Factors Affecting Farm Enterprise Diversification

Ashok K. Mishra, Hisham S. El-Osta, and Carmen L. Sandretto

Abstract

Enterprise diversification is a self-insuring strategy used by farmers to protect against risk. This study examines the impact of various farm, operator, and household characteristics on the level of onfarm enterprise diversification. Evidence exists that larger farms are more specialized. Also, farmers who participate in off-farm work, farms located near urban areas, or farms with higher debt-to-asset ratios are less likely to be diversified. In contrast, evidence suggests there is a significant positive relationship between diversification and whether the farm business has crop insurance, is organized as a sole proprietorship, or receives any direct payments from current farm commodity programs.

Key words: debt-to-asset ratio, enterprise diversification, farm size, government payments, insurance, location, off-farm income, soil productivity

Historically, enterprise diversification has been an important characteristic of American agriculture. Diversification was a requirement for subsistence farms or even commercial farms with limited access to transportation or that were geographically isolated. In recent decades, the trend has been toward specialization enabling farmers to concentrate their management skills, capital resources, and specialized knowledge on the production of a small number of commodities. Specialization allows farmers to pursue the production of those commodities for which they have the greatest relative advantage or the least relative disadvantage given the physical and biological factors and economic forces that limit their enterprise possibilities (Castle, Becker, and Nelson, 1987). Nonetheless, as Montgomery (1994) points out, the diversified (multi-product) firm still is the rule rather than the exception.

Farming is a risky business. However, enterprise diversification is a risk management strategy an individual farmer can use to reduce the adverse impact of wide fluctuations in yields and/or prices of specific commodities, whether due to natural causes such as weather or the impact of uncertainties derived from business cycles, wars, or other factors. Besides its risk-reduction benefits, diversification provides an opportunity to exploit the potential complementary and/or supplementary relationships between enterprises through improved utilization of the natural resources of the farm and available operator and family labor and management skills over the entire year. In addition, enterprise diversification may be advantageous when local demand exists for specific products.
Factors Affecting Farm Enterprise Diversification

(niche or specialized market opportunities) that are not competitive with the primary enterprise(s) and yet earn a profit.

Farming deals with uncertain factors such as weather and market conditions. These uncertainties can result in variable returns (farm income) to the decisions farmers make in a particular year. Therefore, farm income variability is a problem the farm household must deal with. Enterprise diversification is one method of reducing income variability (Robison and Barry, 1987; Newbery and Stiglitz, 1985).

Diversification is characterized by two distinct aspects. One is that of planning under an assumption of perfect knowledge, and the other is to minimize the variance of an outcome by attempting to put a floor under the income level or by preventing the occurrence of undesirable outcomes (Heady, 1952). Farmers and farm managers, faced by price and yield variability, may wish to select a combination of enterprises to reduce the variability of farm income.

Diversification, as a frequently used risk management strategy, has the added advantage of mitigating price risk as well as variations in outputs since it reduces reliance on only one market and exposure to its price fluctuations (Clark, 2004). In less developed economies, Walker and Jodha (1986) report multiple crops and inter-cropping are common, including agro-forestry. In the United States, corn and soybeans, and corn with beef or hogs are common enterprise combinations, but economically sized and diversified enterprises may not be realized on the average farm. Livestock investments should be large enough to take advantage of the economies of size, but divisible into units that can be financed by the average farm business. The management skills and capital required to establish and successfully maintain such a business may be beyond the ability of some farmers.

Despite the frequent observation that diversification plays an important role in agriculture, there are only a few empirical studies addressing the factors found to contribute to farm enterprise diversification. One purpose of this study is to examine factors associated with farm enterprise diversification in the United States in 1996 and 2000. This focus is particularly important, as it allows for testing the notion that production flexibility prescribed under the Federal Agriculture Improvement and Reform (FAIR) Act of 1996 would allow farmers to alter their cropping mix (or production decisions). If this is the case, then one would expect the impact of government payments on diversification in 1996, when FAIR was enacted, to differ from the impact in 2000 after several years had passed to allow time for farmers to adjust their production decisions. The analysis is conducted on a national scope using farm-level data with the unique feature of a larger sample than previously reported, comprising farms of different economic sizes and in different regions of the United States.

The dual objectives of this study are: (a) to determine whether the FAIR Act of 1996 had a discernible impact on the level of enterprise diversification between 1996 and 2000 on sample farms, i.e., did the production flexibility provisions of the 1996 legislation influence the long-term trend toward greater specialization on U.S. farms? and (b) to identify those farm business, operator, and farm household characteristics associated with onfarm enterprise diversification.

Literature Review

Analysis of the factors affecting farm diversification remains an active area of research in strategic management and industrial organization (Briglauer, 2000). While the literature on onfarm diversification in the United States is limited, researchers in European countries

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1 The government payments considered in this analysis include Agricultural Market Transition Act (AMTA) payments that are based on historical production and yield levels, and loan deficiency payments (LDP).
such as England, France, and Greece have studied onfarm diversification for some time. Ilbery (1991) suggests business diversification can be viewed as the outcome of a range of factors working both “externally” and “internally” on the farm household. Internal factors include farm and farm household characteristics that help to determine the nature of diversification, if any, undertaken by the farm business.

A common finding in the literature on onfarm diversification is the correlation between farm size and diversification. Findings by some researchers indicate large farms are more likely to be diversified (Ilbery, 1991; Pope and Prescott, 1980; Shucksmith and Smith, 1991) because they can exploit capital more effectively and more efficiently employ available labor. However, White and Irwin (1972), using aggregate U.S. Census data to compare diversification across farm size classes, concluded that larger farms are more specialized based on the perceived benefits from economies of scale. In analyzing data on 2,192 farms across three U.S. regions, Sun, Jinkins, and El-Osta (1995) distinguished between different “stages of diversification” which were found to influence the relationship between size and diversification.

Soil productivity should have implications for onfarm enterprise diversification. One notion is that if the soils are productive, the farm operator will have more cropping pattern options available, and therefore be more inclined to engage in more than one crop enterprise on the farm. However, if the farm includes soils of differing characteristics and productivities, the farm operation will more likely include livestock or specialty crop enterprises that are better suited to effective utilization of the farm’s soil resource endowment. In addition, crop diversification in the form of diversified crop rotations has been shown to contribute to higher and more stable net farm income when compared to traditional monoculture which, over extended periods of time, has shown evidence of degradation of soil quality and reduced crop productivity (Clark, 2004; Zentner et al., 2002). Consequently, this study includes a measure of soil productivity in the analytical model.2

The proximity of a farm to an urban area will be less likely to encourage diversification.3 One argument in support of this assertion is that a farm operator located near an urban area, when faced with financial stress, is more likely to sell the farm and move out of agriculture, or to seek off-farm employment rather than engage in onfarm enterprise diversification.4 This notion is consistent with the land pricing literature (Moss and Schmitz, 2003).

Farmers may adopt diversification strategies as a way to reduce the financial risks inherent in their farm business. Barry and Baker (1984) explain that financial risk increases with higher levels of leverage. Hence, one might expect a positive association between leverage and onfarm enterprise diversification.

In a study of California farmers, Pope and Prescott (1980) used net worth per acre cropped as a measure of financial risk. They found that farms with higher net worth are more specialized, and farm organization has an impact on onfarm diversification. Corporate farms were found to be more specialized than other farms. Further, the authors note that

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2 A soil productivity index, ranging from 0–100, is used—with zero representing the least productive soil and 100 representing the most productive soil (for further details, see Pierce et al., 1983).

3 An urban influence index (FRM$URBAN) was derived from a gravity model of urban development by Economic Research Service (ERS) geographers and economists. A gravity index accounts for both population size and distance of the parcel from that population. The index, which has been labeled as a population-accessibility index, increases as population increases and/or as distance from the parcel to population decreases. The population-accessibility index is calculated on the basis of population within a 50-mile radius of each parcel (for more details, see Moss and Schmitz, 2003, Chapter 18).

4 Off-farm employment is a form of income diversification for the farm household. However, this analysis is confined to examining onfarm enterprise diversification.
increased farm diversification places greater demands on management and coordination skills. Improved managerial skills, education, and training better prepare the farm operator to run a farm which is more diversified. Another factor identified as critical in onfarm diversification is age of the operator. Because farmers tend to accumulate wealth over a lifetime, one would expect older farm operators to be less likely to engage in onfarm diversification since age and wealth are positively correlated. Based on this relationship, Pope and Prescott argue that wealthier farmers are less risk averse and hence less diversified, all else being equal.

Family size is an indicator of onfarm labor availability and an attribute that affects farm diversification. As Bowler et al. (1996) note, larger families may have pressure to create employment opportunities on the farm, and consequently encourage the operator to adopt a land use pattern that utilizes available resources more effectively, including family labor, in an effort to increase profit. Time allocation of operator and family labor between farm and off-farm alternatives influences onfarm enterprise diversification. If operators are working full time on the farm, this may be an indicator that the comparative advantage for their labor is on the farm. Hence, operators would be more likely to diversify onfarm enterprises to increase profit. Full-time farming status may also be an indicator of farm-specific human capital.

Farmers use various private risk management strategies (such as production and marketing contracts, insurance, and input contracts) to reduce financial risk and variability in production (Harwood et al., 1999). There is a view that farmers who use crop insurance or business insurance and contracts are less likely to pursue onfarm diversification—the contention being that onfarm diversification and private risk management strategies are complements. However, a risk-averse farmer who uses onfarm diversification may also buy insurance and use production and marketing contracts to reduce agricultural production risks.

Robison and Barry (1987) suggest that the availability of government payments is one of the factors affecting onfarm diversification. Farm operators and their spouses work off the farm to increase their total household income and also to reduce the variability in household income associated with fluctuations in farm income (Mishra and Goodwin, 1997). If the household receives income from off-farm work, operators of those farms are less likely to pursue onfarm diversification as a method of reducing financial risk associated with farming.

The farm’s location among the geographic regions may be thought of as a physical characteristic of the farm (Damianos and Skuras, 1996). However, location places constraints (climatic, soil characteristics, topographic, etc.) on potential farm business strategies and imposes limitations on human capital development opportunities. In addition, location influences the choice of enterprise options on the farm and the development of alternative methods of marketing the agricultural products.

Although the preceding studies differ substantially in their empirical approaches and results reported, they share two common characteristics. First, they consider farm production diversification only and do not control for the impact of additional off-farm income. Second, the impact of commodity program participation is generally ignored. To the extent that participation in government commodity programs is viewed as a risk-reducing mechanism (Goodwin, 1993; Calvin, 1992; Just and Calvin, 1990), and

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5 The farm business insurance category includes all casualty, hail, and blanket insurance policies.

6 Mishra and Goodwin (1997) examined income diversification only from the time allocation perspective.
because the 1996 FAIR Act implements a reduction in commodity program payments, this study specifically examines the potential impact of commodity program payments (AMTA and LDP) on diversification. The need for this focus lies in the effect a change in commodity specialization or diversification might have on input usage and/or the environment.

Theoretical Consideration

The mean-variance (E-V) approach, which underlies this study, is a straightforward extension of utility theory. Under the assumptions of an E-V approach, an individual’s preference ordering depends solely on the mean and variance of returns—an uncertain prospect can be represented fully by its mean and variance. The decision rule used by a farmer to choose the appropriate enterprise mix from among virtually unlimited possibilities is to maximize the utility of income derived from the possible enterprise portfolios, where utility depends only on the mean and variance of returns. The assumption here is that the farmer’s preference function can be described, approximately at least, in terms of the mean and the variance of returns.

There are several reasons why this assumption may be valid. One is that individuals maximize expected utility, and either the underlying utility function is approximately quadratic in income or the distribution of returns involves only the mean and variance. Second, even if expected utility maximization is not assumed, the mean-variance approach still can be considered a reasonable first approximation of behavior.\(^8\)

\(^7\) In practice, payments have far exceeded the amounts called for in the 1996 FAIR Act, and the payments made were disbursed based on the ability to earn payments under the 1996 Act (e.g., emergency payments were based on some proportion of AMTA payments).

\(^8\) Several reasons are offered for this approximation: people find it easier to compute (Borch, 1968), distributions facing individuals exhibit little

Markowitz (1951) asserted the existence of a utility function for income \(U(E, V)\), where \(dU/dE > 0\) and \(dU/dV < 0\) hold. Our model is based on the assumption that \(U(E, V)\) exists.

Given the existence of \(U(E, V)\), the preference function can be linearized for ease of estimation in the following manner:

\[
1. \quad U(E, V) = E & bV,
\]

where \(b\) represents the subjective risk coefficient of the farm operator. Now the utility of returns to the farm operator is a direct function of the mean and variance of the returns. An extension of this model can be defined so that the choice object, the maximization of utility of an enterprise portfolio, is quite simple for a two-enterprise case. If the farm operator makes an enterprise decision between two enterprises, the equation for portfolio selection is to maximize:

\[
2. \quad U(Z) = 8\mu_x \%(1 & 8)\mu_y
& b\left[8^2\mu_x^2 \%(1 & 8)^2\mu_y^2 + 2(8 & 8^2)F_{xy}\right],
\]

where \(Z\) represents the returns from a portfolio of two enterprises, \(x\) and \(y\). The two enterprises are treated as stochastic variables, where \(8 \leq 0\) is the fraction of the total portfolio allocated to enterprise \(x\), and \(1 - 8\) is the fraction of the total portfolio allocated to enterprise \(y\). In equation (2), \(\mu_x = E(x)\) and \(\mu_y = E(y)\) represent the expected (mean) returns from enterprise \(x\) and expected (mean) returns from enterprise \(y\), respectively. The variance of returns from enterprise \(x\) is \(\mu_x^2\), and the variance of returns from enterprise \(y\) is \(\mu_y^2\). Finally, the covariance of returns from enterprises \(x\) and \(y\) is \(F_{xy}\). Thus, the expected value of returns per enterprise for a two-enterprise portfolio is expressed as

\[
3. \quad E(Z) = 8\mu_x \%(1 & 8)\mu_y,
\]
and the variance of returns from the portfolio is

\[ V^2 = E[(1 & \theta)^2 E_y^2 \%2(1 & \theta) F_{xy}]. \]

where \( E(Z) \) and \( F(Z) \) are simply the mean and variance of the combination of the two enterprises, respectively. For a portfolio consisting of two enterprises, the model will be of the form in equation (2). The farm operator is assumed to maximize \( U \), and the decision is to choose \( \theta \) that would lead to this maximization. The first-order condition for the maximization of \( U \) is:

\[ \frac{dU(Z)}{d\theta} = \mu_x \& \mu_y \]

\[ \& b[28F_x^2 \& 2(1 & \theta) F_y^2 \%2(1 & \theta) F_{xy}] = 0. \]

The model presented here could be generalized for more than two enterprises. Assume that the return from the \( i \)th enterprise is \( R_i \), and the farm operator allocates a fraction \( \theta_i \) of the portfolio to enterprise \( i \). Then total income is designed by:

\[ \tilde{I} = \sum_{i=1}^{n} \theta_i R_i, \]

which has the following mean and variance:

\[ \tilde{I} = \sum_{i=1}^{n} \theta_i R_i, \]

\[ \tilde{V} = \sum_{i=1}^{n} \theta_i^2 \text{Var}(R_i) \%2 \sum_{i,j} \theta_i \theta_j \text{Cov}(R_i, R_j). \]

As a farm operator varies his or her portfolio (i.e., the farm plan), the returns (income) remain normally distributed, though their mean and standard deviation will depend on the choice of the fractions \( \theta_i \). Figure 1 plots the outcome of efficient portfolio choices (those which minimize \( V \) for a given \( \theta_i \), and the indifference curves associated with the utility function (lines of constant expected utility). One goal of this analysis is to determine the effect of farm and operator characteristics, soil productivity, government program payments, and distance to market on farm enterprise diversification. An empirical representation of equation (3) that relates diversification to several relevant explanatory variables is given by:

\[ Y_i = X_i^* \%N_i, \]

where \( Y_i \) is the entropy index (measure of diversification); \( X_i \) is a vector of farm and operator characteristics, location, soil productivity, and distance to market; \( X_i \) is a vector of unknown parameters to be estimated; and \( N_i \) is a residual term.

**Empirical Model and Estimation**

Estimation of the diversification model as specified by equation [8] is performed based on the following:

\[ L_i \log \left[ \frac{Y_i}{1 + Y_i} \right] \]

\[ = \theta_1 X_{1,j} \%\theta_2 X_{2,j} \%.. \%\theta_k X_{k,j} \%N_i, \]

where \( \log \) is the natural logarithm operator, \( X \) is an explanatory variable, and \( * \) is a coefficient to be estimated. Since the values of \( Y_i \) are between 1 and 0, and in order to avoid violating the standard assumption about the error term (i.e., \( N_i \) is required to have a nontruncated normal distribution) which is needed in least squares, a logistic transformation of \( Y_i \) is carried out as depicted in \( L \) [equation (9)]. El-Osta, Bernat, and Ahearn (1995) used a similar transformation of a Gini coefficient to investigate the role of off-farm income in income inequality (also see Fomby, Hill, and Johnson, 1984; Slottje, Hayes, and Shackett, 1992; Greene, 2000).

There are several measures of diversification used in the literature (e.g., concentration ratio, Berry index, Herfindhal index, entropy index). The properties of these measures are discussed in more detail by Hackbart and Anderson (1978) as well as Gollop and Monahan (1991). The entropy index was initially developed in information theory as a measure of the probability distribution or entropy of random variables with a finite sample space, but its application has been...
expanded to other sciences. For example, it has been used in studies in ecology on species diversification within habitats, and in economics as a measure of the size disparity of firms (Jacquemin and Kumps, 1971) and of product diversification of firms and corporations (MacDonald, 1985; Carter, 1977; Berry, 1971).

In this study enterprise diversification is measured using an entropy index (Theil, 1971):

$$EINDX = \sum_{i=1}^{N} \log \left( \frac{\% \text{ value of production from enterprise } i}{\log(N)} \right)$$

where $i$ refers to each of the $N$ possible enterprises. This index accounts for both the mix of commodities and the relative importance of each commodity to the farm business. The entropy index spans a continuous range from 0 to 1. The value of the index for a completely specialized farm producing one commodity is 0. A completely diversified farm with equal shares of each commodity has an entropy index of 1. Specifically, an entropy measure of farm diversification considers the number of enterprises in which a farm participates and the relative importance of each enterprise to the farm. An operation with many enterprises, but with one predominant enterprise, would have a lower number on the diversification index scale. Higher index numbers go to operations that distribute their production more equally among several enterprises.

The model is estimated using weighted least squares. Additionally, a multiplicative dummy variable approach is used to test for statistical difference among regression coefficients over the two time periods considered here (1996 and 2000).
Test of Equivalency of Separate Coefficients Across Two Regressions

Let the following represent the regression performed on the pooled data (1996 and 2000):

\[
\begin{align*}
L_i &= \sum_{j=0}^{16} \%_j X_k \%_{19} D \\
&\quad \sum_{k=1}^{37} \%_{20} D X_k \%_>, \\
&\text{where, for example, } X_1 \text{ is age of the operator (OP}\$\text{AGE}) \text{ and } X_{18} \text{ is the urbanization index (FRM}\$\text{URBAN}) \text{, and where } D \text{ is a dummy variable equal to one if the year is 1996 and zero otherwise.}
\end{align*}
\]

Since each of the dummy coefficients $^\%_{19}, \ldots, ^\%_{37}$, also known as differential slope coefficients, measures the difference in respective slopes across the two years (1996 and 2000), resulting $t$-tests from the regression performed on equation (10) provide useful information. For example, if the $t$-test corresponding to $^\%_{20}$ (i.e., coefficient of the variable $D \text{OP}\$\text{AGE}$) indicates $^\%_{20}$ is significantly different than zero, this is equivalent to the finding that the coefficients of the variable $\text{OP}\$\text{AGE}$, which are based on two separate regressions (one for each year, 1996 and 2000), are significantly different. If the resulting $t$-ratio is positively signed, this indicates the $\text{OP}\$\text{AGE}$ coefficient in the year 2000 is significantly larger than its counterpart in the year 1996.

Data

Data for the analysis are pooled from the 1996 and 2000 Agricultural Resource Management Surveys (ARMS). This survey is conducted annually by the USDA’s Economic Research Service and National Agricultural Statistics Service. ARMS uses a multi-phase sampling design and allows each sampled farm to represent a number of farms that are similar, where this number is defined as the survey expansion factor. The survey collects data to measure the financial condition (farm income, expenses, assets, and debts) and operating characteristics of farm businesses, the cost of producing agricultural commodities, and the well-being of farm operator households. In addition to collecting basic financial data, ARMS is dedicated to the collection of special data on farms and farm operator households. In 1996 and 2000, ARMS collected information on business contracts by farm operators, management decisions, information sources, use of technology, management strategies, and off-farm employment.

Table 1 presents the definitions and mean values of the explanatory variables and the dependent variable ($E\text{INDX}$) for the 1996 and 2000 study years. In general, farms in year 2000 were slightly more diversified than farms in 1996. The average age of the farm operator (OP\$AGE) in year 2000 was approximately 2½ years higher than the average age of the farm operator in 1996. The average level of education for farm operators (OP\$\text{EDUC}$) was similar between the two sample years.

The level of AMTA and LDP$^9$ government payments (GOV\$PMT) received by an average farm in 2000 was twice as high as in 1996 (approximately $\$4,600 in 2000 compared to $\$2,400 in 1996) (Table 1). In the fall of 2000, Congress wanted to disburse the emergency payments$^{10}$ (including supplemental appropriations) to farmers without protracted delay, and therefore emergency payments were directed to farmers who were already receiving AMTA payments. Since emergency payments (including supplemental appropriations) were based

$^9$ Other types of government payments, such as conservation, disaster, and other payments, are not included because the latter two in particular are not anticipated at the start of the growing season, and therefore are not assumed to influence production decisions.

$^{10}$ Under normal circumstances, to receive any emergency payments, farmers must go through the usual application, certification, and qualification process that is laid out by the Farm Service Agency.
on an individual farm’s AMTA payments, 
these emergency payments are included in 
total AMTA payments.

Average value of agricultural products sold 
by the sample farms (FRM$SIZE) fell from 
$82,300 in 1996 to $69,700 in 2000. 
Finally, the data show that the number of 
full-time farm operators (WRK$STAT) 
decreased between the two years, from 
30% in 1996 to 28% in 2000.

Correspondingly, income from off-farm 
wages and salaried jobs (OFF$WAGE) 
increased by 29%, from $26,200 in 1996 
 to $33,700 in 2000 (Table 1).

Results

Weighted least squares estimates of factors 
affecting farm enterprise diversification 
as depicted in equation (9), for 1996 
and 2000, are presented in Table 2.
Table 2. Weighted Least Squares Estimates for Factors Affecting Farm Diversification, 1996 and 2000

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates, 1996</th>
<th>Parameter Estimates, 2000</th>
<th>( H_0: \hat{\beta}<em>{1996} = \hat{\beta}</em>{2000} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>19.564*** 5.12</td>
<td>19.506*** 4.15</td>
<td><img src="image" alt="a" /> 2.03**</td>
</tr>
<tr>
<td>OP$\times$AGE</td>
<td>0.010** 2.14</td>
<td>0.013** 1.93</td>
<td><img src="image" alt="a" /> 0.78</td>
</tr>
<tr>
<td>OP$\times$EDUC</td>
<td>0.059 1.15</td>
<td>0.064 0.51</td>
<td><img src="image" alt="a" /></td>
</tr>
<tr>
<td>HH$\times$SIZE</td>
<td>0.105*** 2.59</td>
<td>0.146*** 3.19</td>
<td><img src="image" alt="a" /> 0.81</td>
</tr>
<tr>
<td>OP$\times$GEND</td>
<td>0.298 1.26</td>
<td>0.008 0.41</td>
<td><img src="image" alt="a" /> 0.27</td>
</tr>
<tr>
<td>HAV$\times$INSUR</td>
<td>0.454*** 2.92</td>
<td>0.669*** 2.95</td>
<td><img src="image" alt="a" /> 5.49**</td>
</tr>
<tr>
<td>HAV$\times$CONTR</td>
<td>1.973 1.13</td>
<td>0.623 0.55</td>
<td><img src="image" alt="a" /> 5.77**</td>
</tr>
<tr>
<td>GOV$\times$PMT</td>
<td>0.350 1.69</td>
<td>0.300*** 3.09</td>
<td><img src="image" alt="a" /> 2.81***</td>
</tr>
<tr>
<td>FRM$\times$SIZE</td>
<td>1.002*** 3.63</td>
<td>1.001*** 3.26</td>
<td><img src="image" alt="a" /> 0.39</td>
</tr>
<tr>
<td>OFF$\times$WAGE</td>
<td>1.013 1.35</td>
<td>1.039** 2.90</td>
<td><img src="image" alt="a" /> 2.94**</td>
</tr>
<tr>
<td>DEBT$\times$ASST</td>
<td>0.722*** 2.72</td>
<td>0.104** 2.00</td>
<td><img src="image" alt="a" /> 3.05***</td>
</tr>
<tr>
<td>WRK$\times$STAT</td>
<td>1.994*** 3.45</td>
<td>1.924*** 3.54</td>
<td><img src="image" alt="a" /> 2.34**</td>
</tr>
<tr>
<td>FRM$\times$SOLE</td>
<td>0.418** 2.36</td>
<td>0.354** 2.44</td>
<td><img src="image" alt="a" /> 0.90</td>
</tr>
<tr>
<td>FRM$\times$PART</td>
<td>1.023 0.70</td>
<td>1.015 0.25</td>
<td><img src="image" alt="a" /> 0.57</td>
</tr>
<tr>
<td>F$\times$NEAST</td>
<td>0.356* 1.81</td>
<td>1.015** 2.08</td>
<td><img src="image" alt="a" /> 4.07***</td>
</tr>
<tr>
<td>F$\times$MWEST</td>
<td>1.711** 1.96</td>
<td>1.762** 2.19</td>
<td><img src="image" alt="a" /> 1.31</td>
</tr>
<tr>
<td>F$\times$WEST</td>
<td>1.398 1.21</td>
<td>1.598 0.96</td>
<td><img src="image" alt="a" /> 0.93</td>
</tr>
<tr>
<td>FRM$\times$PROD</td>
<td>0.033*** 4.40</td>
<td>0.038*** 4.19</td>
<td><img src="image" alt="a" /> 0.34</td>
</tr>
<tr>
<td>FRM$\times$URBAN</td>
<td>0.094** 2.09</td>
<td>0.241* 2.44</td>
<td><img src="image" alt="a" /> <img src="image" alt="b" /> 0.61</td>
</tr>
</tbody>
</table>

Adjusted \( R^2 \) 0.19 0.22

Note: Single, double, and triple asterisks (*) denote two-tailed statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

a Reported \( t \)-statistics are absolute values.

b Each \( t \)-statistic in this column tests the hypothesis that a specific estimated parameter in the farm diversification model of 1996 is equal to the corresponding parameter in the 2000 farm diversification model.

A negative statistically significant \( t \)-statistic indicates that the corresponding \( \hat{\beta}_{2000} \) is statistically smaller than its \( \hat{\beta}_{1996} \) counterpart. A positive statistically significant \( t \)-statistic shows the opposite (i.e., \( \hat{\beta}_{2000} \) > \( \hat{\beta}_{1996} \)).

The adjusted \( R^2 \) s of 0.19 and 0.22 for 1996 and 2000, respectively, indicate that the explanatory variables used in the weighted least squares regression model explained 19% and 22% of the variation in farm diversification. These levels of explained variation are fairly typical when analyses are based on cross-sectional data. In 1996, the estimated model in equation (9) reveals that 12 variables are significantly correlated with farm diversification.

The \( t \)-test results presented in the final column of Table 2 were obtained using the multiplicative dummy variable approach (see Pindyck and Rubinfeld, 1991). This \( t \)-test is used to highlight any significant parameter differences across the 1996 and 2000 time periods. Based on the values of the \( t \)-statistics, use of insurance, amount of government payments received, financial position, off-farm income, or whether the farm is located in the Northeast are all variables that exhibit strong statistical difference between the two time periods. Additionally, age of operator, whether the operator is a full-time farmer, or uses marketing or production contracts are variables also showing statistical difference across the two periods.
Farm size measured by the value of agricultural products sold by the farm \((FRMSIZE)\) is significant and inversely related to farm diversification \((EINDX)\) in both study years. This result is consistent with those reported by White and Irwin (1972), but contrasts with findings that diversification activities are concentrated on large farms (Pope and Prescott, 1980; Gasson, 1988a,b; Ilbery, 1991; Shucksmith and Smith, 1991). The suggestion that larger farms may be more specialized is consistent with an argument based on economies of scale—i.e., if there are large-scale economies in an enterprise, then one might expect large farms to be more specialized. Another possible explanation is that since farm size and wealth tend to be positively correlated, one can deduce that wealthier farms are less risk averse and less diversified—all else being equal. This position is supported by Pope and Prescott (1980) who report a negative and significant relationship between wealth and farm diversification.

The coefficient for age of the farm operator \((OP\$AGE)\) is negative and statistically significant at the 5% level for both the 1996 and 2000 models. Results suggest that older farm operators are less likely to diversify. One possible explanation is that older farm operators have more wealth, and wealthier farm operators are less risk averse and less diversified (Pope and Prescott, 1980). In contrast, young and beginning farm operators are more risk averse and are in the wealth accumulation phase of their life cycle. But more plausibly, young farmers may start small and diversified, and perhaps become more specialized as they expand their operation.

The size of the farm household \((HH\$SIZE)\) is included in the analysis because Bowler et al. (1996), among others, report that the need to create employment for family members is one of the important factors motivating farm diversification. Additionally, Damianos and Skuras (1996) note the size of the farm household may be an indication that diversified farms are at an earlier stage in the life cycle. This is the stage when farmers tend to make the greatest change to the farm business (Potter and Gasson, 1988). Based on the results of our study, the size of the farm household and diversification are positively correlated in both models (1996 and 2000). These results are consistent with the findings of Damianos and Skuras (1996); Bowler et al. (1996); and McNally (2001).

The debt-to-asset ratio \((DEBT\$ASST)\) can be used as a measure of leverage. The coefficient of \(DEBT\$ASST\) is negative and statistically significant in both models (1996 and 2000). This result suggests farms with a higher debt-to-asset ratio are less diversified. Higher debt-to-asset ratios are often associated with energetic and dynamic farmers, or entrepreneurs and innovators (Bowler, 1992). Another possible explanation is that a high level of debt might also be indicative of the farm business having borrowed in order to upgrade the commitment to agriculture by adopting the latest production technology for a specific enterprise with the goal of expanding output to capture economies of scale. These results also reveal, based on equivalency tests, that the impact of the debt-to-asset ratio on diversification was stronger in 2000 than in 1996.

Government payments play an important role in production agriculture and the survival of farms. For example, in 2000, government payments played a major role in stabilizing gross and net income of U.S. farms. The bulk of these government payments were provided, under the existing 1996 FAIR Act, through three specific forms of direct payments: production flexibility contract payments (which replaced most commodity program payments), loan deficiency payments, and emergency supplemental appropriations (specifically those enacted in October 2000). Federal direct payments to farmers totaled approximately $23 billion in 2000, with 22% of this amount in the form of production flexibility payments, 28% in loan deficiency payments, and the remainder primarily in the form of emergency assistance payments.
The coefficient of $\text{GOV}^{\text{PMT}}$—which captures total AMTA (including production flexibility and emergency assistance payments) and LDP payments received by the farm—is positive and significant in both the 1996 and 2000 models. The results also indicate, based on equivalency tests, the impact of government payments on diversification was stronger in 1996 than in 2000. These findings suggest government payments and enterprise diversification are complementary risk-reduction strategies.

Other studies have concluded that receiving payments from government programs is a primary risk-reducing mechanism (Kramer and Pope, 1981; Musser and Stamoulis, 1981). As Goodwin and Schroeder (1994) note, government programs are intended to decrease agricultural producer risks. In addition, Robison and Barry (1987) point out that government programs emphasize the provision of risk-reducing opportunities for the farm.

The coefficient of off-farm income from wages and salaries ($\text{OFF}^{\text{WAGE}}$) is negative in both models, but statistically significant only in the 2000 model. The combination of low farm income, represented by a reduction in average value of agricultural products sold in 2000, and a strong nonfarm economy encouraged many farm operators and their spouses to work off the farm. This is reflected in a 29% increase in off-farm wages and salaries between 1996 and 2000. This view is further supported by the fact that the average number of farm operators working full time on the farm decreased in 2000. Additionally, Mishra and Goodwin (1997) found a positive relationship between the coefficient of variation for farm income and off-farm work. Specifically, the greater the variability of farm income, the higher the farm operators’ off-farm labor participation rate. Off-farm income diversifies a farm operator’s income portfolio and reduces the need for enterprise diversification. This is consistent with the findings of Calvin (1992); Just and Calvin (1990); and Mishra and Sandretto (2002). A negative and significant coefficient of $\text{OFF}^{\text{WAGE}}$ in the 2000 model supports the potential ability of farmers to self-insure.

Table 2 shows there is a positive and significant relationship between diversification and full-time farm operators ($\text{WRK}^{\text{STAT}}$). Results indicate a full-time farmer is more likely to diversify compared with a part-time farm operator. Full-time farmers demonstrate a commitment to farming, and therefore desire to employ the available labor more uniformly throughout the course of a year in addition to diversifying risk on the farm. Another explanation could be that full-time farm operators are involved in labor-intensive farming, such as dairy, which leaves very little time to work off the farm. Other full-time operators may be constrained from seeking off-farm work because of age, disability, location, or other factors.

Purchase of insurance, crop insurance or revenue insurance, is a private risk management strategy farmers have used to reduce risk and uncertainty associated with farm income (Harwood et al., 1999). The coefficient of farm insurance ($\text{HAV}^{\text{INSUR}}$) is positive and statistically significant at the 1% level for both 1996 and 2000, indicating farmers who buy insurance operate diversified farms. This may be a case of a farm operator who is risk averse and reduces risk in several ways (Goodwin and Schroeder, 1994). This result demonstrates the farm operator’s ability to self-insure and bolsters the view that insurance and diversification are complements (Mishra and Goodwin, 2003).

A positive and significant correlation is found to exist between farm diversification and the legal form of business organization, enterprise diversification. This is consistent with the findings of Calvin (1992); Just and Calvin (1990); and Mishra and Sandretto (2002). A negative and significant coefficient of $\text{OFF}^{\text{WAGE}}$ in the 2000 model supports the potential ability of farmers to self-insure.

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A positive and significant correlation is found to exist between farm diversification and the legal form of business organization,

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11 Farmers involved in highly seasonal production activities, such as cash grains, have more time to pursue nonagricultural activities—both on and off their farms.
particularly if the business is organized as a sole proprietorship ($FRM$SOLE), when compared with other forms of business organization. In the case of sole proprietorship, the farm operator has much at stake in the form of capital financing (unlimited personal liability for the business’s debts) and there is no risk sharing. Therefore, it is not surprising for a sole proprietor to diversify the farm, given that diversification is a private risk management strategy. Further, sole proprietorship is the most common form of business organization on small and medium-sized farms, and these farms (small and medium) are more likely to be diversified as evident from the results reported above.

Aside from farm, operator, and household characteristics, soil productivity and distance to an urban area are also factors that may affect farm diversification. For example, if the soil is productive and can produce several crops, then the farm operator might be inclined to try new crops and other enterprises on the farm. Crop diversification through the use of rotations suited to the site-specific conditions at the field level has been demonstrated to be beneficial in protecting soil quality and productivity over the long term and can contribute to higher and more stable net farm income (Clark, 2001; Zentner et al., 2002). The coefficient of the mean productivity index ($FRM$PROD) is positive and significant for both models at the 1% level.

Previous work on farm diversification has highlighted the importance of proximity to main roads and urban centers for development of other farm enterprises (Ilbery, 1991; Shucksmith et al., 1981; Edmond, Corcoran, and Crabtree, 1993). Such access is assumed to provide the market stimulus for the development of farm enterprises. Results show a negative and significant correlation between farm diversification and proximity to an urban area ($FRM$URBAN) in both models.

Operators and family members of farms located near urban areas are more likely to work off the farm. One interpretation is that off-farm work is a substitute for onfarm enterprise diversification. This is evident from the negative and significant correlation between off-farm work and diversification in the 2000 model. Additionally, farms located near urban areas tend to specialize in niche products.

Finally, geographic location determines rainfall, soil productivity, and access to markets, which in turn influences potential cropping patterns. Four regional dummies to indicate location of the farm were defined, and three were included in the regression. However, only the coefficients of $F$MWEST and $F$NEAST were statistically significant in both the 1996 and 2000 models. Thus, compared to farms in the South (the benchmark), Midwestern and Northeastern farms are found to be more likely to diversify.

### Summary and Conclusions

The objectives of this study were to determine if there was a discernable difference in the level of enterprise diversification in two time periods (1996 and 2000), and to identify those farm, operator, and financial characteristics that are correlated with farm enterprise diversification. This study has used national farm-level data (1996 and 2000) with great diversity regarding farm size, location, commodities produced, and risk management strategies (such as crop insurance, participation in production and marketing contracts, and off-farm income). In general, farms in 2000 had slightly more diversified farm enterprises than farms in 1996. This finding would support the argument that the “freedom to farm” production flexibility provisions in the FAIR Act of 1996 may have contributed to enterprise diversification.

Evidence reported here suggests diversification and farm size may be negatively correlated. These findings are consistent with economic theory in confirming that economies of scale exist in

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12 Other forms of business organization included family corporations, which acted as the benchmark.
production. In addition, results show that older farm operators, farm households with off-farm income (from wages and salaries), farms with higher debt-to-asset ratios, and farms located near urban areas are less likely to diversify farm enterprises. In contrast, evidence suggests there is a significant positive relationship between farm enterprise diversification and family size, having crop insurance or farm business insurance, and being a sole proprietor and a full-time farmer. Finally, farms that received government commodity program payments are found to be more diversified than their nonparticipating counterparts.

References


