Farm Characteristics that Influence Net Farm Income Variability and Losses

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Abstract

Farm-level, cross-section and panel data were used with econometric methods to examine relationships between variability in net farm income and explanatory variables including government payments, gross crop income, gross livestock income, costs, efficiency measures, and other socioeconomic characteristics such as age, leverage, percent of land rented, and enterprise diversification. The results suggest that quantifying the impacts of socioeconomic factors on variability of net farm income is difficult. Among the income variables, changes in gross crop income had the largest impact. Among cross-section data, increases in interest costs, age, and diversification were found to have positive relationships with net income variability. However, only the diversification variable was significant when deviations below mean net farm income were used as the measure of risk. Increasing farm size also was found to have a positive relationship with net income variability. When panel data were used and the estimated models included adjustments for time or random effects, the age and diversification variables were insignificant.

keywords: diversification, farm planning, panel data, risk, tobit

Introduction

Several factors have contributed to the need for improved understanding of risk management at the farm level. In particular, the elimination of deficiency payments, the development of new risk management tools, and freer trade have brought about changes in the risk environment faced by producers. Farm-level risk is a major area of interest to research and extension personnel at land grant universities including agricultural economists as well as farm managers, particularly with the decoupling of commodity payments from production and prices under the 1996 farm bill.

Collins and Barry presented a brief overview of the extensive literature on risk analysis at the firm level. Although much has been written to guide decision making and analysis of risk management, particularly that from yield and price variabilities, studies of the socioeconomic characteristics of individual farms that impact overall net income variability are more scarce. This scarcity is due largely to the limited availability of detailed farm-level data. This study used farm-level, cross-section and panel data to examine the relationships between government program payments; gross income variability from production and price variabilities; and farm characteristics such as measures of production efficiency, diversification, operator age, leverage, land tenure position, and net return variability. The variation and negative deviations of net farm income about the mean and the change in annual net income across farms as it relates to these farm socioeconomic characteristics were studied. Data from farms participating in the record-keeping program of the Kansas Farm Management Associations were used.

Previous Work

Zenger and Schurle investigated net income variability related to size for a sample of 128 north central Kansas farms from 1973-1979. Gross farm income, acres per operator, taxable non-farm income, and machinery investment per acre were related significantly to variability of net income. Schurle and Williams used second degree stochastic dominance to identify preferred farm organizations in Kansas. Their results suggested that larger farms usually generate net income distributions that have higher average incomes and higher variance, but they were preferred by risk-averse individuals. Pope and Prescott examined the relationship between farm size, other socioeconomic variables, and diversification for a cross section of California crop farms. They found that diversification was related positively to farm size. They also suggested that a trade-off occurred between the diversification benefits of reducing risk and the economies of size benefits from specialization. Sonka, Hornbaker, and Hudson used panel data from Illinois grain producers to examine how farm characteristics influenced the placement of farms into top and bottom quartiles based upon returns to management per acre. Their logit model results indicated that although prices and yields were related positively to better returns, soil productivity and operating expenses were related negatively. The result for soil productivity indicated that higher quality land may have been overvalued relative to its income generating capacity. Their data also indicated that year-to-year variation in performance was substantial for both high- and low-quartile groups.

An alternative approach to using econometric methods for examining the impact of socioeconomic variables on farm risk is to apply portfolio theory. Farms can be considered a portfolio of enterprises, for which variability of net farm income can be described with the following equation.

$$\text{Net Income Variance} = \sum_{i=1}^{N}\sum_{j=1}^{N} X_i X_j r_{ij} s_i s_j \qquad [1]$$

where:

X_i = proportion of farm assets invested in enterprise i

X_j = proportion of farm assets invested in enterprise j

N = number of enterprises

D_{ij} = correlation coefficient between net return from enterprise i and j

F_i = standard deviation of net return for enterprise i

F_j = standard deviation of net return for enterprise j

Variability of net return as measured by variance or standard deviation is influenced by the proportion of total investment allocated to each enterprise and the correlation between the return on these investments and the standard deviation of these investments. Theoretically, this equation could be used to determine how the mix of investments on a farm could affect the standard deviation of net farm income. These results could be used to examine the optimal enterprise mix given a decision criterion for risk versus net return. The typical approach is to construct a representative case farm using farm enterprise budgets that reflect current costs. A distribution of net returns then is estimated by subtracting these costs from gross returns calculated with historical yields and prices. These distributions are used to obtain correlation coefficients between enterprises and standard deviations of net return for each enterprise. Examples of studies using this method include Schurle and Erven and Held and Zink.

This approach potentially could be used to determine how changes in enterprise mix reduces risk on these farms. This result could be compared to the actual enterprise allocations. Although this approach is conceptually useful, few farm level data are available that organize returns by enterprise or contain accurate estimates of the dollars invested in each enterprise on a typical diversified farm. Some investments such as machinery, buildings, and equipment are shared by several enterprises. Developing these shares is complex. This process is complicated further by the reality that many farms have both crops and livestock enterprises, so all returns cannot be measured on a per acre basis, which often is done with crop enterprise data to standardize the analysis.

Schurle and Tholstrup used econometric methods to examine income variability for farms in Kansas over a 13-year period from 1973 to 1985. However, the portfolio approach was used as a conceptual guide for their work. Their basic model estimated the relationship between the ratio of variance to the square of capital managed and enterprise shares as well as other variables such as government payments, age of operator, interest payments, and machinery investment. Their conceptual approach followed the general form

$$\frac{V(Net)}{T^2} = \sum_i S_i^2 V(N_i) + \sum_i \sum_j S_1 S_j C(N_i, N_1) \quad for\ i \neq j \qquad [2]$$

which is the relative variance of

$$\text{Net} = \sum_i S_i TN_i \qquad [3]$$

where:

Net = net farm income

S_i = share of assets in enterprise i

T = total assets

N_i = net income per dollar of assets in enterprise i

V = variance

C = covariance

Their study has some limitations, because specific crop enterprise net returns were not available, so sales of crops were based upon production and average prices. Shares of assets devoted to each enterprise also had to be approximated using budgets, because they were not available in the farm data.

Data

The data for this study were obtained from the Kansas State University Farm Management Whole-Farm Data Bank (Langemeier). This data set contained records for individual farms enrolled in the Kansas Farm Management Association Farm Records program, although it did not contain net return and cost information for individual enterprises. Data were obtained from 282 farms that participated continuously in the records program each year between 1973 and 1996, which provided a panel data set for 24 years. The distribution of farms by county is provided in Figure 1. There were potentially 6,768 observations for each variable. All financial variables were adjusted to 1996 dollars using the personal consumption expenditure (PCE) index, so that variability measures used would reflect constant dollars. Gross farm income in the data was calculated on an accrual basis as total commodity sales plus all forms of government payments, inventory changes, and miscellaneous farm income. Expenses were calculated as cash operating expenses including interest plus a depreciation estimate. Depreciation was that calculated for tax reporting purposes. Net farm income was calculated by subtracting cash farm expenses and depreciation from accrual gross income.

Variability in net farm income was measured in four ways: the standard deviation of net farm income, the average of the absolute value of the negative deviations from each farms' mean return, the absolute value of the negative deviation from each farm's mean return, and the annual change in net farm income. Two types of data sets were used in the analysis. The first two measures required the use of cross-section data. To examine the impact of farm characteristics on the standard deviation of net farm income and the average of the negative deviations, the data were collapsed to means, resulting in 282 observations for each variable. When the absolute value of the negative deviation from each farm's average net income and the annual change in net income was used, a panel data set was needed. This data set contained 6,768 observations for each variable. Summary statistics for the farms are reported in Table 1.

Structure of Models

Three models using cross-section data and two models using panel data were estimated.

Models Using Cross-Section Data

The models estimated using cross-section data to examine effects of farm characteristics on standard deviation follow the general form

$$y_i = b_0 + b x_i + e_i \qquad [4]$$

A description of the three models that were estimated using ordinary least squares (OLS) regression and cross-section data follow.

(1) STDNET = F(SGOVP, SGCI, SGLI, SCOST, LABOR, CROP, LIVE, INT, AGE, DIV, D/E, RENT, NW, WC, NC, C, SC, NE, EC, SE)

(2) STDNET = F(NET, GCI, GLI, COST, LABOR, CROP, LIVE, INT, AGE, ACRES,

DIV, D/E, RENT, NW, WC, NC, C, SC, NE, EC, SE)

(3) DEVNET = F(DGOVP, DGCI, DGLI, DCOST, LABOR, CROP, LIVE, INT, AGE, DIV, D/E, RENT, NW, WC, NC, C, SC, NE, EC, SE)

where:

STDNET =	standard deviation of accrual net farm income
DEVNET =	average of absolute value of negative deviations from mean accrual net farm income
NET =	accrual net farm income
SGOVP =	standard deviation of all sources of government payments
GOVP =	all sources of government payments
DGOVP =	average of absolute value of negative deviations from mean of government payments
SGCI =	standard deviation of gross crop income
GCI =	gross crop income
DGCI =	average of absolute value of negative deviations from mean gross crop income
SGLI =	standard deviation of gross livestock income
GLI =	gross livestock income
DGLI =	average of absolute value of negative deviations from mean of gross livestock income
SCOST =	standard deviation of cash production costs plus depreciation
COST =	cash production costs plus depreciation
DCOST =	average of absolute value of negative deviations from mean of cash production costs plus depreciation
LABOR =	hired labor cost per dollar of gross farm income from crop and livestock sales
CROP =	crop production expense per dollar of gross farm income from crop and livestock sales (seed, fertilizer and lime, herbicide and insecticide, machinery repairs, gas-fuel-oil, and equipment depreciation)

LIVE =	livestock production expense per dollar of gross farm income from crop and livestock sales (feed purchased, veterinary and drug costs, marketing and breeding expenses, building repairs, and building depreciation)
INT =	total interest expense per dollar of gross income
AGE =	age of principal operator
DIV =	a diversification index that accounts for both crop and livestock enterprises.
D/E =	debt to equity ratio
RENT =	percent of total acres farmed that are rented
ACRES =	total acres farmed
NW =	northwestern Kansas Crop and Livestock Reporting Region
WC =	west central Kansas Crop and Livestock Reporting Region
NC =	north central Kansas Crop and Livestock Reporting Region
C =	central Kansas Crop and Livestock Reporting Region
SC =	south central Kansas Crop and Livestock Reporting Region
EC =	east central Kansas Crop and Livestock Reporting Region
NE =	northeast Kansas Crop and Livestock Reporting Region
SE =	southeast Kansas Crop and Livestock Reporting Region

Model (1) was designed to determine the effects on variability in net farm income by the three major sources of revenue for a farm; cost efficiency measures; and other farm characteristics such as diversification, operators age, leverage, tenure position, and region.

Sales or gross returns on these farms fit into three major categories. Those included government payments, income from crop sales, and income from livestock sales. Therefore, three variables were used to examine the impact each of these income sources had on the standard deviation of net farm income. These variables were the standard deviation of government payments, the standard deviation of gross crop income, and the standard deviation of gross livestock income. We hypothesized that increasing the standard deviation of any of these three variables would increase the standard deviation of net farm income. Which variable had the greatest influence on the standard deviation of net farm income was of interest.

Government payments were common sources of revenue on most of these farms. Farms in this data set received an average of 52% of their net farm income from government payments. We hypothesized that more variability in government payments would increase the standard deviation of net farm income. Government payments were correlated highly with the size of the farm, and the size of the farm was correlated highly with the standard deviation of net farm income. Therefore, government payments as well as farm size might increase the standard deviation of net farm income.

Because individual enterprise income was not available nor were prices received for each crop and livestock commodity by farm, variables to capture separate crop yield, livestock production, and price variability are not included. The standard deviations of gross crop income and gross livestock income were included in an attempt to capture the aggregate value of yield and production variabilities.

Variation in costs also affects variability of net income. We hypothesized that increased variation in costs also would lead to increased variation in net farm income.

Four variables were used to measure how input efficiency influences the standard deviation of net farm income. Labor costs, crop expenses, livestock expenses, and interest costs, all were divided by the total of gross crop and livestock income. The total of gross crop and livestock income was used because many of these farms market grain produced through livestock enterprises in the form of feed. These variables are percentages. The lower the percentage, the more efficient the farm is at producing gross income relative to input costs. Decreasing efficiencies measured by an increase in these variables generally would decrease net farm income. We hypothesized that less input efficiency would lead to a higher standard deviation of net farm income.

The impact that the age of the principal operator had also was considered. We hypothesized that as an operator ages, the standard deviation of net farm income would decline because of increasing management experience and better ability to manage risk. However, an alternative hypothesis is that older operators take on additional risk because of improved financial positions.

We used an enterprise diversification variable (equation [5]), which was based on percentages of produced value in 17 potential enterprises that exist in the production information of the farm database. Diversification based upon production value was used, because livestock enterprises exist on all but a few farms, so creating a diversification index based upon acres alone was not logical. The value of livestock sales from each livestock enterprise was used. For crop enterprises, the values were the products of annual farm yields and average annual commodity prices.

$$DIV = N - \frac{N}{2}\left(\sum_{i=1}^{N}\left|P_i - \frac{1}{N}\right|\right) \qquad [5]$$

The variable N is the total number of enterprises that exist in the data (17), and P_i is the percentage that the enterprise contributes to gross value of production. For this diversification index, a 1 indicates complete specialization and N indicates complete diversification. The reader should note that this is the reverse interpretation of a Herfindahl index, where a value closer to 0 indicates more diversification, and a value of 1 indicates complete specialization. As suggested by portfolio theory, we hypothesized that farms with more diversification would have lower standard deviations of net farm income. An alternative hypothesis is that farms that are more specialized have lower standard deviations of net farm income because of economies of scale.

The impact of financial strength was measured with the debt to equity ratio. We hypothesized that a higher debt to equity ratio would increase the standard deviation of net farm income. Farm tenure characteristics were measured by using the percentage of acres farmed that are rented. Increasing the percent rented may increase the standard deviation of net farm income by increasing management complexity.

The nine Crop and Livestock Reporting Regions in Kansas were used to capture the impact of varying weather conditions (Figure 1). We hypothesized that regional variables such as rainfall and temperature conditions would cause differences in the standard deviations and net farm incomes. The base region was southwestern Kansas. Rainfall and humidity generally increase from west to east in the state.

Variables that specifically account for size were not included in the model, because acres, gross income, and value of capital managed were correlated highly with the standard deviations of government payments, gross crop, and gross livestock income. Therefore, a second model was estimated. Model (2) considered the impact of size and other characteristics on the standard deviation of net farm income. This equation did not contain any standard deviations as independent variables. The average of gross crop income, livestock income, and costs were used instead. Net farm income was used instead of capital managed because of the high correlations among capital managed and other independent variables. Average government payments were excluded because of the high correlation with average gross crop income. We expected that each of these variables would have a positive relationship to the standard deviation of net farm income.

Model (3) was used to examine factors that affect losses or downside risk. The average of the absolute value of negative deviations from the mean net farm income of each farm was used as the dependent variable. Instead of using the standard deviations of government payments, gross crop income, gross livestock income, and production costs, the averages of the absolute value of the negative deviations below their respective means were used. All other variables remained the same as in Model (1). We hypothesized that as the absolute values of negative deviations for government payments, gross crop income, gross livestock income, and production costs increased, the average absolute values of negative deviations of net income also would increase. The directions of impacts of other variables in this model were expected to be the same as with Model (1).

Models Using Panel Data

Panel data sets provide a rich source of information and enable regressions to capture variations across groups and time. Because panel data were available, they were used in the analysis of variability in net farm income (NFI). The fundamental advantage of a panel data set over a cross section is that it allows the researcher greater flexibility in modeling the differences in behavior across groups (Greene, 1997).

Panel regressions take two general forms, a fixed effects model and a random effects model. These two systems also can reflect one-way or two-way effects, which are for group (farm) and/or time effects. The fixed effects (FE) model, also called the least squares dummy variable (LSDV) model, uses binary variables (dummies) to capture variance unique to cross-section and/or time periods. These dummy variables are treated as parameter shifts presented in the following two equations,

$$y_{it} = a_i + x_{it} b + e_{it} \qquad \text{(one-way effects)} \qquad [6]$$

$$y_{it} = a_i + g_t + x_{it} b + e_{it} \qquad \text{(two-way effects)} \qquad [7]$$

where "$_i$ represents group effects, and ($_t$ denotes time period effects. A common formulation of the model assumes that differences across groups can be captured in differences in the constant term. The usual t ratio for "$_i$ and/or ($_t$ implies a test of the hypothesis that "$_i$ and/or ($_t$ equals zero, but the hypothesis that the constant terms are all equal to zero also can be tested with an F-test. This test determines if the group and time effects were jointly significant at a given level and also establishes whether or not the FE model was preferred to the OLS regression.

The FE model assumes that differences between cross section and/or time can be viewed as parametric shifts in the regression. The random effects (RE) model, however, uses random error in time, space, or both to derive efficient and unbiased estimates. The error structure is captured in the covariance matrix. The RE model also has one-way (OW) and two-way (TW) systems. The following equations represent the RE models,

$$y_{it} = a + x_{it} b + u_i + e_{it} \qquad \text{(one-way effects)} \qquad [8]$$

$$y_{it} = a + x_{it} b + e_{it} + u_i + v_t \qquad \text{(two-way effects)} \qquad [9]$$

The component u_i is the random distribution characterizing the i^{th} observation and is consistent through time. In equation [9], the v_t variable designates the random distribution contained in the t^{th} period. The OWRE model is estimated using generalized least squares (GLS), whereas the TWRE model is estimated with feasible generalized least squares (FGLS). The significance of the random effects model then can be determined using a Lagrange multiplier test.

An area of some concern when conducting panel data analysis is the selection of the fixed or random effects model as the appropriate formulation. The FE model is costly in terms of degrees of freedom, but the RE model may be inconsistent because of omitted variable bias. The FE model allows estimation and interpretation of each specific group or time effect; however, the RE model may be more appropriate for longitudinal data. The Hausman test can be used to determine which model is suitable. It tests the hypothesis that although both OLS and GLS are consistent, OLS is inefficient. The following equation represents the test statistic and the hypothesis

$$H = [b - \hat{b}]\hat{\Sigma}^{-1}[b - \hat{b}] \sim c_k^2 \qquad [10]$$

H_0: random effects (OLS is inefficient)

H_1: fixed effects (OLS is not inefficient relative to GLS)

where k is the number of continuous independent variables, b are from OLS, and $\hat{b}$ are from GLS.

If the null hypothesis is rejected, then the FE model is preferred to the RE model.

The preceding concepts were applied to this study of net farm income variability in an attempt to better explain the interactions of deviations and changes in net farm income with gross revenue attributes and farm characteristics. The panel data models were estimated using LIMDEP version 7.0 because of its panel data capabilities. The two models used in the analysis are as follows:

(4) DEVNETI = F(DEVGOVP, DEVGCI, DEVGLI, DEVCOST, LABOR, CROP, LIVE, INT, AGE, DIV, D/E, RENT, IWHEAT, ICORN, IMILO, IBEANS, IALF, ISILAGE, DWHEAT, DCORN, DMILO, DBEANS, DALF, DSILAGE, BEEF, DAIRY, SHEEP, SWINE)

(5) A)NFI = F(A)GOVP, A)GCI, A)GLI, A)COST, LABOR, CROP, LIVE, INT, AGE, DIV, D/E, RENT)

where:

DEVNETI = absolute value of negative deviations from mean accrual net farm income

A)NFI = annual change in accrual net farm income for each farm

DEVGOVP = absolute value of negative deviations from mean of government payments

A)GOVP = annual change in all sources of government payments for each farm

DEVGCI = absolute value of negative deviations from mean gross crop income

A)GCI = annual change in gross crop income for each farm

DEVGLI = absolute value of negative deviations from mean gross livestock income

A)GLI = annual change in gross livestock income

DEVCOST = absolute value of negative deviations from mean of cash production costs plus deprecation

A)COST = annual change in cash production costs plus depreciation

LABOR = hired labor cost per dollar of gross farm income from crop and livestock sales

CROP = crop production expense per dollar of gross farm income from crop and livestock sales (seed, fertilizer and lime, herbicide and insecticide, machinery repairs, gas-fuel-oil, and equipment depreciation)

LIVE = livestock production expense per dollar of gross farm income from crop and livestock sales (feed purchased, veterinary and drug costs, marketing and breeding expenses, building repairs and building depreciation)

INT = total interest expense per dollar of gross income from crop and livestock sales

AGE = age of principal operator

DIV = diversification index that considers both crop and livestock enterprises

D/E = debt to equity ratio

RENT = percent of total acres farmed that are rented

IWHEAT = percent of total value from irrigated wheat

ICORN = percent of total value from irrigated corn

IMILO = percent of total value from irrigated grain sorghum

IBEANS = percent of total value from irrigated beans

IALF = percent of total value from irrigated alfalfa hay

ISILAGE = percent of total value from irrigated silage

DWHEAT = percent of total value from dryland wheat

DCORN = percent of total value from dryland corn

DMILO = percent of total value from dryland grain sorghum

DBEANS = percent of total value from dryland soybeans

DALF = percent of total value from dryland alfalfa hay

DSILAGE = percent of total value from dryland silage

BEEF = percent of total value from beef sales

DAIRY = percent of total value from dairy sales

SHEEP = percent of total value from sheep sales

SWINE = percent of total value from swine sales

Model (4) is similar to Model (3) used in the prior cross-section analysis, except the data set was not collapsed to reflect farm averages, and "percent of total value" parameters were included in the model. This model was used to investigate factors that affect losses or downside risk. The absolute value of negative deviations from the mean net farm income of each farm was used as the dependent variable, instead of the average negative deviation or standard deviation. The absolute value of the negative deviations of government payments, gross crop income, gross livestock income, and production costs were used as the independent variables. The cost efficiency measures and other farm characteristic variables (diversification, operators age, leverage, and tenure position) also were included in the model.

We hypothesized that as the absolute value of negative deviations for government payments, gross crop income, gross livestock income, and production costs increased, the absolute value of negative deviations of net income also would increase. In addition, as cost efficiency declined, the absolute value of negative deviations of net farm income would increase. The directions of impacts of other variables in this model were expected to be the same as with Model (1).

The "percent of total value" variables were included in this model specification to quantify the impact of individual enterprises on the negative deviation of net farm income. These 16 variables also should capture some of the variabilities in crop and livestock production. They were calculated by dividing the production value of each enterprise by the total value of production. Because individual crop income was not available, production data were used in conjunction with average state prices to estimate a value of production for the cropping enterprises. Value of livestock production was calculated using sales figures contained in the data set. Six crops were considered: wheat, corn, grain sorghum, soybeans, alfalfa, and silage. Each of these crops had irrigated and dryland production, creating 12 total cropping values. The livestock factors contained beef, dairy, sheep, swine, and poultry sales. Seventeen total enterprises were used in these calculations. The poultry variable was dropped from the model to avoid collinearity problems.

These variables were believed to have varying effects. For example, a high percentage of total value in an enterprise with relatively low net returns might increase the absolute value of negative deviations in net farm income. A high percentage in an enterprise with relatively high returns might have the opposite effect on the negative deviations of net farm income. Therefore, it should be possible to determine which enterprises have positive and negative impacts on net farm income losses.

The variables that comprise absolute values of negative deviations were defined such that they had lower bounds of zero. Because Model (4) does not use averages but individual observations, it has a censored data set. A tobit regression approach for a censored model was employed. The LIMDEP software allows for a tobit procedure and the inclusion of fixed and random effects for panel analysis. Results were obtained for a one-way fixed effects model where binary observations were used for years. Unfortunately, because of the size of the censored panel data, solutions for a one-way fixed effects model by group (farm), a two-way fixed effects model, and random effects model could not solved.

Model (5), which was the second panel data model, examined the annual change in net farm income based on the annual change in gross revenues and expenses. Cost efficiency measures and farm characteristics also were included. The change in net farm income from year to year was used as the dependent variable, instead of the deviation from the mean net farm income. The annual changes in government payments, gross crop income, gross livestock income, and production costs were four of the independent variables. Because these variables were no longer measured as the absolute values of the negative deviations, the interpretation of the effects changed slightly. We hypothesized that increases in the annual changes in government payments, gross crop income, and gross livestock income would have positive impacts on the annual change of net farm income. However, we expected that an increase in the annual production costs would have a negative effect on the annual change in net farm income.

The cost efficiency measures and farm characteristics used in the previous model were the remaining independent variables in this system. We believed that as cost efficiency, (percentage increase in costs relative to gross) declined the annual change in net farm income also would decrease. The "percent of total value" parameters were found to have jointly insignificant effects and, therefore, were excluded from the system.

The data set had 6,768 observations with no bounds on the ranges. The LIMDEP software package was used to estimate one-way and two-way, fixed and random effects models.

Results and Analysis

Cross-Section Models

Each of the cross-section models was estimated using OLS with Stata Statistical Software. The Breush-Pagan test for heteroskedasticity was used and was determined to be insignificant. The results of Model (1) are reported in Table 2. With the exception of the livestock production expenses per dollar of gross income (LIVE), debt to equity (D/E), percent of total acres rented (RENT), and several region variables, the hypothesized explanatory variables were significant to at least " of .10.

Increases in the standard deviation of government payments (SGOVP), gross crop income (SGCI), and gross livestock income (SGLI) all had positive effects on the standard deviation of net farm income. An increase in the standard deviation of gross crop income had the largest impact on variability in net farm income. An increase of $1.00 in the standard deviation of gross crop income increased the standard deviation of net farm income by $0.73, whereas a similar increase in gross livestock income increased it by $0.44. Government payments was a close third and increased the standard deviation by $0.35. This result is consistent with that reported by Harwood et al. They reported that during the years 1987-1996, price variability was generally higher for crops than livestock. Livestock production per unit generally was more stable than yields per acre.

Increasing the standard deviation of production costs (SCOST) decreased the standard deviation of net farm income. This was not the result that was hypothesized. It might be plausible, if those managers who have a higher standard deviation for production costs adjust inputs more to changing economic conditions and are better at reducing net return variability. In addition, those farms that have greater variability in production costs might have enterprises that are less variable in net income because the level of gross income is correlated with the production cost.

Two of the four efficiency measures, labor (LABOR) and interest costs (INT) per dollar of gross crop and livestock income, had the hypothesized sign and were statistically significant. As labor efficiency decreased and interest costs per dollar of gross crop and livestock increased, the standard deviation of net farm income increased. This suggests that as hired labor costs and interest obligations relative to gross income increase, the variability of net farm income increases. The sign for livestock costs (LIVE) for per dollar of gross was as expected, but the coefficient was not statistically significant. However, the sign for crop production costs (CROP) per dollar of gross was negative and significant.

The average age variable (AGE) indicated that as farmers aged, the standard deviation of net farm income increased. Schurle and Tholstrup presented several possible reasons for this. "It is possible that the operator's experience was overshadowed by inability or unwillingness to extend their labor efforts. Second, the older operator may be less flexible in adjusting to unusual circumstances. Third, older operators may not keep pace with technological advances. Finally, as the operator gets older, his wealth position may increase, so he may not be as risk averse. Thus, he may not be so willing to sacrifice to reduce income variability."

The diversification variable (DIV) had a positive sign and was statistically significant. As the amount of diversification increased, the standard deviation of net farm income also increased. This result was not consistent with the prior hypotheses or with portfolio theory. Portfolio theory indicates that the standard deviation can be reduced if diversification takes place with enterprises that are not correlated perfectly. Portfolio theory was developed and tested with liquid investments that are homogeneous across units and have similar attributes like common stocks. Increasing the investment in a crop or livestock enterprise by $10,000 is not the same as increasing the investment in a stock by $10,000. With stocks, the variance of income per unit is constant as more units are added to the portfolio. This relationship generally does not hold in agricultural enterprises because of size factors. Each unit of common stock behaves the same, but has been shown with field segment data from precision agriculture research, each acre of a crop enterprise does not. In addition, different production skills as well as different equipment and marketing knowledge are required for different enterprises. Changing the allocation of investments in a portfolio is a simple procedure compared to managing several farm enterprises and adjusting the investment allocated to each. Diversification of farm enterprises may spread the managerial capacity of the producer too much. Interestingly, Coble et al. using a Herfindahl index, found that the degree of crop specialization did not impact a manager's decision to purchase crop insurance. Goodwin also found that a Herfindahl index calculated on sales shares showed no statistically significant relationships to the coefficient of variation for crop yields with the exception of irrigated sorghum. In that one case, the CV decreased as specialization increased. The analysis of Model 1 also was performed with a Herfindahl index. Although the relation indicated that specialization decreased variation in net income, the coefficient was insignificant. It is important to note that the model examined absolute variability and not variability in percent returns. Determining how diversification impacts return to equity or investment may be important. That relationship may be more consistent with what portfolio theory suggests.

The debt to equity ratio variable (D/E) had a negative sign but was insignificant. The tenure variable (RENT) measured by percent of total acres rented also was insignificant. Two of the crop reporting region intercept shifters were significant. Compared to the southwest region, the northwest region (NW) had a lower standard deviation of net farm income, and the west central region (WC) had a higher standard deviation of net farm income.

The results of Model (2) are reported in Table 3. This model substituted absolute values or size measures for the standard deviations of gross crop income, gross livestock income, and costs. In addition, average net farm income and acres were included. Average government payments were excluded, because they were correlated highly with average gross crop income.

The signs on the coefficients for average net farm income (NET), gross crop income (GCI), gross livestock income (GLI), and production costs (COST) were positive as expected and significant as well. The standard deviation of net farm income increased as the average value of any of these variables (all measures of size) increased.

The results indicated that as labor (LABOR) and crop production (CROP) per dollar of gross income increased, the standard deviation of net farm income increased. The direction of change was as expected, but these coefficients were not statistically significant. The interest costs (INT) per dollar of gross income coefficient had the expected sign and was statistically significant. As interest costs increased, the standard deviation of net farm income increased.

The results also indicated that as livestock production (LIVE) costs per dollar of gross income increased the standard deviation of net farm income declined. This result was significant, but it did not have the expected sign.

Increases in the operator age (AGE) and number of acres (ACRES) farmed also increased the standard deviation of net farm income. Although the diversification coefficient (DIV) was negative as hypothesized, the coefficient was insignificant. All of the other variables were insignificant with the exception of the west central (WC) region binary variable, which had a higher standard deviation than that of the southwest region.

Model (3) used the average of the absolute value of deviations below each farm's average net income as the dependent variable. Although individual-year observations were censored, the data used in the regression were not, because they were averages. The results of this estimation are reported in Table 4. The first four independent variables are the averages of the absolute values of the negative deviations of government payments, gross crop income, gross livestock income, and production costs from their mean. All four coefficients were statistically significant. Larger average absolute negative deviations of the revenue sources increased the average absolute value of negative deviations of net farm income as expected. The production costs had the opposite effect. As in Model (1), deviations of gross crop income had the largest effect of the income variables.

Two of the four efficiency measures, labor costs (LABOR) and livestock costs (LIVE) per dollar of the gross crop and livestock income, had the expected sign and were statistically significant. As these efficiency measures declined or as the cost per dollar of gross income increased, the average of the absolute value of negative deviations of net farm income increased. The interest cost (INT) coefficient also had the expected sign, but was not significant. As in the original model, the crop cost coefficient (CROP) did not have the expected sign and was significant.

Again, the coefficient for age (AGE) suggested that the average value of absolute negative deviations increased as the manager aged, but it was insignificant. The diversification coefficient (DIV) was significant and positive. The debt to equity ratio variable (D/E) had a negative sign, but was insignificant. The tenure variable (RENT) measured by percent of total acres rented also was insignificant. One of the crop reporting region intercept shifters were significant. Compared to the southwest region, the northwest region (NW) had a higher standard deviation of net farm income.

Other variables that measure the impact of individual enterprises on the standard deviation of net farm income were examined as well. Because the data did not contain net income by crop and livestock enterprise, the average percent of total farm production contributed by each enterprise on the farm was estimated. Crop yields multiplied by annual prices were used to estimate production value for crop enterprises. These were used with the historical accrual income values for livestock enterprises, which were available. The total value of all production and the percent that each enterprise contributed to the total then were calculated. None of these variables were shown to be significant when they were included in Model (1), where the standard deviation of net farm income was the dependent variable.

Panel Data Models

To begin the estimation of Model (4), the joint significance of the fixed time effects was tested. The normal F-test would not be appropriate, because tobit estimation, which employs maximum likelihood procedures, was used for the censored data. Thus, a likelihood ratio test was applied to measure the need for the fixed effects model. It showed that time effects had a highly significant impact on the system. The likelihood ratio test also confirmed that the “percent of total value” variables were jointly significant. Therefore, a fixed effects model was estimated that contained both the “percent of total value” variables and binary (dummy) variables for the years. A constant was included in the equation, so the dummy for the 24^{th} year (1996) was dropped and set as the default.

The panel data set also was checked for autocorrelation. A Durbin-Watson test statistic was calculated for each individual group (farm), and then statistics were averaged over the groups. This method provides the appropriate test in panel data analysis. The statistic indicated that little to no autocorrelation existed in the data set.

The results from Model (4) are reported in Table 5. The table contains the coefficients, marginal effects, t-tests, and p-values for the traditional variables of the equation and also the fixed time effects and their characteristics. With tobit regression, the marginal effects should be used to evaluate the impact on the dependent variable and the significance of that impact. Seven of the independent variables and several of the time binary variables were significant to at least the " of .10.

The first four independent variables are the absolute values of the negative deviations of government payments (DEVGOVP), gross crop income (DEVGCI), gross livestock income (DEVGLI), and production costs (DEVCOST) about their mean. All four coefficients were statistically significant. The revenue variables showed positive effects, so a larger absolute negative deviation of the revenue sources increased the absolute value of negative deviation of net farm income. For example, a decline in government payments from the average would increase a loss in net farm income. Gross crop income had the largest effect of the income variables at 0.94. The production costs had the opposite effect, a negative impact on the dependent variable. This implies that a larger absolute negative deviation of production expenses results in a decrease in the absolute value of the negative deviation of net farm income. This result is surprising, but also consistent with the results obtained with Models (1) and (3).

Only one of the four efficiency measures, livestock cost per dollar of the gross crop and livestock income (LIVE), was statistically significant. The negative sign on the coefficient was unexpected. It suggests that a reduction in the efficiency of livestock costs, which would be represented by an increase in this variable, will decrease the absolute value of the negative deviation of net farm income. The remaining efficiency measures had the expected sign but were insignificant to at least the " of .10.

The coefficient for age (AGE), the diversification coefficient (DIV), and the tenure variable (RENT) also were insignificant. The debt to equity ratio variable (D/E) was significant. It had a positive sign, which indicates that a higher debt to equity ratio increases the absolute negative deviation of net farm income.

All of the 16 “percent of total value” variables displayed positive effects on the dependent variable, but only DAIRY was statistically significant. An increase in the percent of total value contained in the dairy enterprise would increase the absolute negative deviation of net farm income.

This suggests that specialization in a dairy enterprise should not be encouraged, if one wished to reduce risk.

The fixed time effects showed several significant coefficients. Seventeen of the time binary variables were significant to at least the " = .10 level, leaving only six that were not statistically significant. The parameters on the time dummies were both positive and negative, and some of the year impacts were large in magnitude. These variables captured the differences across the time periods and treated it as a parametric shift in the constant term, relative to 1996.

Model (5) was estimated using the *panel* command in the LIMDEP software package, which automatically examined the one-way and two-way, fixed and random effects models for panel data sets. Results showed that the one-way fixed effects model did not have a significant impact on the ordinary least squares (OLS) regression; thus, OLS was preferred to the fixed effects model. However, the one-way random effects model was favored over both the fixed effects and OLS methods according to the Hausman test and Lagrange Multiplier test. Similar results were discovered when the two-way effects were analyzed. Two-way random effects models were preferred to two-way fixed effects and OLS models. Table 6 displays the coefficient estimates, along with their p-values, for the one-way and two-way random effects models. The OLS estimates also are included in Table 6 for comparison purposes.

Selecting between the two random effects models is somewhat subjective. The r-squared values could be evaluated to determine the better model. They were identical to at least the sixth decimal place, indicating that the two-way model was no better than the one-way model. Because random effects models merely capture random error structure in the covariance matrix, capturing as much random error as possible (i.e., the two-way effects model) could be advantageous. Because of this uncertainty, both models are displayed in Table 6, which shows that only small changes occurred in the significant variables between them.

Seven coefficients in these models statistically were significant. They were the three gross revenue variables, the production cost, and three of the cost efficiency measures. None of the farm characteristic parameters were statistically significant.

The first four independent variables are the annual changes in government payments (DEVGOVP), gross crop income (DEVGCI), gross livestock income (DEVGLI), and production costs (DEVCOST). All four coefficients were highly significant. The revenue variables show positive effects (i.e., a larger annual change of the revenue sources increased the annual change of net farm income). Gross crop income and gross livestock income had the largest effects of the income variables, approximately $0.96. The production costs had the opposite effect, a negative impact on the dependent variable. This implies that a larger annual change of production expenses results in a decrease in the annual change of net farm income. This result is generally consistent with the other model results.

Three of the four efficiency measures, crop costs (CROP), livestock costs (LIVE), and interest expense (INT) per dollar of the gross crop and livestock income, were statistically significant. Crop cost efficiency had the expected negative sign. This suggests that as the efficiency measure declines, or as the cost per dollar of gross income increases, the annual change in net farm income decreases. The livestock and interest coefficients had an unexpected positive effect, implying that a reduction in cost efficiency would increase the annual change of net farm income.

The coefficient for age (AGE) indicated that the annual change in net farm income increased as the manager aged, but this variable was not significant. The diversification coefficient (DIV) also was positive, indicating more diversification increased the annual change in net farm income, but insignificant. The debt to equity ratio variable (D/E) and tenure variable (RENT) were positive and insignificant as well.

Summary and Conclusions

This study conducted both cross-sectional and panel data analyses to determine the farm characteristics that impact the variability of net farm income. It also established the magnitude and rank of these effects on farm income. Five models were used in the examination of different factors that might have significant consequences on income variability at the farm level. The first three used cross-section data, and the remaining two used panel data.

The first two cross-section models had the same dependent variable (standard deviation of net farm income), cost efficiency measures, and farm characteristic variables. However, Model (1) used the standard deviations of gross revenues and costs as independent parameters, whereas Model (2) utilized average net farm income, gross crop income, gross livestock income, and cost as explanatory variables.

Model (1) showed that increasing the standard deviation of the gross revenues also increased the standard deviation of net farm income, but the standard deviation of cost had the opposite impact. Labor and interest cost efficiency had positive effects on the dependent variable, meaning a growth in the cost to gross revenue ratio (reduction in efficiency) would increase the standard deviation of net farm income. Crop cost efficiency had an unexpected negative impact. Model (2) determined that increases in average net farm income, gross farm incomes, and cost would increase the standard deviation of net farm income. As in Model (1), interest cost efficiency had a positive effect, but livestock efficiency now had a negative and significant effect. In both Models (1) and (2), age of the operator was related positively to increases in the standard deviation of net income. Diversification also had a positive effect in Model (1), and the acre variable had a positive effect in Model (2). All of the above effects were significant to at least α of .10.

Model (1) showed that deviations in gross revenues caused deviations in net income, which was expected. Yet cost deviations appeared to lower the standard deviation of net farm income. Cost efficiency measures proved important, especially regarding labor and interest, but cropping efficiency had an unusual effect. Further exploration of the individual cost components of this variable may be important. These results also indicated that diversification does not always have the anticipated impact, and specialization may hold some advantages in reducing income variability. Inferences about the size of a farming operation can be drawn from results of Model (2). As gross and net incomes and costs grew, so did the variability of net farm income. Results for acre variable also implied that size positively effects net income deviation.

Models (3) and (4) dealt with factors that affected losses or downside risk. The dependent variable in both instances was the absolute value of the negative deviation from the mean net farm income of each farm. However, Model (3) used averages for a cross-section analysis, whereas Model (4) used a panel data approach with individual observations. These models employed approximately the same dependent variables, with the exception of the "percent of total value" variables in Model (4) to account for individual enterprise impacts.

Even though they took different approaches, both of these models revealed similar effects. An increase in the negative deviations of the gross revenues resulted in an increase in the negative deviations of net farm income, but the opposite occurred with the deviations of costs. This occurred with averages for Model (3) and with individual observations for Model (4). Model (3) saw positive impacts on the dependent variable from labor and livestock cost efficiency measures; as the efficiency declined, the negative deviation of net farm income grew. However, the crop cost efficiency measure had a negative impact. Model (4) differed on this point, indicating negative effects from the livestock cost efficiency measure. This was attributed to the different model styles. Diversification effects were another point of difference. Model (3) implied that increased diversification caused larger negative deviations of net income. Model (4) suggested that increased specialization in a dairy enterprise resulted in greater negative deviations of net income. However, the overall diversification variable in the same model was insignificant. Leverage was also an important factor in Model (4) and had the expected positive effect on the dependent variable.

The two downside risk models showed that gross revenues and cost were still very important in income variability. However, the cost efficiency measures had varying significance and effects on net income negative deviations. The impact of diversification was also questionable. The leverage variable was significant in the panel data model but irrelevant in Model (3), leaving mixed results for its effect on net income losses.

Model (5) was another panel data analysis, but focused on annual changes as opposed to losses or downside risk. The annual change in net farm income was the dependent variable, with annual change in gross revenues and cost as dependent variables. Cost efficiency measures and the farm characteristics variables were the same independent variables used in the other models. As found in the previous models, increased changes in the gross revenues and decreased changes in cost increased the change in net farm income. Livestock, interest, and crop expense efficiency measures were also significant. Decreases in the efficiency of livestock and interest resulted in a larger change in net income, whereas crop cost efficiency caused the opposite effect. The above findings reaffirmed that reducing the variation in gross revenue and increasing the variation in cost will lower the variability in net farm income. Cost efficiency measures were also important, but with the previous models, the effects on net farm income was uncertain.

The overall results suggest that income variability is related significantly to gross income changes, government payments, and farm size. Of course, gross income changes are affected largely affected by production variability and price changes. Obtaining consistent results for the other socioeconomic variables such as cost efficiency measures, age, diversification, and debt to equity is more difficult. The panel data models suggest that time and random effects are important, and most farm characteristics beyond gross income, government payments, and cost are not as important.

Further Work

Preliminary work to adjust the dependent variable and some of the independent variables for farm size has been conducted. The coefficient of variation of net farm income and variability of return on investment have been examined. The results of the work thus far have been disappointing. The models have shown little explanatory power. This may be occurring because the standard deviation of net income increases with the mean. Categorizing farms by farm type also has been considered. Categorization of farms across time is difficult, because many of these farms have placed more or less emphasis on some crop and livestock enterprises over the years. Panel data analysis with farm type categories may prove fruitful. Replacement of the region binary variables with a county yield or rainfall index also is planned.

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Figure 1: Farms per county and Kansas crop reporting districts

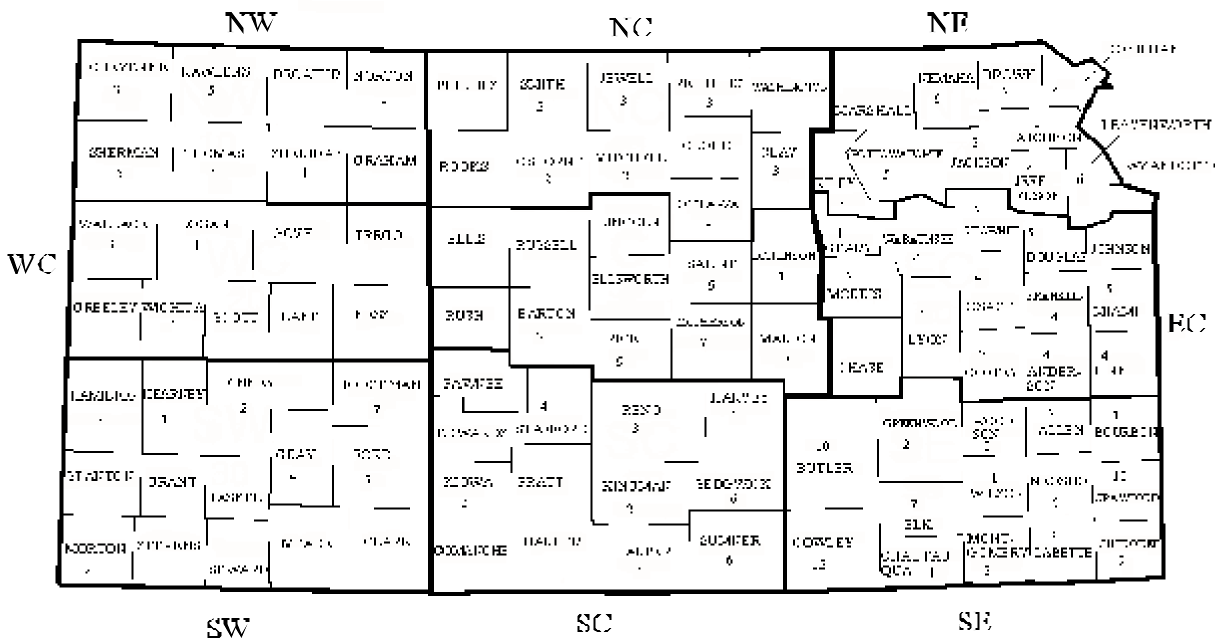

Table 1. Descriptive statistics in 1996 dollars for data from 282 farms, 1973 to 1996.

Variable	Mean	Min	Max
Net Income	53,844	-10,107	271,606
Government Payments	17,279	0	70,681
Gross Crop Income	113,629	205	684,919
Gross Livestock Income	99,503	-105	815,530
Acres	1589	164	7,405
Age	53	33	76
Diversification[1]	4.12	1.16	7.34
Debt/Equity	.80	-13.12	42.13
Rent %	.54	0	1

[1] The larger the diversification index, the greater the amount of diversification.

Table 2: Regression coefficients and test statistics with the standard deviation of net farm income as the dependent variable and standard deviations of gross return and other farm characteristics as the independent variables.

Independent Variable	Coefficient	t Value	p Value
SGOVP(	.3508652	1.953	0.052
SGCI((	.7263451	15.080	0.000
SGLI((	.4386245	11.685	0.000
SCOST((	-.2646279	-5.380	0.000
LABOR((	543.2301	4.827	0.000
CROP((	-88.87758	-2.809	0.005
LIVE	24.82482	1.479	0.140
INT(	84.94363	1.697	0.091
AGE(	277.4674	1.843	0.067
DIV((	2003.352	2.028	0.044
D/E	-304.7458	-0.904	0.367
RENT	-823.254	-0.176	0.860
NW((	-12848.15	-2.330	0.021
WC((	21953.31	2.469	0.014
NC	4725.322	0.829	0.408
C	56.60087	0.012	0.991
SC	-5588.486	-1.200	0.231
NE	7872.154	1.561	0.120
EC	-1102.314	-0.225	0.822
SE	2521.768	0.546	0.585
intercept	-12106.99	-1.045	0.297

N = 282

Adj R^2 = .80

(Variable significant at .10 level, ((variable significant at .05 level.

Table 3: Regression coefficients and test statistics with the standard deviation of net farm income as the dependent variable and farm size and other characteristics as the independent variables.

Independent Variable	Coefficient	t Value	p Value
NET((	.095569	2.437	0.015
GCI((	.1027201	5.025	0.000
GLI(	.0340788	1.939	0.054
COST((	.0939624	5.857	0.000
LABOR	181.1649	1.369	0.172
CROP	36.27377	1.048	0.296
LIVE((	-44.17237	-2.376	0.018
INT(	94.21903	1.661	0.098
AGE((	540.8876	3.270	0.001
ACRE((	10.17994	7.021	0.000
DIV	-529.8509	-0.475	0.635
D/E	237.7292	0.651	0.515
RENT	-6778.991	-1.312	0.191
NW	-4900.902	-0.816	0.415
WC(	17918.13	1.807	0.072
NC	4268.685	0.688	0.492
C	3538.31	0.671	0.503
SC	-2965.087	-0.571	0.568
NE	4044.243	0.744	0.458
EC	-161.5064	-0.032	0.975
SE	-3102.221	-0.656	0.512
intercept	-19117.93	-1.509	0.133

N = 282

Adj R^2 = .76

(Variable significant at .10 level, ((variable significant at .05 level.

Table 4: Regression coefficients and test statistics with the average of absolute value of negative deviations of net farm income as the dependent variable and deviations of gross returns and other farm characteristics as the independent variables.

Independent Variable	Coefficient	t Value	p Value
DGOVP((	.4323078	2.440	0.015
DGCI((	.6669504	14.368	0.000
DGLI((	.3607236	10.174	0.000
DCOST((	-.1885759	-4.111	0.000
LABOR((	211.8909	4.850	0.000
CROP((	-36.52635	-2.967	0.003
LIVE(	11.73079	1.801	0.073
INT	27.00313	1.389	0.166
AGE	42.99658	0.734	0.464
DIV(	737.4	1.921	0.056
D/E	-34.67489	-0.266	0.790
RENT	-953.6991	-0.525	0.600
NW((	5447.806	-2.526	0.012
WC	5282.802	1.510	0.132
NC	1911.784	0.857	0.392
C	4.401756	0.002	0.998
SC	-2889.989	-1.591	0.113
NE	3114.97	1.555	0.121
EC	-146.1404	-0.075	0.940
SE	1526.832	0.840	0.402
intercept	-961.7336	-0.212	0.832

N = 282

Adj R^2 = .78

(Variable significant at .10 level, ((variable significant at .05 level.

Table 5: Coefficients and test statistics from the tobit regression with the absolute value of the negative deviations of net farm income as the dependent variable and negative deviations of gross returns and other farm characteristics as the independent variable.

Independent Variable	Coefficient	Marginal Effect	t Value	p Value
DEVGOVP**	0.528170	0.283985	6.924	0.000
DEVGCI**	0.941511	0.506228	50.897	0.000
DEVGLI**	0.755933	0.406447	40.529	0.000
DEVCOST**	-0.701593	-0.377230	-34.583	0.000
LABOR	1160.030	623.7204	0.563	0.574
CROP	414.4186	222.8230	1.104	0.270
LIVE**	-599.9370	-322.5719	-2.211	0.027
INT	467.5133	251.3708	0.718	0.473
AGE	32.02711	17.22022	0.497	0.620
DIV	-589.5759	-317.0010	-1.296	0.195
D/E*	78.19048	42.04116	1.813	0.070
RENT	-2511.498	-1350.373	-1.307	0.191
IWHEAT	81.23462	43.67793	0.331	0.741
ICORN	175.0490	94.11968	0.846	0.398
IMILO	269.7759	145.0521	1.181	0.237
IBEANS	409.6946	220.2831	1.592	0.111
IALF	38.37047	20.63089	0.137	0.891
ISILAGE	363.1952	195.2814	1.385	0.166
DWHEAT	134.1634	72.13646	0.659	0.510
DCORN	305.9153	164.4834	1.443	0.149
DMILO	216.8201	116.5790	1.056	0.291
DBEANS	195.0488	104.8731	0.949	0.343
DALF	316.2178	170.0228	1.480	0.139
DSILAGE	94.12322	50.60782	0.422	0.673
BEEF	199.2708	107.1432	0.986	0.324
DAIRY**	745.9355	401.0718	3.517	0.000
SHEEP	244.6705	131.5535	0.821	0.412
SWINE	232.0674	124.7771	1.141	0.254
Intercept*	-37138.04	-19968.241	-1.767	0.077

(Variable significant at .10 level, ((variable significant at .05 level.

Table 5: Continued

Independent Variable	Coefficient	Marginal Effect	t Value	p Value
1973**	-49579.36	-26657.65	-7.927	0.000
1974	4365.412	2347.179	1.097	0.273
1975**	-11696.79	-6289.086	-2.864	0.004
1976**	8742.551	4700.662	2.231	0.026
1977	-2113.505	-1136.381	-0.547	0.585
1978**	-33621.44	-18077.451	-7.720	0.000
1979**	-34403.49	-18497.941	-7.288	0.000
1980**	17187.39	9241.2518	4.495	0.000
1981**	29805.29	16025.598	8.019	0.000
1982**	21598.05	11612.760	5.846	0.000
1983**	26339.58	14162.167	7.122	0.000
1984**	30264.01	16272.238	8.321	0.000
1985**	31451.11	16910.514	8.771	0.000
1986	1989.434	1069.6718	0.551	0.582
1987**	-22983.88	-12357.887	-5.889	0.000
1988**	-22504.01	-12099.869	-5.531	0.000
1989	1456.090	782.90527	0.400	0.689
1990**	-9382.625	-5044.8144	-2.513	0.012
1991*	6865.798	3691.5767	1.913	0.056
1992	-5583.690	-3002.2173	-1.472	0.141
1993	2320.033	1247.4265	0.639	0.523
1994**	12314.60	6621.2700	3.460	0.001
1995**	16208.49	8714.9188	4.589	0.000

L-Likelihood = - 45853.98

(Variable significant at .10 level, ((variable significant at .05 level.

Table 6: Coefficients and test statistics from the panel regression analysis with the annual change in net farm income as the dependent variable and annual changes of gross returns and other farm characteristics as the independent variables.

	No Effects (OLS)		One-Way Random Effects		Two-Way Random Effects	
Variable	Coefficient	p Value	Coefficient	p Value	Coefficient	p Value
A) GOVP**	0.817747	0.000	0.817682	0.000	0.811128	0.000
A) GCI**	0.961626	0.000	0.961734	0.000	0.962121	0.000
A) GLI**	0.964245	0.000	0.964461	0.000	0.961866	0.000
A) COST**	-0.911755	0.000	-0.912055	0.000	-0.909705	0.000
LABOR	593.8025	0.597	753.0530	0.518	850.7725	0.465
CROP**	-673.9264	0.001	-690.3276	0.002	-701.7941	0.001
LIVE**	367.6430	0.011	382.5429	0.011	386.1485	0.010
INT**	830.3402	0.021	823.3143	0.026	833.6366	0.024
AGE	1.9970.75	0.943	3.251089	0.915	24.99497	0.473
DIV	98.15188	0.628	93.67313	0.677	106.8523	0.638
D/E	13.68410	0.525	11.49179	0.602	9.094181	0.680
RENT	1208.032	0.220	1312.939	0.229	1392.184	0.207
Intercept	-1510.412	0.451	-1617.306	0.458	-2876.732	0.241
R^2	.9415		.9415		.9415	

(Variable significant at .10 level, ((variable significant at .05 level.