QUANTIFYING THE SOURCES OF DAIRY FARM BUSINESS RISK AND UNDERSTANDING THE IMPLICATIONS FOR RISK MANAGEMENT STRATEGIES[1]

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Abstract

The major sources of variability of net farm income on individual New York dairy farms over the past 10 years are identified using methods in variance decomposition. The most important source of income variability is the fluctuation in the price of milk received by farmers, followed closely by year-to-year variation in the quantity of feed purchased. The degree of success in engaging in activities that increase diversification that lead to a reduction in the variance in farm income is higher for older farmers and for those that milk in a milking parlor, use recombinant bovine somatotropin, have greater assets per cow, and have engaged in activities to earn income from off-farm sources.

Keywords: dairy farm income variability, risk, variance decomposition

Introduction

It is perceived that dairy farms currently experience greater risks than in past years. Support for this perception is found in data such as farm income per cow of a group of New York dairy farms (Figure 1). During the first half of this period, labor and management income ranged between a loss of $12 per cow to a profit of $240 per cow. In contrast, over the second half of this period, dairy farm income per cow ranged from a loss of $90 to a profit of $430. It is thought that this increased variability is due primarily to increased volatility in milk prices. According to the New York Agricultural Statistics, dairy farmers received an average of $32.47 per hectoliter of milk during the 10-year period ending in 2004; prices ranged from $38.17 to $29.09 per hectoliter, with a coefficient of variation of 0.10. For the prior 10-year period, New York dairy farmers received an average of $29.97 per hectoliter--slightly more than two dollars less. Prices varied over a narrower range—from $28.63 to $33.18 per hectoliter and the coefficient of variation was only 0.05.

While recent fluctuations in milk prices explain some of the increased variability in farm income, there are other determinants. For example, over the 10-year period ending in 2004, dairy feed prices averaged $211 per metric ton in New York, but their relative variability (coefficient of variation of 0.10), was as large as that for milk prices (New York Agricultural Statistics). For the earlier period ending in 1994, average dairy feed prices were slightly lower, $189 per metric ton; the coefficient of variation of 0.06 was also much lower. Another factor that could affect income variability, milk production per cow, is much more stable across the State, but for individual farms, it can be substantially more variable.

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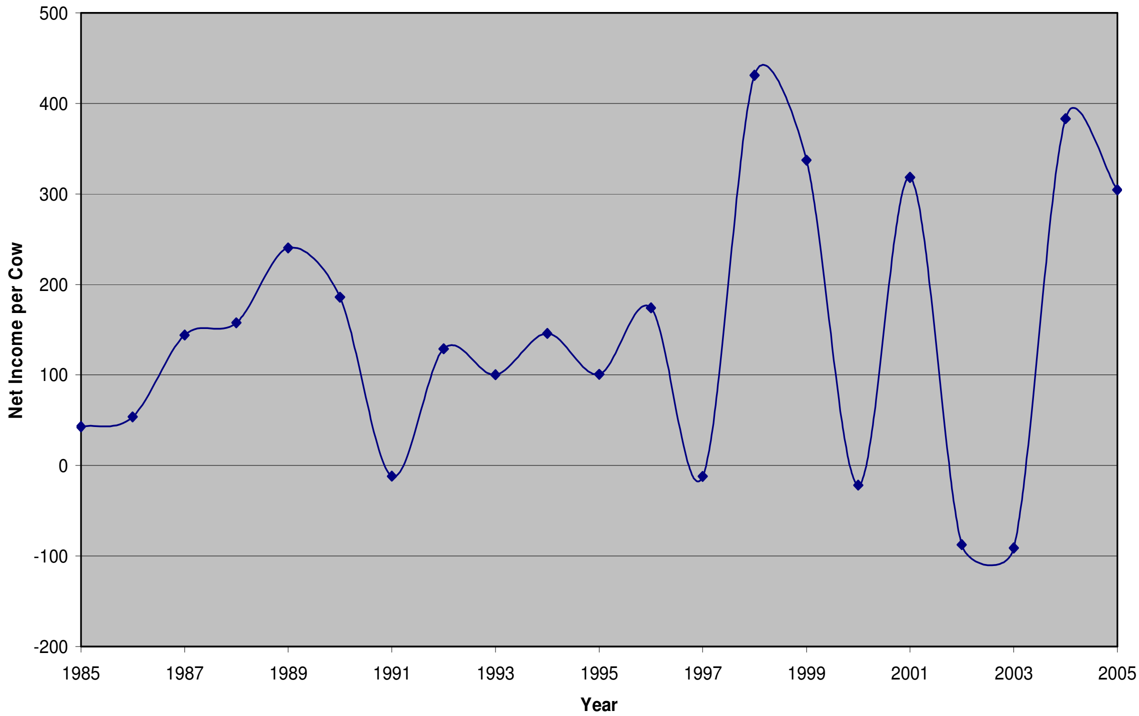
Figure 1: Average Net Return to Labour and Management per Cow for all Farms Participating in the New York Dairy Farm Business Summary Program



To address these concerns, there have been recent discussions about developing additional financial products and management strategies for reducing risk for agriculture (Dismukes and Durst). To identify the products needed to manage dairy risk effectively one must quantify the important sources of dairy farm income variability. Then farmers can begin to control fluctuating incomes through business and financial management strategies, including hedging or insurance. This paper reports research that quantifies the major sources of income variability on New York dairy farms. Using dairy farm record data, we decompose the variability in net farm income for the 10-year period ending in 2002 into the several components of revenue and cost, accounted for the variability in both the quantity and price associated with each component. We extend this decomposition analysis, by constructing a variable that is the ratio of the variance in farm income divided by the sum of the direct contributions of all components of farm income to variance (e.g. as though these sources are uncorrelated). We regress this variable on characteristics of the dairy operation. Those characteristics that reduce this ratio contribute to a farmer's success in undertaking production activities to reduce risk by diversifying into activities that are negatively correlated with one another.

Method for Decomposing the Variation in Net Farm Returns

According to the theory of risk aversion, and mean-variance analysis, risky prospects are evaluated by examining the mean and variance in returns. In comparing alternatives with the same mean, the one with the lowest variance is considered the least risky, and is preferred (e.g. Boisvert and McCarl, 1990). Thus, the variance in returns serves as a measure of risk. The variance in net returns depends on the variability in the quantities of individual inputs and outputs, and on the variability in input and output prices.

To isolate the effects of these prices and quantities on this measure of risk, we define net farm income (NFI) as the revenue from selling M commodities, q_i ($i = 1,\ldots,M$), at per unit prices, p_i, less the cost of buying N inputs, x_j ($j = 1,\ldots,N$) at unit costs of, c_j. Algebraically, NFI is:

$$\text{(1)}\quad \text{NFI}(\mathbf{p}, \mathbf{q}, \mathbf{c}, \mathbf{x}) = \sum_{i=1}^{M} p_i q_i - \sum_{j=1}^{N} c_j x_j .$$

Mean NFI is:

$$\text{(2)}\quad \text{E}\,[NFI] = \sum_{i=1}^{M} \text{E}(p_i q_i) - \sum_{j=1}^{N} \text{E}(c_j x_j);$$

E is the expectations operator.

There are two ways to decompose variability in NFI. One way is treat each separate component of revenue and cost as the product of price times quantity (e.g. $z_i = p_i q_i$, and $y_j = c_j x_j$). Thus, NFI is the sum of M random variables minus the sum of another N random variables, and its variance can be decomposed into:

$$\text{(3)}\quad \text{Var(NFI)} = \sigma^2_{\text{NFI}} = \sum_{i=1}^{M} \sigma^2_{z_i} + \sum_{j=1}^{N} \sigma^2_{y_j} + 2\sum_{i=1}^{M-1}\sum_{k=1}^{M} \sigma_{z_i, z_k} + 2\sum_{j=1}^{N-1}\sum_{l=1}^{N} \sigma_{y_j, y_l} - 2\sum_{i=1}^{M}\sum_{j=1}^{N} \sigma_{z_i, y_j} ,$$

where $i < k$, $j < l$, *and* $\sigma^2_{z_i}, \sigma^2_{y_j}, \sigma^2_{z_i z_k}, \sigma^2_{y_{ji} y_l}, \sigma^2_{z_i y_j}$ are variances of revenue and cost components, and covariances between pairs of revenue components, pairs of the cost component, and pairs of revenue and cost components, respectively.

This expression isolates the contribution to the variance in NFI of each individual revenue and cost component. Because each component is the product of two variables (only some of which can be controlled by the farmer), equation (3) fails to isolate the contribution of individual quantities or prices to the variance in NFI. To circumvent this problem, Bohrnstedt and Goldberger (1969) derived a linear approximation to the variance of the product of random variables, which has been used to decompose the variance in such things as farm returns and returns to agricultural land (e.g. Burt and Finley, 1968, Boisvert and Bills,1984, and Schmit, et al., 2001).Using this approximation, the variance in NFI is:

$$\begin{aligned}
\text{(4)}\quad \sigma^2_{\text{NFI}} = {} & \sum_{i=1}^{M}\left[\text{E}^2(q_i)\sigma^2_{p_i} + \text{E}^2(p_i)\sigma^2_{q_i}\right] + \sum_{j=1}^{N}\left[\text{E}^2(x_j)\sigma^2_{c_j} + \text{E}^2(c_j)\sigma^2_{x_j}\right] \\
& + 2\left[\sum_{i=1}^{M}\text{E}(p_i)\text{E}(q_i)\sigma_{p_i,q_i} + \sum_{j=1}^{N}\text{E}(c_j)\text{E}(x_j)\sigma_{c_j,x_j}\right] \\
& + 2\left[\sum_{i=1}^{M-1}\sum_{k=2}^{M}\left(\text{E}(q_i)\text{E}(q_k)\sigma_{p_i,p_k} + \text{E}(q_i)\text{E}(p_k)\sigma_{p_i,q_k} + \text{E}(p_i)\text{E}(q_k)\sigma_{q_i,p_k} + \text{E}(p_i)\text{E}(p_k)\sigma_{q_i,q_k}\right)\right] \\
& + 2\left[\sum_{j=1}^{N-1}\sum_{l=2}^{N}\left(\text{E}(x_j)\text{E}(x_l)\sigma_{c_j,c_l} + \text{E}(x_j)\text{E}(c_l)\sigma_{c_j,x_l} + \text{E}(c_j)\text{E}(x_l)\sigma_{x_j,c_l} + \text{E}(c_j)\text{E}(c_l)\sigma_{x_j,x_l}\right)\right] \\
& - 2\left[\sum_{i=1}^{M}\sum_{l=2}^{N}\left(\text{E}(q_i)\text{E}(x_j)\sigma_{p_i,c_j} + \text{E}(q_i)\text{E}(c_j)\sigma_{p_i,x_j} + \text{E}(p_i)\text{E}(x_j)\sigma_{q_i,c_j} + \text{E}(p_i)\text{E}(c_j)\sigma_{q_i,x_j}\right)\right] \\
& + \sum_{i=1}^{M} RM_{z_i} + \sum_{j=1}^{N} RM_{y_j} + 2\sum_{i=1}^{M-1}\sum_{k=2}^{M} RM_{z_i,z_k} + 2\sum_{j=1}^{N-1}\sum_{l=2}^{N} RM_{y_j,y_l} - 2\sum_{i=1}^{M}\sum_{j=2}^{N} RM_{z_i,y_j} ,
\end{aligned}$$

where $i<k$, $j<l$, E is the expectations operator, and the σ's are respective variances and covariances among components.

The first line of (4) gives the direct contributions of q_i, p_i, x_j, and c_j, to the variance in NFI; their size depends on the square of the component's expected value and its variance. The next four lines contain first-order interaction effects between pairs of components-- products of the component's expected value and the covariance between them. Since the expected values of input and output prices and quantities are positive, each term has the sign of the covariance. If two components move in opposite directions over time, the covariance is negative; if they move in the same direction, the covariance is positive. Where both terms are revenue components (cost components), the variation in revenue (cost) increases if the covariance between the terms is positive, and *ceteris paribus* the variance in net return increases.

The situation is different for terms involving revenue and cost components (terms with a negative 2 in front of the brackets). If the covariance is negative, *ceteris paribus* cost and revenue move in opposite directions; the variance in NFI increases. Similarly, if the covariance between revenue and cost components is positive, cost and revenue move in the same direction; the variance in NFI is reduced.

The last line of (4) contains a set of remainders (*RM*) that include the interaction effects of higher-order moments of the distribution that cannot be decomposed. If these remainders are small, other terms effectively isolate the individual contributions of prices and quantities to the variance in NFI. To identify the proportional effects of each price and quantity component, we normalize the direct and first-order interaction effects by dividing each term by total variance (Burt and Finley, 1968).

The Data

For the analysis it is necessary to have annual data on a number of dairy farms over some period of time. We focus on the dairy farms that participated in New York's Dairy Farm Business Summary Program each year from 1993 through 2002 (Knoblauch, et al., 2005). These 57 farms represent about one-fourth of the total farms participating in the program during any of these 10 years. These farms are located throughout New York. The ages of the farm operators vary significantly, as does the level of education. Farm operators utilize different milking systems. The average herd size is 270 cows, ranging from 40 to 1,160. Milk production per cow averaged over 8,618 kilograms, and ranged from about 3,629 kilograms to over 12,247 kilograms.

For the decomposition, NFI is defined as total receipts minus operating expenses. The sources of income and expenses are: milk sales, cull cow sales, off-farm income, paid labor expenses, and purchased and grown feed expenditures. Fixed costs are not deducted from expenses, but in general year-to-year variations in fixed costs on these farms are small, and typically reflect changes in long term investments rather than annual changes in input and output prices or quantities. Because of its increasing importance, we add income from non-farm sources to our measure of net farm income to identify the extent to which non-farm income reduces variability of income to farm households.

Measures of revenue and expenditures are calculated on an accrual basis. To put them on a comparable basis they are converted into constant (1993) dollars. Farm revenues are deflated by the U.S. Index of Farm Prices Received, while farm expenses are deflated by the U.S. Index of Farm Prices Paid. Off-farm income is deflated by the U.S. Consumer Price Index. To abstract from the effects of farm size, data are converted to a per cow basis. After converting to constant 1993 dollars, the NFI across these 57 farms averaged about $1,550 per cow and ranged from $609 to over $3,800.

In most farm record systems, data on input quantities and expenses are often reported, but prices are not. To circumvent this problem, unique, implicit output and input prices are estimated for each farm for each year by dividing the deflated receipt or expenditure item by the physical quantity of input used or output sold by that farm. These implicit prices vary significantly across farms (Table 1).[2] As an example, the average price paid for purchased feed is just over $97 per metric ton, but the range is from about $78 to $143 per metric ton. Some of this variation in prices may reflect local market conditions, but also the heterogeneity in the quality of labor or other inputs. Since the decomposition of net farm income is conducted separately by farm, problems in not controlling for differences in input quality are likely

[2] Since the farm records contain data on the payment for off-farm work but not hours worked, we cannot calculate an implicit price. Thus, the quantity of off-farm work is measured in dollar units so the implicit price is a constant one dollar over all years. Similarly, since only the value of grown feed is reported, its implicit price is unity in all years as well. While these minor limitations in the data don't allow us to decompose these revenue and expenditure items into their price and quantity components, they do not affect our ability to decompose the other revenue and expenditure components into the price and quantity effects.

minimized. The quality of labor or other inputs is likely to be relatively consistent across years for the same farm.

Table 1: Major Compnents of Net Farm Income for the Sample of 57 Dairy Farms

Variable	Mean[a]	Standard Deviation	Minimum	Maximum
Receipts ($ per cow)[b]				
Milk Sales	2712.68	487.78	1228.21	4145.36
Cull Cow Sales	132.84	113.57	0.00	2445.49
Off-Farm Income	43.44	111.27	0.00	1073.48
Expenditures ($ per cow)[b]				
Hired Labor	329.89	203.42	0.00	824.84
Purchased Feed	764.76	218.25	87.44	1542.60
Net Return ($ per cow)[b]	1551.63	382.46	608.95	3821.31
Prices[b]				
Milk ($ per hectoliter.)	32.27	2.98	24.65	42.45
Cull Cows ($ per kilo.)	0.32	0.11	0.59	0.99
Hired Labor ($ per month)	1781.65	706.89	0.00	8734.01
Purchased Feed ($ per metric ton)	90.44	18.34	78.52	143.00
Quantities				
Milk (kilograms per cow)	8,677	1,403	3,914	12,353
Cull Cows (kilograms per cow)	167.37	136.98	0.00	2917.41
Hired Labor (months per cow)	0.18	0.09	0.00	0.44
Purchased Feed (metric tons per cow)	9.86	3.31	1.28	22.29
Feed Grown ($ per cow)	242.68	104.80	31.90	663.58

[a] These are the 10-year averages for the 57 farms over the years 1993-2002.
[b] These monetary values are deflated into 1993 constant dollars using the appropriate indices of prices received, prices paid, and the CPI as described in the text.

The Results of the Variance Decomposition

The variance in NFI across the 10 years for each of the 57 farms is decomposed according to equation (4). The results are unique by farm. They are summarized in Table 2. Since the component effects are normalized, they sum to unity. Because some of the first-order correlations between components are negative, some direct contributions can be greater than unity. To draw inferences from these results, the linear approximation of the variance, as estimated by the direct contributions of prices and quantities and the first-order interaction effects associated with the decomposition, must be a good approximation of the actual variance. The combined size of the *RM* terms in equation (4) must be small. Although not reported in Table 2, this is the case. The average absolute error is less than 8 percent. For just over 70 percent of the farms, absolute errors are no greater than 10 percent, and for nearly 90 percent absolute errors are less than 25 percent.

Table 2: Normalised Decomposition of the Variance in Dairy Net Farm Income

Item	Mean	St. Dev.	Minimum	Maximum
	Direct contribution of revenue component			
Prices				
Milk	1.19	0.73	0.11	4.30
Cull cows	0.01	0.01	0.00	0.03
Quantities				
Milk	0.63	0.63	0.07	3.34
Cull cows	0.06	0.18	0.00	1.29
Off-farm work	0.06	0.13	0.00	0.77
	Direct contribution of expenditure component			
Prices				
Labor	0.10	0.10	0.00	0.43
Purchased feed	0.53	0.38	0.06	2.11
Quantitities				
Labor	0.09	0.10	0.00	0.57
Purchased feed	0.98	0.79	0.05	4.76
Grown feed	0.11	0.10	0.01	0.47
	Indirect contribution of covariance terms[a]			
Two Revenue Components				
Milk-P & milk-Q	-0.32	0.84	-3.06	0.87
Two Cost Components				
Purchased feed-Q & grown feed-Q	0.18	0.24	-0.22	0.82
Purchased feed-P & purchased feed-Q	-1.00	0.79	-4.21	0.08
Purchased feed-P & grown feed-Q	-0.16	0.18	-0.56	0.45
Revenue & Cost Components[b]				
Milk-P & purchased feed-P	1.01	0.62	0.11	3.03
Milk-P & purchased feed-Q	-1.27	1.00	-4.30	0.51
Milk-P & grown feed-Q	-0.35	0.32	-1.13	0.04
Milk-Q & purchased feed-Q	-0.34	0.61	-2.41	0.86
Milk-P & labor-P	-0.18	0.27	-0.91	0.33

[a] While we report all the direct effects, only the first-order covariance terms greater than 0.15 in absolute value are reported. Thus, the components do not add to unity.

[b] The signs on first-order covariance terms that involve a revenue and cost component implicitly include the (-2) from the 4th line of equation (4).

Factors Affecting Variance Directly

Examining the results in Table 2, it is evident that the price of milk, with an average contribution of 1.19, is the revenue component with the largest direct contributor to the variance in net return on these farms. If an effect of this magnitude persists into the future, farmers will likely find strategies to reduce risk such as the forward pricing of milk increasingly desirable and useful. It is also true that the variability in milk output is another component of revenue that contributes directly to the variability in net return. However, its average relative contribution of 0.63 is only about half the size of the contribution of milk prices.

The other revenue components (price and quantity of cull cows and off-farm income) make only minor direct contributions to the variance in NFI; on average, the relative contribution to the variance in NFI is 0.06 for both components. This is hardly surprising since the sale of cull cows is primarily a by-product of milk production, and dairy farmers or their spouses typically work less off the farm than on other types of farms. On average, these activities constitute only about 4.6 and 1.5 percent of NFI, respectively (Table 1). Yet, for several farms, the effect of these components on variance in NFI is quite large, especially for cull cows, where the range is from 0 to 129 percent. The likely explanation is that for several farms, production or disease problems necessitated large cattle sales. While these problems are low probability events, there may be an opportunity to deal with them through an insurance product.

For expenditures, the average direct contributions to NFI variability of the quantity of feed purchased and the price of purchased feed of 0.98 and 0.53, respectively, dwarf the direct contributions of other components (Table 2). The quantity and price of purchased feed are the third and fourth largest direct contributors to NFI variability, suggesting that forward pricing of purchased feed may be a useful strategy on dairy farms. However, based on the relatively small contribution of grown feed expense to variability in NFI (0.11), there may continue to be little interest among New York dairy farmers in crop insurance; this value, however, reflects grown feed expenditures and not grown feed production.

Indirect Contributions to Variability in NFI

The previous discussion underscores the importance of revenue and cost components that contribute directly to increased variability in NFI. However, there are important first-order covariance effects whereby the revenue and cost components interact to affect the variance in NFI. If these first-order correlation effects are positive, then the two components vary over time to increase the variance over and above the two separate direct effects. Alternatively, direct effects are tempered through negative first-order correlation effects. It is this type of negative relationship that makes diversification in a financial portfolio or diversification in economic production, sales, or purchase activities such an effective strategy to manage risk. To manage risk in this way, it is often necessary to accept somewhat smaller average return over time.

To begin the discussion, the negative covariance effect (-0.32) between milk price and quantity in Table 2 does not reflect a normal production response to price changes, where output price and output quantity should be positively related, but such a response does leads to less variability in NFI. Farmers expand or contract through adjustments to both purchased and grown feed, but through the covariance effect (0.18) *ceteris paribus*, this leads to an increase in NFI variability. However, the natural opposite movements in the price and quantity of purchased feed (covariance effect of -1.00) tend to reduce the NFI variability, as does the price of purchased feed and grown feed quantities (covariance effect of -0.16).

Since milk price is a revenue component and the feed price is a cost component, the positive effect of (1.01) means the components move in opposite directions. Increases in purchased feed prices appear to be accompanied by lower milk prices, leading to increased costs, decreased revenue, and increased variance in NFI. This inverse relationship is unfortunate from a risk management strategy since a natural hedge would exist if higher milk price were accompanied by higher purchased feed prices.

Analogously, the negative covariance effect (-1.27) squares with management decisions to purchase more feed when the price of milk is high—presumably to increase milk production; the combined result is a reduction in the NFI variability. The same logic explains the negative covariance effect (-0.35) between milk price and the quantity of feed grown. The negative covariance effect (-0.34) between milk production and purchased feed suggests that these quantities also tend to move in the same direction, serving to reinforce the variance-reduction effects on NFI due to positive correlation between feed use and milk prices.

Variance Reduction Estimates

A management action on a farm hopefully increases NFI but in the process may also increase its variability. In contrast, when the action is negatively correlated with other net income increasing actions, the variability in NFI falls, even though each individual activity adds to NFI variability in net farm income. This is the essence of diversification in selecting an appropriate portfolio of financial assets, or in selecting a combination of agricultural production decisions, where the negative correlation comes about through the complex interactions between components of revenue and cost. In dairy production, these interactions are captured by first-order covariance terms in Table 2.

The effective diversification of dairy operations will differ from farm to farm. However, an implicit measure of this effectiveness is constructed by dividing our estimate of a farm's variance in NFI by the sum of the direct contributions to income variability—those revenue and cost components in the first two sections of Table 2. This divisor estimates the variance in NFI assuming all components of cost and revenue are uncorrelated. This variable (DIVER) must be non-negative, and is likely to range between zero and unity, but it could exceed unity if there are no negative, but some positive first-order covariance effects. A low value for DIVER reflects successful diversification.

One should expect that successful diversification depends on characteristics of the farm and farmer, and on management choices. To identify factors contributing to successful diversification the variable DIVER is regressed on various characteristics of the farm operations (Table 3). These variables are the farm average over the 10 years, except as indicated, such as off-farm income. Some of these factors, such as age and education of the farmer, reflect experience and the potential ability to make decisions. Other variables reflect the characteristic of the farm, such as the type of milking system (parlor or no parlor milking), size of the farm, or location within the state. Some may be proxies for unobserved factors that identify successful managers in terms of tactical and strategic decision making. Since a low value of DIVER reflects successful diversification, the effects of factors associated with good management are expected to be negative.

Table 3: Sample Statistics for 57 Farmers (Data used for OLS Model)

Variable	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*
DIVER[a]	0.35	0.20	0.08	1.07
Operator age (years)	49.01	8.41	32.30	71.50
Operator education (years)	13.52	1.74	10.80	18.00
If parlor milking (any type) is used as milking system (=1)	0.82	0.38	0.00	1.00
Ratio of grown feed expenses to total feed expenses	0.25	0.08	0.06	0.45
If rBST adoption (=1) used on farm; 0 otherwise	0.79	0.41	0.00	1.00
Numbers of cows (1,000)	0.27	0.25	0.04	1.16
Located in western New York	0.39	0.49	0.00	1.00
Asset value per cow ($10,000)	0.69	0.20	0.34	1.63
If the farm household ever received off-farm income (=1)	0.91	0.29	0.00	1.00

[a] Sum of direct variances terms plus the sum of indirect covariance effects, all divided by the sum of direct variances. Direct variance consists of the components in the first two sections of Table 2. Indirect variance consists of the components in the last sections of Table 2.

From Table 4, the negative sign on a farmer's age suggests that older farmers are more successful at diversification; for each year of age the DIVER variable decreases by 0.007. Farmers with more of education also appear to be more successful at diversification, although the effect is not statistically significant. This may be in part explained by the fact that years of education is an imperfect measure of educational attainment, or there may be too little variation in the variable to obtain a precise measure of its effect. Although these dairy farmers receive a small fraction of their income from off-farm jobs, those that do appear somewhat more effectively diversified.

In contrast, increased farm size, as measured by the number of milk cows, seems to be associated with less effective diversification, but the effect is small, and it is not statistically significant. However, the level of capitalization of the farm, as measured by assets per cow, is also associated with less effective diversification, and this effect is statistically significant.

Table 4: OLS Estimation Results

Dependent Variable: DIVER[a]				
Variable	*Estimate*	*Std. Dev.*	*t-value*	*p-value*
Intercept	1.127	0.316	3.570	0.001
Operator age (years)	-0.007	0.003	-2.210	0.032
Operator education (years)	-0.013	0.017	-0.790	0.435
If parlor milking (any type) is used as milking system (=1)	-0.151	0.068	-2.230	0.031
Ratio of grown feed expenses to total feed expenses	-0.231	0.324	-0.710	0.480
If rBST adoption (=1) is used on farm; 0 otherwise	-0.162	0.068	-2.380	0.021
Numbers of cows (1,000)	0.112	0.130	0.860	0.394
Located in western New York	-0.085	0.061	-1.400	0.169
Asset value per cow ($10,000)	0.263	0.128	2.060	0.045
If the farm household ever received off-farm income (=1)	-0.161	0.081	-1.980	0.053
R-Square	0.478			
Adj R-Sq	0.379			
* 57 observations				

[a] Sum of direct variances terms plus the sum of indirect covariance effects, all divided by the sum of direct variances. Direct variance consists of the components in the first two sections of Table 2. Indirect variance consists of the components in the last sections of Table 2.

There are three rather specific management decisions that lead to effective diversification. Farms that milk using a parlor are more diversified, lowering the diversification index by 0.151. The use of recombinant bovine somatotropin is clearly associated with more effective diversification; the estimated parameter is -0.162. By increasing the proportion of feed grown on the farm, a farmer may be somewhat more insulated from fluctuating feed prices. The negative sign on this coefficient appears consistent with this expectation, but the effect is not statistically significant.

Conclusions

Net farm income varies from year to year, and the sources of that variation over a ten year period for a sample of 57 New York dairy farms are identified using a variance decomposition technique. The single largest source of net farm income variability is the variation in the price of milk, followed closely by the price of purchased feed. However, there was a positive covariance effect between the price of milk and the price of purchased feed, suggesting that if purchased feed prices increase, then milk price decrease that year. None-the-less, there may be opportunities to use insurance or forward pricing tactics to reduce income variability. On the price side, milk price and purchase feed prices are the prices that should be targeted. On the quantity side, milk output and grown feed might be insured. Interesting, although dairy farmers have had crop insurance products for a number of years, including insurance for grown corn silage, corn grain, and hay, the impact of variation in milk output on net income variability is much larger than for grown feed expenditures. Off-farm income is often considered to have a stabilizing effect on income. Although more off-farm income would obviously increase net income, it represents such a small fraction of income for farms in this sample that it has almost no effect on income variability.

Diversification on individual farms is measured as the sum of variances terms plus the sum of covariance effects, many of which are negative, all divided by the sum of variances—a measure of variance if all factors are uncorrelated. Regression of this variable, which differs by farm, on farm and farmer characteristics, suggests that age, use of a milking parlor and rBST, and reliance on off- farm income lead to more effective diversification. An older farmer may have a more stable farm operation with less variable income, and off-farm income should reduce income variability. The significance of the use of a milking parlor and rBST in leading to a more effectively diversified dairy operation indicates that the adoption of selected technologies may be effective risk reduction management decisions.

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