29.47	24.27
XX_{23}	1.91	2.36	-2.83	6.66
X_{23}	-16.16	20.96	-58.69	25.76
Constant	109.04	345.32	-583.59	801.67
"Best" Model				
XX_8	1199.36	1307.56		
XX_6	-300.31	41.55		
XX_{17}	-.66E-03	.16E-03		
XX_{16}	-.29E-03	.62E-04		
X_{16}	1.02	.21		
X_{22}	-8.43	3.98		
X_{14}	-.34	.16		
XX_{13}	-.90E-03	.67E-03		
XX_9	-630.17	190.90		
X_4	-30.94	13.09		
XX_{21}	31.35	13.39		
Constant	-681.75			

Table V-17. Contribution of variables to explained variations: complete model

Variable	Path Coefficient	% Explained Variation
XX_8	.16	.062
XX_6	.61	.922
XX_{17}	-.29	.203
X_{16}	4.77	98.030
XX_{16}	-4.33	
X_{22}	-.16	.062
X_{14}	-.33	.271
XX_{13}	-.09	.018
XX_9	-.27	.182
X_4	-.19	.086
XX_{21}	.25	.164
		100.000%

feed expense/gross income (X_6^2)
milk revenue/milk cow (X_{16}, X_{16}^2)
net worth/total assets (X_4)
feed expense/cow equivalent (X_{12}, X_{12}^2)
milk fat/milk cow (X_{20})
labor expense/cow equivalent (X_{13})
other revenue/gross income (X_{11}^2)
other revenue/cow equivalent (X_{18}^2)

The direct contribution of these variables to variation explained by the entire model (R^2 = 81.7) is shown in Table V-18. Table V-18 suggests that 91.7% of the explained variation is directly contributed by these variables. In order of importance, these variables are:

Table V-18. Contribution of specified variables to explained variation when all variables are fitted

Variable	Path Coefficients	% Explained Variation
XX_6	-1.11	1.3
X_{16}	5.62	33.8
XX_{16}	5.11	28.1
X_4	1.35	1.9
X_{12}	3.24	11.3
XX_{12}	2.94	9.5
X_{20}	1.15	1.4
X_{13}	1.00	1.1
XX_{11}	1.19	1.5
XX_{18}	1.32	1.8
		91.7%

milk revenue/milk cow (X_{16})
feed expense/cow equivalent (X_{12})
net worth/total assets (X_4)
other revenue/cow equivalent (X_{18})
other revenue/gross income (X_{11})
milk fat/milk cow (X_{20})
feed expense/gross income (X_6)
labor expense/milk cow (X_{13})

Both Tables V-17 and V-18 suggest that an analysis using milk revenue/milk cow as a dependent variable is an appropriate investigation for future research.

Analysis of Residuals

Residuals were examined after fitting the entire model. Casewise plotting of residuals suggested the possibility of an outlier. The outlier was tested by the David, Hartley, and Pearson method (48) and retained in the study. The plot of residuals against predicted Y's suggested no abnormality (see Figure A1) according to the standards set by Draper and Smith, thus supporting underlying assumptions. Finally, 1975 residuals were plotted against 1974 residuals. Figure A2 in the Appendix suggests little correlation of residuals, thus supporting underlying assumptions.

VI. CONCLUSIONS

Results of this study suggest a variety of practical applications for dairy managers, extension personnel, accountants, financial institutions, and others interested in drylot dairy business analysis. It is to be understood that these applications do not necessarily extend to dairies other than the type studied. Practical implications are as follows:

1) Historical valuation of assets and liabilities does not prohibit the use of financial ratios developed from accrual based accounting data in a drylot dairy business analysis. In all models studied, the age of the accounting record did not have any significant bearing on the variation of return to net worth. This suggests that when ratios are used balance sheets may be compared between farms. It does not suggest that land appreciation and other inflationary effects should be ignored. Rather, if they are ignored, balance sheets can still be compared on a similar basis.

2) Leverage, as measured by total liabilities/net worth or in effect by net worth/total assets, is an important financial ratio for use in business analysis of highly capitalized dairies. Leverage directly contributed over 80% of the explained variation in the financial model

and almost 2% in the entire model. The difficulty of measuring indirect contributions of leverage may have masked its importance and the author believes that alternative statistical means might unravel this contribution. The function of debt capital in such highly specialized operations deserves further investigation.

3) Milk revenue/milk cow appears to be the most important of all ratios studied. In examining path coefficients from the entire model, it was discovered that milk revenue/milk cow directly contributed over 60% of the explained variation in return to net worth (R^2 = .817). One would expect this to be true when it is realized that milk revenue/milk cow is highly correlated with a number of other ratios. This does not necessarily imply that the price of milk is the important factor. Rather, it suggests that the quantity of milk produced and sold is the important factor.

4) Feed expense/cow equivalent is an important "marketing" ratio for use in a drylot dairy business analysis. When path coefficients for the entire model were examined, feed expense/cow equivalent directly contributed over 20% of the explained variation in return to net worth. It should also be realized that feed expense/<u>gross income</u> directly contributed over 44% of the explained variation when income generating efficiency ratios alone were considered and less than 2% when the entire model was considered. However, the correlation between milk revenue/milk cow and feed expense/cow equivalent is much

higher than between milk revenue/milk cow and feed expense/gross income. This suggests to the author that efficient feed conversion by livestock and feed cost control are important factors easily monitored by using the ratio feed expense/cow equivalent.

5) Two ratios measuring minor enterprise diversification, other revenue/cow equivalent and other revenue/gross income, accounted for a small amount of variation in return to net worth. This suggests to the author that such enterprises as heifer feeding for other dairymen or sale of feed contribute some to the variation. Whether such auxiliary activities are profitable or not has not been determined. The author believes these ratios to be of minor importance.

6) Labor expense/milk cow and milk fat/milk cow also appeared to be important when path coefficients for the entire model were considered although neither ratio contributed more than 1.4% of the explained variation.

7) Finally, it is believed that business analysis ratios can be used in forming a business success-predictive equation when all facets of the business are studied simultaneously. The predictive equation developed considered return to net worth as a function of:

herd replacement expense/gross income
feed expense/gross income
cattle revenue/milk cow
milk revenue/milk cow
grain/cow equivalent
labor expense/cow equivalent
other operating expenses/gross income
net worth/total assets
raised heifers/total cows

In retrospect it is the author's opinion that the analytical method used for this study has strong limitations. Although the study seems to have satisfactorily put the use of financial ratios in proper perspective, the true direct and indirect contributions of marketing and production ratios have remained somewhat elusive. It is the author's opinion that a keener insight into the use of ratios in dairy business analysis will be obtained when statistical methods beyond the author's present abilities are applied.

VII. SUMMARY

Financial, marketing, and production data were obtained from 50 southwestern U.S. drylot dairies owning 500 or more mature cows for the purpose of discovering which business measures are most useful for conducting a simple dairy business analysis of a drylot dairy. In addition, the use of business measures for developing a dairy business success-predictive model was investigated. All information was obtained through an accounting agency and was based on the accrual accounting method. Raw data were converted to specified ratios measuring the financial, marketing, and production facets of the dairy business. These ratios were then used in investigation of six functions by means of multiple regression analysis and the Wright method of finding direct and indirect contributions of independent variables to explained variation in the response variable. These functions were:

1) percent return to net worth as a function of financial ratios (ratios measuring the acquisition and use of capital),
2) percent return to net worth as a function of income generating efficiency ratios (monetary inputs or diversifications per unit of gross income),

3) percent return to net worth as a function of input marketing efficiency ratios (cost control ratios),
4) percent return to net worth as a function of output marketing efficiency ratios (price ratios),
5) percent return to net worth as a function of production ratios (ratios measuring physical inputs, outputs, and efficiencies), and
6) percent return to net worth as a function of all the ratios described above (the complete function).

When financial ratios were considered in relation to the return to net worth, total liabilities/net worth contributed over 80% of the explained variation. This suggests that total liabilities/net worth is the most useful measure of financial status. A high correlation between total liabilities/net worth and net worth/total assets suggests that this second measure may serve as well. Financial ratios alone did not produce a satisfactory predictive model.

When income generating efficiency ratios were considered in relation to the return to net worth, herd replacement expense/gross income directly contributed over 55% of the explained variation. Feed expense/gross income directly contributed over 44% of the explained variation. This suggests that these two ratios are the most useful measures of income generating efficiency. Income generating efficiency ratios alone did not produce a satisfactory predictive model.

When input marketing efficiency ratios were considered in relation to return to net worth, herd replacement expense/cow equivalent accounted for 70% of the explained variation. The analysis suggests that such variables are of little use for predictive purposes when considered independently of other types of variables.

When output marketing efficiency ratios are considered in relation to the return to net worth, milk revenue/milk cow accounted for 100% of the explained variation. This suggests that milk revenue/milk cow is the most useful measure of output marketing efficiency. Output marketing ratios alone did not produce a satisfactory prediction model.

When production ratios alone were considered in relation to return to net worth, milk production/milk cow contributed directly and indirectly over 98% of the explained variation. This suggests that milk production/milk cow is the most useful measure of production efficiency. Production ratios alone did not produce a satisfactory prediction model.

The above observations indicate that isolated groups of performance ratios designed to monitor the financial, marketing, and production facets of the dairy enterprise cannot serve as predictive models. In addition, it is realized that the high correlation between these facets limits the researcher's ability to analyze contributions of variables to explained variation in return to net worth when the facets are studied independently. Ratios such as milk revenue/milk cow are so highly correlated with numerous other ratios that contributions of these other ratios are effectively masked in the regression procedure.

When financial, marketing, and production ratios were considered simultaneously in a complete model, 11 variables were selected for the prediction model. The prediction model accounted for 68.8% of the variation in return to net worth. Such a model might serve as a predictive model depending on the needs of the user. Over 98% of the explained variation in this model was contributed by milk revenue/milk cow. In examining the path coefficients of all 50 variables included in the complete model (before a predictor model was selected), it was observed that 8 variables and 2 associated second order terms contributed 91% of the explained variation (R^2 = 81.7) directly. These variables, then, are suggested as those most useful to dairymen, extension personnel, and related institutions attempting to quickly and efficiently analyze large drylot dairy operations of the type studied:

milk revenue/milk cow
feed expense/cow equivalent
net worth/total assets
other revenue/cow equivalent
other revenue/gross income
milk fat/milk cow
feed expense/gross income
labor expense/milk cow

In addition, it was observed that the age of the balance sheet record (i.e., the length of time the dairy had been a client of the accounting firm) did not significantly account for variation of return to net worth in any model studied. The practical implication of this is that the use of ratios appears to nullify the effect of historical valuation when using accrual accounting records.

Finally, it is the author's belief that other statistical procedures, beyond the author's present ability, could provide keener insight on the objectives of this study. It is believed that this attempt can well serve as initial groundwork for further studies.

APPENDIX

Table A1. Descriptive statistics: calculated ratios

Variable Name	Ratio	Mean	Standard Deviation	Range	
AOR	age of record	10.01	5.70	2.000	2.500
Y	(net income/net worth)100	8.35	40.80	-268.100	67.500
X_1	current assets/current liabilities	2.21	4.57	.264	32.100
X_2	total assets/total liabilities	2.20	2.25	.606	17.700
X_3	total liabilities/net worth	3.69	4.96	.217	28.400
X_4	net worth/total assets	.40	.25	.226	1.220
X_5	gross income/total assets	.88	.32	.347	2.500
X_6	feed expense/gross income	.60	.07	.410	7.800
X_7	labor expense/gross income	.07	.02	.030	.120
X_8	herd replacement expense/gross income	.06	.03	.003	.175
X_9	other operating expenses/gross income	.20	.04	.118	.319
X_{10}	withdrawals/gross income	.03	.03	0.000	.170
X_{11}	other revenue/gross income	.01	.02	0.000	.115
X_{12}	feed expense/cow equivalent	711.73	97.40	460.000	908.000

Table A1 (continued)

Variable Name	Ratio	Mean	Standard Deviation	Range	
X_{13}	labor expense/cow equivalent	79.98	21.61	43.000	136.000
X_{14}	herd replacement expense/cow equivalent	67.97	39.54	3.000	189.000
X_{15}	other operating expenses/cow equivalent	232.10	42.51	156.000	361.000
X_{16}	milk revenue/milk cow	1,658.63	189.41	1,090.000	2,033.000
X_{17}	cattle revenue/milk cow	132.63	50.80	0.000	366.000
X_{18}	other revenue/milk cow	15.39	1,461.48	0.000	105.000
X_{19}	milk production/milk cow	15,397.78	71.17	11,590.000	18,605.000
X_{20}	milk fat/milk cow	639.27	0.33	419.000	767.000
X_{21}	raised heifers/total mature cow	0.42	0.76	0.000	1.240
X_{22}	grain/cow equivalent/year (tons)	3.18	1.00	1.100	5.500
X_{23}	roughage/cow equivalent/year (dry tons)	4.07	0.11	1.700	6.200
X_{24}	replacements/mature cow	.34	5.84	0.000	0.691

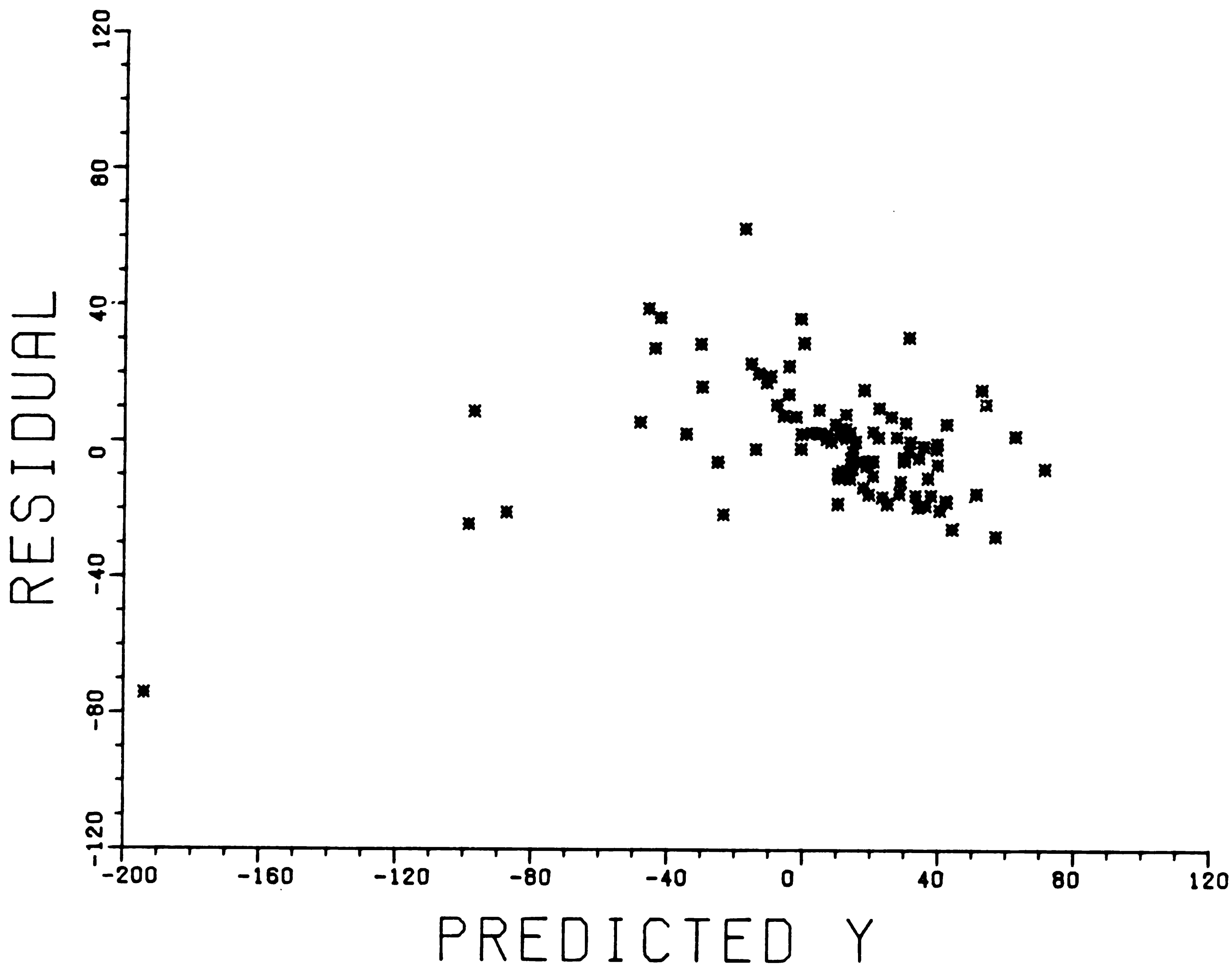

Figure A1. Residuals plotted against $\hat{Y}$.

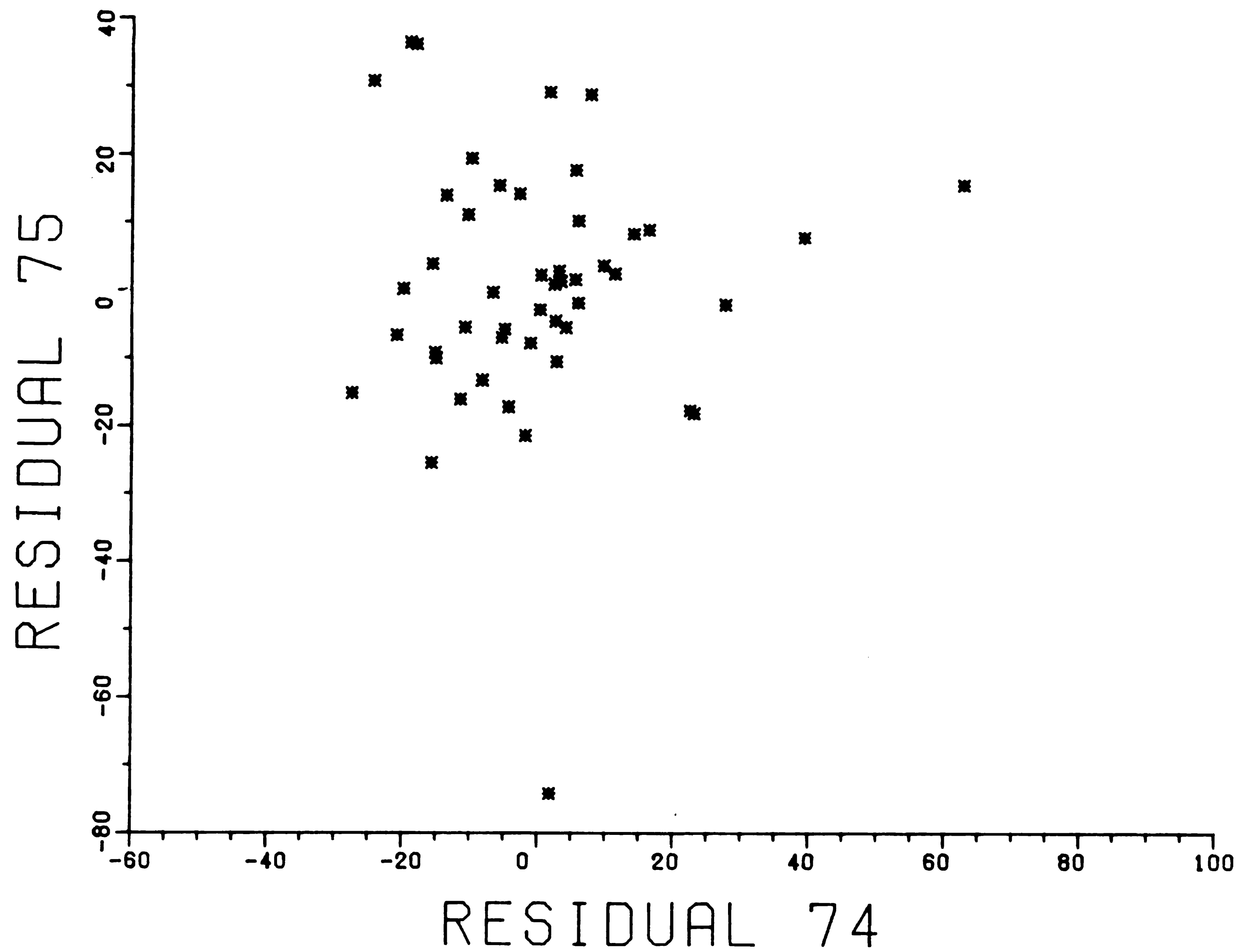

Figure A2. 1975 residuals plotted against 1974 residuals.

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