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Quantifying the Contributions to Dairy Farm Business Risk:

Implications for Producer's Risk Management Strategies

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By

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Abstract

The major sources of variability in net farm income on New York dairy farms over the past 10 years are identified using Dairy Farm Business Summary records. The most important source of income variability is the fluctuation in milk prices, followed closely by year-to-year variation in the quantity of purchased feeds. These results suggest that forward pricing of milk and feed purchases may be effective risk reduction strategies. Since a few farms have large cull cow sales, probably due to disease or other production problems, new insurance products to insure against disease may be useful to dairy farmers. It appears that older farmers are more successful in engaging in activities that increase diversification and reduce the variability in reductions in farm income. The same is true for farmers who utilize milking parlors, use recombinant bovine somatotropin, have greater assets per cow, and have engaged in activities to earn income from off-farm sources.

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Quantifying the Contributions to Dairy Farm Business Risk: Implications for Producer's Risk Management Strategies

Many believe that dairy farms are currently exposed to greater risks than in the past. Support for this perception can be found by reviewing historical data from the New York State Dairy Farm Business Summary where year-to-year variation in average net returns per cow have increased substantially over the past 20 years (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. What are the primary factors driving these changes?

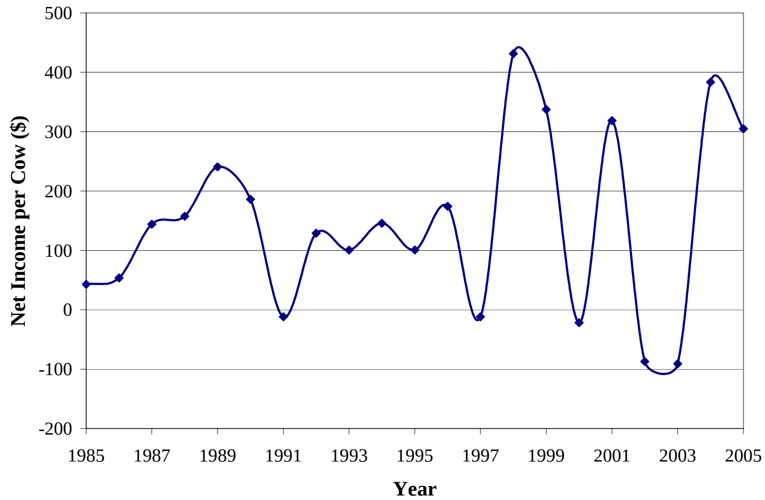


Figure 1. Average net return to labor and management per cow for all farms participating in the New York State Dairy Farm Business Summary Program, 1985-2005

There is some evidence that this increased variability is due primarily to increased volatility in milk prices. Data from the New York Department of Agriculture and Markets, for example, show that dairy farmers received an average of $14.46 per hundredweight of milk during the 10-year period ending in 2004; prices ranged from $12.95 to $17.00 per cwt (Figure 2). For the prior 10-year period, New York dairy farmers received an average of $13.34 per cwt, but prices varied over a much narrower range—from $12.75 to $14.77 per cwt. The relative variation in milk prices, as measured by the coefficient of variation, was also twice as high (0.10) for the period ending in 2004, as it was for the prior 10-year period (0.05).[1]

While fluctuations in milk prices explain some of the increased variability in farm income, there are other important determinants as well. For example, over the 10-year period ending in 2004, dairy feed prices averaged $191 per ton in New York (New York Department of Agriculture and Markets), but their relative variability (coefficient of variation of 0.10), was as large as that for milk prices. For the earlier period ending in 1994, average dairy feed prices were slightly lower ($172 per ton), but the corresponding coefficient of variation (0.06) was much lower as well. Another factor that may contribute to income variability is

[1] The coefficient of variation is the ratio of the standard deviation to the mean (average). By dividing the standard deviation by the mean, the coefficient of variation measures the relative variability in data series with different means. The higher the coefficient of variation, the greater is the relative variability of the item.

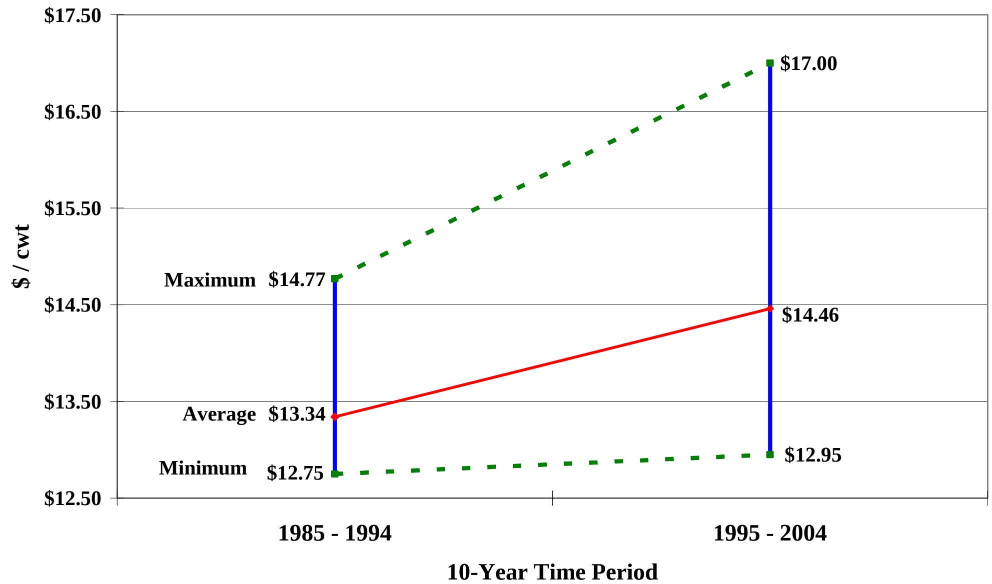


Figure 2. Range in farm milk prices, New York State

variation in milk production per cow. While production per cow is more stable across the State as a whole, it can vary substantially for some individual farms.

These concerns over more volatile prices and other factors contributing to increased variability in farm income can be addressed by producers and agri-service providers through the development of financial products and management strategies for reducing risk. However, to identify the specific products and strategies needed to manage dairy risk effectively, one must first quantify the important sources of dairy farm income variability. It is only then that farmers can begin to control fluctuating incomes through business and financial management strategies, including hedging or insurance.

Here, we use New York dairy farm data to identify these major sources of dairy farm risk. This is accomplished by decomposing the variability in net farm income over the 10-year period ending in 2002 by major components of revenue and cost. For each component, we account for the importance of the variation in both its quantity and its price. By isolating and quantifying the individual contribution of each price or quantity to the variability in income per cow, we measure the contribution of each of these prices and quantities to dairy farm risk.

We then extend our 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. We regress this variable on characteristics of the dairy operation to determine those characteristics that are associated with reduced levels of this ratio and, thereby, contribute to a farmer's success in undertaking activities to reduce risk by diversifying into activities that are negatively correlated with one another. This analysis allows us to determine what types of farms or farmers were best able to control or reduce risk.

Decomposing the Variance in Net Farm Returns

Based on the concept of risk aversion, risky prospects are typically evaluated by examining both their 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, therefore, preferred. In this way, the variance in returns can serve as a measure of risk. Since the computation of farm net returns depends on both the prices received (or paid) and the quantities sold (or purchased), the variance in net returns over time depends on the variability in the quantities of individual inputs and outputs, as well as the variability in input and output prices.

To isolate the effects of these prices and quantities on this measure of risk in dairy farming, we measure net farm income (NFI) as receipts less operating expenses. We consider three sources of revenue, milk sales, revenue from the sale of cull cows, and earnings from off-farm work. To generate the measure of NFI, we subtract from these combined sources of revenue the major components of variable costs, including hired labor expense, cost of purchased feed, and the cost of grown feed. Using P's and Q's to represent prices and quantities, respectively, NFI can be expressed algebraically as:

$$NFI = \{P_m Q_m + P_{cc} Q_{cc} + P_{of} Q_{of}\} - [P_L Q_L + P_{pf} Q_{pf} + P_{gf} Q_{gf}]$$

In this equation, the subscripts are: m = milk, cc = cull cow, of = off-farm, L = labor, pf = purchased feed, and gf = grown feed. The three revenue components are enclosed in { }, while the three cost components are enclosed in [ ].

Each price and quantity in this expression for NFI varies over time. Thus, to measure the contribution of each component to the variance in NFI, one must account for the variation in each separate component (i.e., the direct effects) as well as the effects of any correlation in the year-to-year variation in each pair of components (i.e., the indirect effects). Although the exact decomposition is difficult to ascertain mathematically, we approximate the direct and indirect contributions to the variance in net farm returns using a procedure developed by Bohrnstedt and Goldberger. The details of our decomposition procedure are found in Chang, *et al.* (2007).

To understand the intuition behind these direct and indirect effects, some explanation is necessary. Let us first consider the variance in any one of price or quantity components.

1) As the variance in any single price or quantity increases, with all else held constant, it follows logically that the variance in NFI must also increase. Similarly, if the variance in any single price or quantity falls, the variance in net farm income must also fall. It is these separate effects that are captured by the direct effects.

It is more difficult to disentangle the nature of the indirect effects on the variance in NFI that are due to the correlation between any pair of components. These effects depend on the nature of the correlation between the components. If, for example, two components of NFI move in opposite directions over time, the correlation between them is negative. Alternatively, if two components move in the same direction, the correlation between them is positive. We must consider the situations involving two revenue components, those involving two cost components, and those involving one cost and one revenue component. The results can be summarized in the following way.

2) When both terms are revenue components (e.g., the price and quantity of milk), the variation in revenue increases if the correlation between the two terms is positive, and with all else held constant, the variance in net income also increases. If the correlation is negative, then the variance in net income decreases.

3) Similarly, when both terms are cost components (e.g., the price and quantity of purchased feed), the variation in NFI increases if the correlation between the two terms is

positive, and with all else held constant, the variance in net income also increases. If the correlation is negative, then the variance in net income decreases.

The situation is more complex when there is one cost and one revenue component.

4) When there is one cost and one revenue component (e.g. the quantity of purchased feed and the price of milk), and the correlation between the two terms is negative, then, with all else held constant, cost and revenue move in opposite directions, and thus the variance in NFI increases.

5) Similarly, when the correlation between the revenue and the cost components is positive, then, all else held constant, cost and revenue move in the same direction and the variance in NFI is reduced.

For ease of exposition and to identify the relative effects of each price and quantity component, it is convenient in the empirical analysis below to normalize the direct and indirect effects by dividing each term by the total variance in NFI.

The Data

For the analysis, it is necessary to have data on a number of dairy farms over some period of time. We focus on dairy farms that participated in New York's Dairy Farm Business Summary Program each year from 1993 through 2002 (Knoblauch, Putnam, and Karszes). Although more recent data are available, this particular period was chosen because it contained the largest number of farms continually participating in the DFBS program.

Some selected characteristics of these farms are in Table 1. These farms are located throughout New York. The age of the farm operators varies significantly, as does their level of education. Farm operators utilize different milking systems. The average herd size is 270 cows, but it ranges from 40 to 1,160. Annual milk production per cow averaged 19,130 pounds, and it ranged from 8,629 pounds to 27,234 pounds (Table 2).

Table 1. Selected statistics for sample of 57 New York dairy farms, 1993 - 2002.

Variable	Mean	Standard Deviation	Minimum	Maximum
Operator age (years)	49.05	8.41	32.30	71.50
Operator education (years)	13.52	1.74	10.80	18.00
Milking parlor used (1=yes, 0=no)	0.82	0.38	0.00	1.00
Grown to total feed expense ratio	0.25	0.08	0.06	0.45
rBST used on farm (1=yes, 0=no)	0.79	0.41	0.00	1.00
Number 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
Received off-farm income (1=yes, 0=no)	0.91	0.29	0.00	1.00
DIVER[a]	0.35	0.20	0.08	1.07

[a] Sum of direct variance terms and indirect covariance effects, divided by the sum of direct variances. Direct variances consist of the components in the first two sections of Appendix Table 1A below. Indirect variances consist of the components in the last section of Appendix Table 1A below.

Table 2. Major components of net farm income for sample of 57 dairy farms, 1993-2002.

Variable	Mean[a]	Standard Deviation	Minimum	Maximum
Receipts ($ per cow)[a]				
Milk sales	2,712.68	487.78	1,228.21	4,145.36
Cull cow sales	132.84	113.57	0.00	2,445.49
Off-farm income	43.44	111.27	0.00	1,073.48
Expenditures ($ per cow)				
Hired labor	329.89	203.42	0.00	824.84
Purchased feed	764.76	218.25	87.44	1,542.60
Net return ($ per cow)	1,551.63	382.46	608.95	3,821.31
Prices[b]				
Milk ($ per hundredweight)	14.37	1.33	10.98	18.90
Cull cows ($ per pound)	0.15	0.05	0.27	0.45
Hired labor ($ per month)	1,781.65	706.89	0.00	8,734.01
Purchased feed ($ per ton)	81.67	16.64	70.78	129.76
Quantities				
Milk (pounds per cow)	19,129.51	3,093.09	8,628.89	27,233.70
Cull cows (pounds per cow)	368.99	301.99	0.00	6,431.99
Hired labor (months per cow)	0.18	0.09	0.00	0.44
Purchased feed (tons per cow)	10.87	3.65	1.41	24.56
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 Consumer Price Index as described below in the text.

As stated above, for purposes of decomposition, NFI is defined as total receipts minus operating expenses. The sources of income are: milk sales, cull cow sales, off-farm income. Expenses include: 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 across years, 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 (Table 2).

In most farm record systems, data on input quantities and expenses are often reported, but prices are not. For this reason, 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. These computed or implicit prices, as they are often called, vary significantly across farms (Table 2). As an example, the average price paid for purchased feed is nearly $82 per ton, but the range is from about $71 to $130 per ton. Some of the variation in prices may reflect local market conditions, but also reflect the differences in the quality of inputs. The decomposition of net farm income is conducted separately for each farm. Thus, there is no reason to control for differences in input quality across farms. Furthermore, the quality of inputs is likely to be relatively consistent across years for the same farm.[2]

Results of the Variance Decomposition

The variance in NFI for each of the 57 farms is decomposed as discussed above. The results are unique by farm and are summarized in Appendix Table 1A. Since the component effects are normalized, they sum to one. Because some of the first-order correlations between components are negative, some direct contributions can be greater than one. The results in this table are taken directly from the computer output generated from the variance decomposition analysis, and although the normalization of these effects helps in their interpretation, the effects are not completely transparent from the data in this table.

The table is included in an appendix mostly for completeness, but to facilitate the interpretation of the results, we reorganize the results by placing each effect into one of three groups, as is described above in the discussion of the intuition surrounding variance decomposition (i.e. items 1 through 5 above). These groups are: the direct effects, the positive indirect effects, and the negative indirect effects.

These results of the decomposition analysis reorganized into these three groups are reported in the three separate sections of Figure 3. The height of each column in the figure reflects the relative size of each of the three effects. Furthermore, the percentage contributions of the individual components to the direct effects on variance are reflected in the detail on the first column of the figure. The percentage contributions of the components to the positive indirect effects are reflected in the detail in the second column of the figure. Similar percentage contributions to the negative indirect effects are in the detail in the third column. In what follows, we begin with a discussion of the relative sizes of each of the three effects. This provides important information about how effectively dairy farm activities are diversified. With this as background, we then discuss the implications of the individual components of the decomposition for risk reduction.

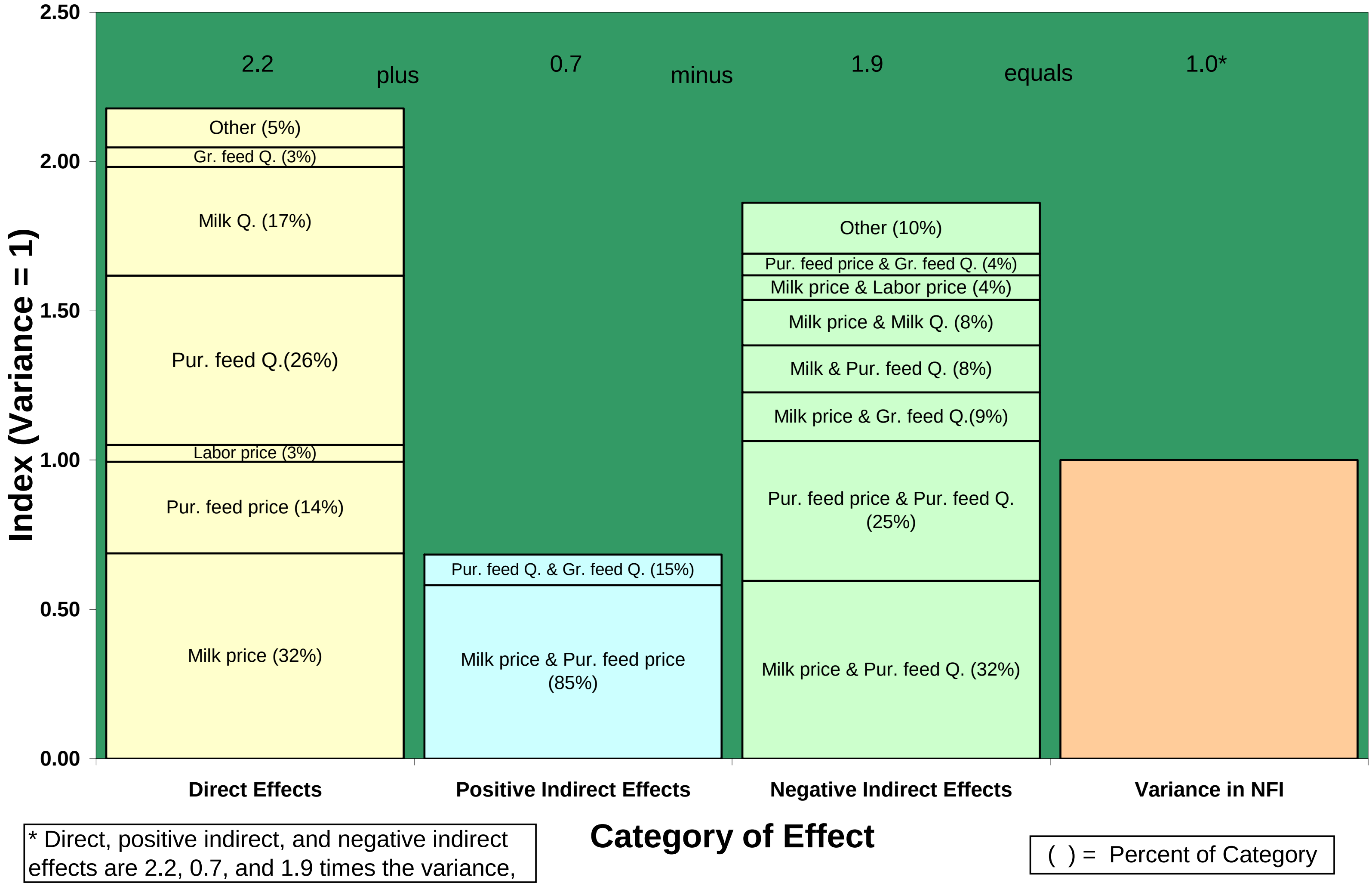
Interpreting the Aggregate Direct and Indirect Effects

The direct contributions to the variance in NFI attributable to the variability in all prices and quantities (i.e., item 1 above) are given by the height of the first column in the figure. Thus, if there was absolutely no correlation over time between any of the prices or quantities, the average variance in NFI for the 57 farms would be over twice (2.2 times) the actual average variance. In turn, this large difference is reconciled by accounting for the indirect effects as discussed in items 2) through 5) above.

The second column of the figure reflects the indirect increases in the variance in NFI due to: a) a positive correlation between two revenue or two cost components, or b) a negative

[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 do not 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 their price and quantity effects.

Figure 3. Decomposition of Variance in Net Farm Income



correlation between a cost and a revenue component. These positive indirect effects are about 0.7 times the actual variance, and these effects add to the overall variance in NFI.

From the perspective of managing risk, it is the third column of Figure 3 that is perhaps of most interest. It is in this column that the negative indirect effects on the variance in NFI are recorded. They include the indirect effects due to: c) a negative correlation between two revenue or two cost components, or d) a positive correlation between a cost and a revenue component.

In contrast to the size of the positive indirect effects, the absolute value of the average negative indirect effects is about 1.9 times as large as the actual variance. Since the combined positive direct and indirect effects are 2.9 times as large as the actual variance, these negative indirect effects work to offset much of the positive effects. Thus, in a real sense, it is the size of these combined negative indirect effects relative to the size of the combined positive indirect effects that measure the effective "diversification" of farming activities. Furthermore, given the large size of these negative indirect effects, it would seem reasonable to conclude that dairy farming activities are well diversified. However, to discover the specific implications of this decomposition analysis for managing risk, we must discuss the individual effects in greater detail.

Specific Factors Affecting Variance Directly

From the results in Figure 3, it is evident that the price of milk is the largest direct contributor to the variance in net returns, accounting for about 32% of the total (column 1). This effect is more than double that in an earlier study by Schmit, *et al*. (2001). Thus, if an effect of this magnitude persists into the future, farmers will likely find strategies to reduce price risk such as the forward pricing of milk increasingly desirable and useful.

It is also true that the variability in milk output contributes directly to the variability in net return. However, its relative contribution of about 17% (column 1 in Figure 3) is roughly only half the size of the direct contribution of milk prices and is only two-thirds the size of the effect from the previous study. One interpretation of these comparative results is that in recent years, these dairy farmers seem to have found methods to reduce the year-to-year variability in milk production per cow.

The revenue components of price and quantity of cull cows and off-farm income make only minor direct contributions to the variance in NFI. Since the combined direct effect is less than 2%, they are reported in the "other" category. 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 2). Despite this minimal direct contribution on average, a careful examination of the information in Appendix Table 1A reveals that the range in this effect across the farms is extremely large, especially for cull cow quantities, where the range is from 0 to 129%. The likely explanation is that for some farms, production or disease problems necessitated large cattle sales. Since these problems are certainly low probability events, there may be an opportunity to deal with them through the development of an appropriate insurance product.

On the expenditure side, the quantity of feed purchased and the price of purchased feed account for about 26% and 14%, respectively, of the direct contribution to NFI variability (Figure 3, column 1). This suggests that forward pricing of purchased feed may be a useful strategy on dairy farms. However, based on the relatively small direct contribution of grown feed expense to variability in NFI (3%), 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, Figure 3 also identifies the important indirect correlation effects whereby the revenue and cost components interact to affect the variance in NFI, both positively and negatively. If these correlation effects are positive, then the two components vary over time to increase the variance over and above the separate direct effects. Alternatively, direct effects are tempered through negative 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. And as emphasized above, these negative indirect effects are nearly as large as the direct effects well over twice as large as the positive indirect effects. However, to manage risk in this way, it is often necessary to accept somewhat smaller average return over time.

To begin the discussion, the negative indirect (correlation) effect between milk price and quantity accounts for about 8% of the total negative indirect effects on the variance in NFI (Figure 3, column 3). Since both of these are revenue components, there is, over the 10-year period, a negative correlation between milk production and milk price. However, this would appear counter to a normal production response to price changes at the firm level, where output price and output quantity should be positively related to one another. This empirical result may be a reflection of the regional or national relationship between lower milk production and higher milk prices. Another example of a negative individual farm response, while not profit maximizing, could be that farm operators increase herd size to sustain gross milk revenues in the face of falling milk prices.[3] Whatever the reason, such a negative relationship does lead to less variability in NFI.

Farmers expand or contract through adjustments in both purchased and grown feed, but the interaction of these two activities over time seems to have lead to a small increase in the variance in NFI, accounting for about 15% of the positive indirect effect (Figure 3, column 2). However, the natural opposite movements in the price and quantity of purchased feed, accounting for about 25% of the negative indirect effects, tend to reduce the NFI variability, as do similar movements in the price of purchased feed and grown feed quantities, accounting for a modest 3% of the negative indirect effects (Figure 3, column 3).

Since milk price is a revenue component and the feed price is a cost component, and their interaction accounts for 85% of the positive indirect effects (Figure 3, column 2) on the variance in NFI, we know that over the study period, 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 negative correlation is unfortunate from a risk management strategy since a natural hedge would exist if lower milk prices were accompanied by lower purchased feed prices.

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[3] Note from Table 1A that with the exception of the milk price and purchased feed price covariance (correlation) effect, individual farm covariance (correlation) effects are both positive and negative. The farmer's ability to react to adjusting market conditions depends on numerous factors such as managerial ability, credit constraints, availability of inputs, and rigidities in production adjustments. It is these factors that lead to a distribution of covariance (correlation) effects - sometimes not in line with expectations from economic theory.

Analogously, the correlation effect between the quantity of purchased feed and milk price accounts for 32% of the negative indirect effect on the variance in NFI (Figure 3, column 3). Since this effect involves a cost and a revenue component, we know that this implies a positive correlation between the two components--squaring with expected 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 effect of the interaction between milk price and the quantity of feed grown. Increases (decreases) in the quantity of grown feed in response to increases (decreases) in the price of milk account for about 9% of the negative indirect effects on the variance of NFI (Figure 3, column 3). Similarly, the fact that the interaction between milk production and purchased feed account for another 9% of the negative indirect effect suggests that these quantities also move in the same direction (Figure 3, column 3). This serves to reinforce the variance-reduction effects on NFI due to the positive correlation between feed use and milk prices.

Factors Associated With Reductions in the Variance of NFI

A management action on a farm hopefully increases NFI, but in the process, it 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 may directly add to 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 the negative indirect effects in Figure 3, or equivalently by the covariance terms in Appendix Table 1A.

While we report the average effects in Figure 3, 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 Appendix Table 1A, or equivalently in the first section of Figure 3. Therefore, this new variable (which we call DIVER) must be non-negative, and is likely to range between zero and unity. However, it could exceed one if the positive correlation effects outweigh the negative correlation effects. A lower value for DIVER reflects successful diversification efforts. As seen in Table 1, this measure of effective diversification has an average value of 0.35, while it varies over the farms from a low of 0.08 to a high of 1.07.

One should expect that successful diversification depends on characteristics of the farm and the farmer, and on management choices. To identify factors contributing to successful diversification, the variable DIVER is regressed on various characteristics of the farmer, farm and operations. Some of these factors, such as age and education of the farmer, reflect experience and potential managerial ability. Other variables reflect the characteristic of the farm, such as the type of milking system, size of the farm, or location within the state. Since a low value of DIVER reflects successful diversification, the effects of factors associated with good management are expected to be negative.

From Appendix Table 2A, the negative coefficient on a farmer's age suggests that older farmers are more successful at diversification; for each year of age, the variable DIVER decreases by 0.007. Farmers with more 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 across the sample of farms 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 as expected. Off-farm income may be more stable than farm income. It is also possible that some members of farm households secure temporary off-farm employment during periods of low farm returns to supplement and maintain total income levels and cover costs.

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. One explanation of this result may be that some highly capitalized firms have less flexiblity in adjusting to market prices; a higher level of fixed assets may lock them into a particular production plan.

There are also three rather specific management decisions that lead to effective diversification. Farms that milk using a parlor are more diversified. The diversification index is lower for these farms; the estimated coefficient is -0.151. The use of recombinant bovine somatotropin is associated with more effective diversification, and 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 incomes on dairy farms vary 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 is a positive covariance (correlation) effect between the price of milk and the price of purchased feed, suggesting that if purchased feed prices increase, then milk prices are lower that year. None-the-less, there may be opportunities to use insurance or forward pricing tactics to reduce income variability. On the price side, the milk price and purchase feed prices should be targeted. On the quantity side, milk output and feed production might be insured. Interestingly, although dairy farmers have been able to purchase crop insurance products for a number of years, including insurance for grown corn silage, corn grain, and hay, the effect 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 variance terms plus the sum of covariance (correlation) 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 characteristics of the farm and the farmer, 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 an effective risk reduction management decision.

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Table 1A. Normalized decomposition of the variance in net farm income, 1993-2002.[a]

Item	Mean		Standard Deviation	Maximum	Minimum
	Direct contribution of revenue components				
Prices (P_i)					
Milk	1.19	[0.45]	0.73	4.30	0.11
Cull cows	0.01	[0.03]	0.01	0.03	0.00
Quantities (Q_i)					
Milk	0.63	[0.97]	0.63	3.34	0.07
Cull cows	0.06	[0.12]	0.18	1.29	0.00
Off-farm work	0.06	[0.08]	0.13	0.77	0.00
	Direct contribution of expenditure components				
Prices (P_j)					
Labor	0.10	[0.12]	0.10	0.43	0.00
Purchased feed	0.53	[0.37]	0.38	2.11	0.06
Quantities (Q_j)					
Labor	0.09	[0.10]	0.10	0.57	0.00
Purchased feed	0.98	[1.12]	0.79	4.76	0.05
Grown feed	0.11	[0.11]	0.10	0.47	0.01
	Contribution of first-order covariance terms[b]				
Revenue Components					
Milk P & Milk Q	-0.32		0.84	0.87	-3.06
Cost Components					
Purchased feed Q & grown feed Q	0.18		0.24	0.82	-0.22
Purchased feed P & purchased feed Q	-1.00	[-0.85]	0.79	0.08	-4.21
Purchased feed P & grown feed Q	-0.16		0.18	0.45	-0.56
Revenue and Cost Components[c]					
Milk P & purchased feed P	1.01	[0.30]	0.62	3.03	0.11
Milk P & purchased feed Q	-1.27	[-0.60]	1.00	0.51	-4.30
Milk P & grown feed Q	-0.35		0.32	0.04	-1.13
Milk Q & purchased feed Q	-0.34	[-0.72]	0.61	0.86	-2.41
Milk P & labor P	-0.18		0.27	0.33	-0.91

[a] The numbers in brackets [ ] represent similar decompositions from an earlier study by Schmit, et al. (2001) for the 10-year period ending in 1997. [b] 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.

[c] The signs on first-order covariance terms that involve a revenue and cost component implicitly include the -2 from the fourth line of equation (4) of Chang, et al. (2007).

Table 2A. Ordinary Least Squares estimation results on diversification index, DIVER[a].

Independent Variable	Estimate	Standard Deviation	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
Milking parlor used (1=yes, 0=no)	-0.151	0.068	-2.230	0.031
Grown to total feed expense ratio	-0.231	0.324	-0.710	0.480
rBST used on farm (1=yes, 0=no)	-0.162	0.068	-2.380	0.021
Number 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
Received off-farm income (1=yes, 0=no)	-0.161	0.081	-1.980	0.053
R-Square = 0.478				
Adjusted R-Square = 0.379				
Observations = 57				

[a] The independent variable in this regression is DIVER, defined as the sum of direct variances terms and indirect covariance effects, divided by the sum of direct variances. Direct variances consist of the components in the first two sections of Table 1A. Indirect variances consist of the components in the last section of Table 1A.

OTHER A.E.M. EXTENSION BULLETINS

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