STAFF PAPER

EXPECTED PROFIT AND FARM CHARACTERISTICS

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Department of Agricultural Economics
Kansas State University

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Abstract

Ordinary least squares is used to test hypotheses about relationships between expected profit and farm characteristics. Results indicate that expected profit may be enhanced by increasing farm size, lease or rental of intermediate and long-term assets, using production and financial inputs efficiently, and hedging.

EXPECTED PROFIT AND FARM CHARACTERISTICS

Long-term declines in farm numbers and recent financial stress experienced by a significant portion of U.S. farms indicate that the survival of many farm businesses is questionable. One of the factors that determines whether a farm will survive is the ability of the farm operator to generate a profit. A better understanding of what farm characteristics influence profit would be useful to producers who wish to make changes in their operations in order to increase profit, to lenders who must decide what farms and what changes in farms to finance, and to policy makers who seek to design policies that will increase farm income and affect the direction of structural changes in agriculture.

The purpose of this study is to test hypotheses about relationships between farm characteristics and expected profit. Profit is defined as the annual return to family labor, management, and owner's equity. Thus, profit means net farm income and may be measured by accounting information summarized in the profit and loss statement.

One approach often used is to group farms according to farm characteristics and measure the profit levels and rates of profit related to those characteristics (e.g., Johnson, Prescott, Banker, and Morehart; Kansas Crop and Livestock Reporting Service [KCLRS]; Reimund and Somwaru; and Strickland). A shortcoming of this descriptive approach is that relationships between profit and farm characteristics are not explicitly measured. In this study, we seek to overcome this shortcoming by using regression analysis to measure magnitudes and significance of relationships between farm characteristics and profit. Research that statistically tests hypotheses about relationships between profit and farm characteristics is rare.

Conceptual Considerations and Related Literature

Consider the profit-maximizing farmer who is a price taker. His problem for each production period is to select the combination of inputs and products that will maximize the difference between expected receipts and costs subject to his production function. His planning problem may be stated mathematically as

$$\text{maximize } \Pi = \Sigma\, p_i q_i - \Sigma\, r_j x_j + \lambda f(q_i, x_j) \quad (1)$$

where Π is expected profit, p_i are product prices, q_i are quantities of each product produced, r_j are input prices, x_j are quantities of each input, λ is a Lagrange multiplier, and $f(q_i, x_i)$ is the production function. Typically, during each short-run planning period, some of the x_j are fixed. So the short-run production function is affected by the quantity and quality of fixed resources.

Costs in this case are contractual costs, defined as the anticipated payments to which the farmer is committed, after he decides how much of each product to produce. Since farms are predominantly owner/operator businesses, payments for family labor[1], management, and owner's equity are typically noncontractual. So, expected profit is the residual return allocated to family labor, management, and owner's equity, after all contractual costs are accounted for.

The appropriate measure of profit has been a topic of much debate among economists (e.g., Bronfenbrenner). The expected return to noncontractual costs is appropriate for this study for the following reasons: it is a decision variable that is probably maximized by producers who prefer more to less, it can be measured by means of pro forma accounting, it will vary in accordance

with farm characteristics, and it is one of the most popular and widely used measures of farm income, often called net farm income.

Choice of independent variables is based on the conceptual model (equation 1) and the related literature discussed below. Results from descriptive studies suggest that characteristics such as large farm size, change in location from eastern to western Kansas, and cash grain production are positively related to a measure of profit, whereas production of livestock, middle-aged operators, primary occupation other than farming, and small farm size are negatively related to a measure of profit (e.g., Johnson, Prescott, Banker, and Morehart; KCLRS; Reimund and Somwaru; and Strickland).

Reinsel and Joseph suggest commodities produced, location, size of operation, management, and natural phenomena as factors that cause returns from production to vary. Ahearn, Johnson, and Strickland mention ability, chance, age structure of the population, individual choice, human capital (e.g., education and on-the-job training), and wealth inheritance as factors that influence the size distribution of income.

Recent studies that statistically test relationships between profit and farm characteristics include Garcia, Sonka, and Yoo; Wood, Johnson, and Ali; and Ali and Johnson. Based on 1977 data from the Illinois Farm Business Farm Management Association, Garcia, Sonka, and Yoo estimated a unit profit function in order to examine economic efficiency of different groups of cash grain farms based on size. They identified acreage, soil productivity, regional climatic conditions, and the ratio of soybean to corn acreage as the most significant variables. Their results indicated that larger farms were not more economically efficient than moderate-sized farms and that increasing the degree of rented acres was positively related to short-run profitability. Our study

differs from theirs in that we did not use a unit profit function and did not convert numerical data to logarithms. Our study is based on data collected in 1984-85, when the environment in agriculture was much different from that in 1977, and our data are based on pro forma farm plans.

Johnson and his associates in North Dakota used average data from 1982-84 record summaries and regression techniques to identify performance factors significantly related to returns to labor and management. We did not become aware of this work until after our study was essentially completed, so it did not influence our choice of independent variables. However, we cite it here because it is important and relevant. Ali and Johnson used stepwise regression and focused on different types of farms. They found that factors enhancing profit included machinery cost control, efficient labor use, crop yields, effective use of government programs, less use of summer fallow, effective marketing, controlled overhead expenses, efficient feed conversion, intensive pastures use, and value of milk production in relation to value of feed. Total farm assets and size of the beef cow herd were negatively related to profit. Using the same data source and correlation and regression analysis, Wood, Johnson, and Ali found government payments per tillable acre, crop yield index, work units per worker, and crop expense per tillable acre to be positively associated with profit; whereas total operator assets and crop yield index interaction with machine cost per acre were negatively associated with profit. Our study differs from the North Dakota studies in that our measure of profit is different and our data are based on pro forma farm plans.

If the decision maker is a price taker, equation 1 suggests that the level of profit is affected by farm characteristics associated with the production function and the related choice of the combination of enterprises. This is

generally consistent with independent variables suggested in the literature, except that some studies identify variables that are independent of the production function, such as chance and natural phenomena. We assume that chance and some natural phenomena are random variables. Some natural phenomena (e.g., climate) may be associated with location.

We consider variables such as ability, age, and human capital to be components of the management factor in the production function. Nonfarm income may affect labor and management. If the sources of the nonfarm income are salaries and wages, then one would expect the effort expended to detract from farm labor and management. However, if the source is a return on investments of accumulated and inherited wealth, such income might accrue with minimal impact on farm labor and management.

In the real world, the decision maker may not be a price taker. He may, for example, receive volume of quality discounts or premiums, obtain higher product prices by successful marketing strategies, or obtain lower input prices by shopping. The level of profit for an individual farm might be increased by increasing size. But without knowledge of the production function, we cannot determine whether such increases are due to economies of size or economies of scale. The effect of wealth inheritance is probably related to measures of size, such as value of assets or equity. Since profit is defined as receipts minus contractual costs, production and financial efficiency should have a significant impact on profit.

Data

Data were obtained from farmers who participated in financial management workshops conducted by the Kansas Cooperative Extension Service (KCES) during the 1984-85 workshop season (November-April). During these workshops, the

microcomputer program FINPACK was used to analyze the financial condition of participants' farms and to evaluate alternative management strategies (Hawkins, Nordqusit, Craven, and Feltes). The projected normal farm situation is used to provide data for this study. KCES personnel worked directly with farmers to help them specify their data correctly. The concept of "projected normal" is used to avoid unusual annual variations in the farm plans from factors such as weather, accounts receivable or payable, and inventories. Thus, the profit and loss statement approximates a statement prepared on the accrual basis and many of the random factors that affect actual profit in a given year do not affect projected normal profit.

In order to obtain permission to use the FINPACK data and to collect data on management characteristics, a one-page questionnaire/release form was designed. The questionnaire requested information about age, education, farm management experience, type of farm organization, marketing strategies, and record systems. At the bottom of the release form was a statement which, if signed, gives permission for the data to be used in research. Extension specialists returned release forms and data for 77 farms; data for 68 farms were usable.[2] Comparison of average characteristics from this sample to averages from other Kansas data (KSBA 66th and 67th Report, U.S. Bureau of Census, KCLRS, USDA and KS Agr. Stats.) indicate that the sample is probably representative of larger, commercial, heavily indebted farms in Kansas.

Average profit (annual return to family labor, management, and owner's equity) for the 68 workshop participants whose data were used was $21,509. The range of profit levels and number of farms in each level was <$0--15 farms, $0-15,000--17 farms, $15-30,000--16 farms, and >$30,000--20 farms.

Empirical Model

Based on the conceptual model and our interest in characteristics that could require a large number of independent variables (e.g., enterprises), the regression equation for profit was estimated as follows.

First, ordinary least squares (OLS) was used to estimate the following preliminary equation.

$$\Pi = \beta_o + \Sigma\beta_i X_i + \Sigma\gamma_j D_j + \epsilon \qquad (2)$$

where Π is expected profit. X_i are farm characteristics for which quantitative data are used--value of total farm assets as a measure of size; value of total farm assets divided by hours of labor as a measure of the capital/labor ratio; percent debt (debt-to-asset ratio multiplied by 100) as a measure of indebtedness; rent, lease, and machinery hire expenses divided by total farm assets as a measure of the degree of nonownership of real estate and machinery;[3] value of hired labor divided by total hours of labor as a measure of the proportion of labor hired; gross farm income divided by total expenses (operating expenses plus depreciation) as a measure of production and financial efficiency; off-farm income as a measure of the family's commitment (or lack of commitment) to the farm operation; years of education as a measure of formal training; and years as manager as a measure of management experience. D_j are qualitative (dummy) variables specified as one if the farm had a particular enterprise, zero otherwise. Eleven enterprises--wheat, grain sorghum, hay, corn, soybeans, farrow-to-finish hogs, hog finishing, beef cow-calf, beef finishing, beef backgrounding, and beef grazing--were included in this preliminary model. Selection of enterprises to be considered was based on the authors' knowledge of importance to Kansas agriculture and frequency of occurrence in the data set. The β_o, β_i, and γ_j are regression coefficients for

the intercept, X_i, and D_j, respectively. ϵ is the stochastic error term.

Second, the D_j that were not statistically significant at the 5% level in the preliminary model were eliminated. Third, D_j representing other farm characteristics such as farm organization, location in Kansas, marketing practices, record keeping system, and age bracket were added to the equation one at a time. Farm organizations included sole proprietorship, partnership, and corporation. Locations included the eastern, central, and western thirds of Kansas. Marketing practices included selling grain on the cash market with pricing on the date of delivery and no use of forward pricing by means of hedging or cash contracts; selling all feeder or finished cattle on the cash market with pricing on the date of delivery; selling all market hogs on the cash market with pricing on the date of delivery; forward pricing by means of hedging on the futures market; forward pricing by means of a cash contract; use of regular or reserve government loan for cash grain; and storage of cash grain that is not under loan. Record keeping systems included the Kansas Farm Account Book and Kansas Farm Management Association. Age brackets were 35 or under, 36-55, and over 55. If an added D_j was statistically significant at the 5% level, it was included in the final equation reported in Table 1.

Results

Results indicate that total farm assets, degree of nonownership of real estate and machinery, and production and financial efficiency are significantly related to profit at the 1% level (Table 1). The enterprise, farrow-to-finish hogs is significant at the 5% level. The positive relationship between total farm assets and profit is consistent with expectations based on much of the literature and with the historical trend of increasing farm size (e.g., U.S. Bureau of Census, p. 1). This differs from the negative relationship between total farm assets and profit found by Wood, Johnson and Ali and Ali and Johnson.

Table 1. OLS Regression Results Using Profit of Kansas Farms as Dependent Variable[a]

Independent Variables and Regression Statistics	Regression Coefficient[b]	t-value
Intercept	-77,003.70**	-3.36
Quantitative Variables		
Total Farm Assets	0.04**	4.18
Capital/Labor Ratio	3.64	0.14
Percent Debt	-46.56	-0.47
Degree of Nonownership of Real Estate and Machinery[c]	236,062.00**	3.25
Proportion of Labor Hired[d]	-1,142.69	-1.49
Production and Financial Efficiency[e]	72,536.81**	5.44
Nonfarm Income	-0.27	-1.10
Years of Formal Education	-535.60	-0.48
Years as Farm Manager	259.79	1.10
Qualitative Variables		
Farrow-to-Finish Hogs	20,352.30*	2.40
Cash Marketing of Hogs	-13,917.10	-1.67
Cash Marketing of Cattle[f]	-8,347.89	-1.72
Hedging on Futures Market[g]	8,538.98	1.41
Equation Statistics		
R^2	71.80	
F-Ratio	10.58	
Prob > F	.0001	

[a]Data are based on projected normal farm plans and other farm characteristics of 68 farms that participated in Kansas Cooperative Extension Service Workshops during the 1984-85 workshop season. The dependent variable representing profit was net farm income.

[b]One * indicates significantly different from zero at the 5% level; ** indicates significant at the 1% level.

[c]Degree of nonownership of real estate and machinery was calculated as rent, lease, and machinery hire expenses divided by total farm assets.

[d]Proportion of labor hired was calculated as value of hired labor divided by total hours of labor.

[e]Production and financial efficiency was calculated as gross farm income divided by total expenses (operating expenses plus depreciation).

[f]Cash marketing of hogs or cattle means that all of the feeder and finished cattle or hogs, respectively, were priced on the date of delivery.

[g]Hedging on the futures market was specified for an observation, if any futures market hedging was used.

The large coefficients on the degree of nonownership of real estate and machinery and on production and financial efficiency reflect the size of these variables relative to the size of profit. Mean profit was $21,509 with a standard deviation $29,985. Mean degree of ownership was 0.03 with a standard deviation 0.03, and mean efficiency was 1.14 with a standard deviation 0.22.

The positive relationship between profit and degree of nonownership of real estate and machinery is consistent with the finding of Garcia, Sonka, and Yoo, who reported a positive relationship between degree of rented land and short run profitability. Since payment to equity is a noncontractual cost, a farmer who has built up equity in land and machinery might be expected to have lower contractual costs, ceteris paribus, than a farmer who rents durable assets and custom hires. Thus, this result might be interpreted to indicate that the impact on profit resulting from additional contractual costs of those who rent real estate and hire machinery is outweighed by their ability to increase profit by using assets they do not own. But it is also possible that contractual costs of purchasing are greater than contractual costs of renting. If the contractual costs of purchasing plus the value of equity in durable assets are greater then the contractual costs of renting, then rental rates are too low and/or purchase prices are too high, compared to rental rates and purchase prices in a perfectly competitive market. Given recent shocks, there are numerous reasons why disequilibria might exist in the market for durable assets used in agriculture. While analysis of exact causes is beyond the scope of this study, results indicate that expected profit increases as the degree of nonownership of real estate and machinery increases.

The strong positive statistical relationship between profit and production and financial efficiency, calculated as gross farm income divided by the sum of

operating expenses and depreciation, indicates the importance to farmers of getting the highest possible output prices, increasing their output per unit of input, and reducing contractual costs. Many of the performance factors examined by Wood, Johnson, and Ali and Ali and Johnson affect production and financial efficiency. Regarding production and financial efficiency, their analysis is much less aggregated than ours.

The enterprise, farrow-to-finish hogs, is positively related to profit and is the only qualitative variable significant at the 5% level. This enterprise was used by 24% of the farmers in the sample. Since expected profit, rather than actual profit, is the dependent variable, results indicate that those farmers who produce hogs from farrow-to-finish expect to receive higher profits than those who do not.

Numerous variables that were expected to influence the level of expected profit are not significant. The capital/labor ratio is not found to significantly affect profit, which suggests that neither capital nor labor intensive farms are more profitable. We expected percent debt to be negatively associated with profit, but we are unable to reject the hypothesis that percent debt does not influence profit. The proportion of labor hired is not significant, suggesting that increasing the proportion of labor costs that are contractual does not affect profit.

While significant factors such as larger size and greater production and financial efficiency may be viewed as indicators of effective management, none of the variables selected to describe the manager is significant. Thus, we failed to reject the hypotheses that nonfarm income, formal education, or farm management experience do not affect profit. The insignificance of nonfarm income may indicate that the source of much of the nonfarm income is

investments of wealth rather than salaries and wages. Indeed, opportunities for nonfarm employment are limited in much of rural Kansas, and the average nonfarm income of our sample is smaller than that reported for Kansas by other studies (USDA and KCLRS).

Of the qualitative variables, the enterprise, farrow-to-finish hogs is the only significant variable (at the 5% level) in the final equation. Thus, we failed to reject the hypotheses that other enterprises, marketing practices, type of farm organization, location, record keeping system, and age bracket do not affect the level of expected profit.

Summary and Conclusions

The purpose of this study was to test hypotheses about relationships between farm characteristics and expected profit. Data were obtained from participants in financial management workshops conducted by the Kansas Cooperative Extension Service. Ordinary least squares was used to regress measures of farm characteristics on expected profit, defined as pro forma net farm income.

Characteristics tested that were <u>not</u> found to be significant at the 5% level include capital/labor ratio, percent debt, proportion of labor hired, off-farm income, formal training, management experience, all but one of the crop and livestock enterprises, marketing practices, type of farm organization, location, record keeping system, and age bracket. Thus, we failed to reject the hypotheses that many farm characteristics, suggested by the literature to be important, do not affect the level of expected profit. Our sample size (68 farms) was small for the amount of information we attempted to extract, and our sample was not randomly selected. Thus, research using other data sets might provide different results.

But three farm characteristics--total farm assets (a measure of size), degree of nonownership of real estate and machinery, and production and financial efficiency--were positively related to expected profit at the 1% level. The farrow-to-finish hog enterprise used by 24% of the sample, was positively related to expected profit at the 5% level.

Use of data based on pro forma income statements representing a projected normal year is a unique aspect of this study. Conceptually, data based on projected normal plans should not include variations caused by unusual circumstances. Pro forma data are affected by producers' expectations, which may by unrealistic. But such data are the basis for farmer decision making. Alternative data sets for additional testing of relationships between farm characteristics and expected or actual profit is desirable. If the expectations expressed in the data of this study are realistic, then farmers who wish to maximize profit should consider the farrow-to-finish hog enterprise, and should implement management strategies to increase farm size, decrease the proportion of durable assets that are owned, and increase production and financial efficiency.

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Footnotes

1. The authors recognize that operators may choose to pay family members a specified wage for tax purposes. Since the extent to which this procedure is used is not known, we retain the term "family labor."
2. One of the original 77 farms was an extreme outlier and therefore, was not used because of the possibility that it would bias the results and eight others were eliminated because of unclear or missing data.
3. The machinery hire expense likely included the labor of those who owned and operated the machinery.