CORNELL
AGRICULTURAL ECONOMICS
STAFF PAPER

Risk Preference and Long-Run Performance
of the Dairy Farm

by

Loren W. Tauer

May 1986 No. 86-10

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

It is the policy of Cornell University actively to support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

Risk Preference and Long-Run Performance of the Dairy Farm*

Loren W. Tauer**

Abstract

Farm performance measures based upon 10 years of individual farm data are linearly regressed on risk preferences of 41 dairy farmers. Greater aversion to risk produces a lower average but more stable income, although the importance of risk preferences in determining long-run performance appears to be minor.

*Paper presented at the American Agricultural Economics Association Meetings, MGM Grand Hotel, Reno, Nevada, July 27-30, 1986.

**Associate Professor, Department of Agricultural Economics, Cornell University. The author thanks George L. Casler for his comments.

Risk Preference and Long-Run Performance of the Dairy Farm

Introduction

Important concepts in the literature of risk are return versus risk and risk aversion. There is a positive relationship between risk and return. If an investor desires a higher average rate of return he or she must be willing to assume a greater degree of risk. The market produces this positive tradeoff between risk and return since most investors are risk averse. Because they prefer to avoid risk, an investment must produce a higher expected rate of return if it is riskier than an otherwise comparable investment.

It is generally believed that aversion to risk can also produce a tradeoff between risk and return in agriculture. Dairying historically has produced modest but stable income while grain farms have experienced higher but fluctuating income (Boehlje and Trede). Less is known about risk versus return and risk aversion at the individual farm level (Young, et al). However, if a risk averse farmer manages the farm choosing less risky strategies, it would be expected that the average return of the farm over time would be lower but more stable. It is that hypothesis which is tested in this paper.

Numerous researchers have derived risk efficient frontiers or sets for different types of agricultural production using various techniques. Normally a large number of options still exist in these efficient sets, and farmers would have to choose based upon his or her own utility function or risk preference. Other researchers have estimated utility functions for farmers, either to assist in this farm management selection problem, or to determine if farmer characteristics can explain risk preference (Halter and Mason). A few

have related a farmer's risk aversion to farm strategies that a farmer has selected (Tauer).

A difficulty with trying to relate risk preference to farm strategy is that the researcher must conjecture the riskiness of a strategy, which may be quite different than a farmer's perception of the risk. A beef-cow enterprise may be considered quite risky by a researcher who observes annual calf prices, but a farmer may not consider it a risky enterprise if it utilizes otherwise unused resources on the farm.

Even if a farmer periodically errors in his perception of what are riskier management strategies, over time a risk averse farmer should select safer management strategies that result in lower but more stable income. In this paper a farmer's average dairy farm income or rate of return is computed from 10 years of farm records. To measure variability the standard deviation is also computed. Each farmer's risk preference is measured and linear equations are estimated to determine if a relationship exists between a farmer's risk preference and his or her average income or return, and the standard deviation.

Data

The data used in this paper have been used in two previous studies analyzing the risk preferences of dairy farmers (Tauer) and successful management strategies under risk (Kauffman and Tauer). Tauer used the interval approach (stochastic dominance with respect to a function) to measure the risk preferences of a group of New York dairy farmers in 1983. He designed the risk questionnaire so that a dairy farm could be placed into one of eight risk preference groups bounded by Pratt-Arrow's absolute risk aversion coefficient. Kauffman and Tauer used 10 years of consecutive farm

record data for 112 New York dairy farmers from 1974 through 1983 to calculate their rates of return and income over that 10 year period. These two data sets have an intersection set of 41 farmers who completed usable risk preference questionnaires and who also participated for 10 years in the summary program. It is this group of 41 farmers who are used as the data set in this paper.

The risk questionnaire was designed with four sections. The first section obtained risk preference at $15,000 annual income and the second section elicited risk preference at $30,000 annual income. Sections 3 and 4 were replications of sections 1 and 2 using different questions and routing schemes. A farmer was required to answer 3 of the 7 questions in each section in order to place him or her into one of eight risk preference intervals. These risk intervals are specified in Table 1. A normal distribution was used to construct the distribution of outcomes in the questionnaire. Further detail concerning the questionnaire is in Tauer and the procedure is discussed in King and Robison.

Table 1. The Number of Farmers in each Risk Preference Group

Risk Preference Group	Range of Pratt-Arrow's Absolute Risk Aversion Coefficient	Mid-point of Range	Number of Farmers	
			Section 3	Section 4
1	$(-\infty, -.0001)$	-.0001*	9	8
2	(-.0005, 0)	-.00025	7	6
3	(-.0001, .0001)	.0	8	16
4	(0, .0003)	.00015	7	2
5	(.0001, .0006)	.00035	9	5
6	(.0003, .001)	.00065	0	2
7	(.0006, .005)	.0028	1	2
8	(.001, ∞)	.001*	0	0

*The end-point rather than the undefined mid-point was used.

Wilson and Eidman, using the same risk elicitation procedure on hog producers, discovered a learning curve and designed their questionnaire accordingly. Tauer also admitted the existence of a learning curve when he noticed that fewer respondents failed the consistency check for sections 2 and 4 than the number who failed the consistency check for sections 1 and 3. Section 1 was the first section completed by a respondent. He also found that those respondents who failed the consistency test were close to being consistent. Thus in this paper responses to sections 3 and 4 are used only and no farmers are eliminated by a consistency test. The number of responses by risk interval group is shown in Table 1.

Complete financial records for 10 years from 1974 through 1983 were available for 41 of the risk survey respondents. These records were used to compute performance measures for each of those 10 years based upon the procedures reported in the 1983 New York farm business summary (Smith and Putnam). That entailed using specific receipt and expense items and following the summary procedure for 1983. The three measures computed each year were rate of return on equity, rate of return on equity excluding appreciation, and labor and management income per operator. The rates of return included all cash receipts, inventory increases and appreciation in assets. Subtracted were all expenses, cash and non-cash, including interest and an opportunity cost for the operator's labor, which had been estimated by each farmer those 10 years. Appreciation was removed from one rate of return measure because appreciation had been estimated by the farmers themselves and may not have been accurately reported each year.

The performance measure most commonly used in farm business analysis is probably labor and management income per operator. To compute this measure all cash and non-cash receipts are added, including inventory increases but

not appreciation. Appreciation is viewed as a return to ownership rather than labor or management. Subtracted from total receipts are expenses, including an opportunity cost for equity at a 5 percent real rate. (Any appreciation is considered a reimbursement to equity above this real rate.) Labor and management income per operator for each farm was also indexed each year by the annual average of the 112 labor and management income per operator observations from Kauffman and Tauer. The results were not significantly different from the non-indexed data so the non-indexed results only are reported below.

For each of the 41 farmers averages were computed for the 10 year period for each of the three performance measures. Also computed were the standard deviations. Summary statistics of the three performance variables for the 41 farms are in Table 2.

Table 2. Summary Statistics of Three Performance Variables for 41 Dairy Farmers for 10 Years.

Performance Variable	Mean of Averages	Mean of Standard Deviations	Maximum Average Value	Minimum Average Value
Rate of return on equity	.0218	.0659	.1603	-.1117
Rate of return on equity without appreciation	-.0366	.1019	.1120	-.2025
Labor and management income per operator	$14,880	$14,268	$59,947	$-12,266

Results

It is important to realize that although the long-run performance of the farm was available from 10 years of observations, the risk preferences of those farmers were obtained for only the last year. It has been shown that risk preference is not stable over time (Ramaratnam, et al.) so it is not expected that the risk preference of a farmer at the beginning or during the 10 year period would be identical to the risk preference at the end of the period. Complicating the analysis is that although risk preference is known to affect decisions, and thus ultimately business performance, it may also be that past business performance will be reflected in current risk preference. Thus, for instance, a farmer may have started as a risk preferrer, suffered losses or low returns, and became risk averse.

Yet, the hypothesis to be tested is that risk preference (measured at the end of the period) has an impact on the performance of the business as measured by the average rate of return over a period of 10 years, and the standard deviation of that return. Performance is also measured by the average labor and management income and it's standard deviation. The relationship between the absolute risk aversion coefficient and average return or income is expected to be negative. That is, a more risk averse individual, represented by a larger absolute risk aversion coefficient, would be expected to operate the business such that a lower return or income is generated over time. Likewise, the relationship between the risk coefficient and standard deviation (as a measure of risk) is also expected to be negative. A more risk averse farmer would operate the business so that variability (standard deviation) is lower. Higher moments may also be important to some farmers depending upon their utility function (functional form) and the prevalence of higher moments defining the distribution of outcomes. However, Anderson,

Dillon and Hardaker argue that moments beyond the third are rarely important to decision-makers. The third moment (skewness) was computed for labor and management income but the results were statistically insignificant and are not reported.

Although these relationships are expected to be negative, it is not known what the functional relationship might be. Thus it was hypothesized that the relationship was linear with an intercept. The midpoint of the risk interval as listed in Table 1 was used as the independent variable in the linear regression models (OLS). The dependent variables are the averages and standard deviations of the three separate performance variables. The residuals of the average and standard deviation equations for the three different farm performance variables were correlated in the range .40 to .50 (absolute value). Seemingly unrelated regression on the two equations did not alter the estimated coefficients so the OLS results only are reported in Table 3.

The estimated relationships between risk preference and the averages of the three performance variables at both income levels are as hypothesized. That is, a more risk averse farmer did experience a lower rate of return or income than a farmer less risk averse. Except for the average of the labor and management income at $30,000, the estimated slope coefficient is statistically significant at least at the 10 percent level. The adjusted coefficients of determination ($\bar{R}^2$) however are only around 5 percent. This would imply that although risk preference influences the operation of the farm and thus average return, the impact is very minor. As Binswanger has stated, differences in investment behavior among farmers facing similar technologies and risks cannot be explained primarily by differences in their attitudes but would have to be explained by differences in their constraint sets. That

information is not generally available from farm records where the emphasize is on measuring performance rather than resources and constraints.

Table 3. Linear Regressions of Performance Variables on Absolute Risk Aversion Coefficients

Dependent Variable	Intercept	Slope	$\bar{R}^2$
	---- At $30,000 Income ----		
Rate of return on equity			
average	.0256 (2.60)*	-50.69 (-1.60)	.04
standard deviation	.0651 (7.48)	10.70 (.38)	.00
Rate of return on equity without appreciation			
average	-.0318 (-2.70)	-65.17 (-1.74)	.05
standard deviation	.0996 (7.14)	30.94 (.69)	.00
Labor and management income (In $10,000)			
average	1.535 (6.65)	-292.0 (-.83)	.02
standard deviation	1.687 (16.05)	-350.4 (-2.19)	.09
	---- At $15,000 Annual Income ----		
Rate of return on equity			
average	.0260 (2.66)	-67.69 (-1.81)	.05
standard deviation	.0646 (7.44)	21.1 (.64)	.00
Rate of return on equity without appreciation			
average	-.0319 (-2.70)	-75.8 (-1.67)	.04
standard deviation	.0982 (7.12)	58.3 (1.10)	.01
Labor and management income (In $10,000)			
average	1.557 (6.90)	-652.5 (-1.40)	.02
standard deviation	1.643 (14.91)	-120.1 (-.53)	.00

*t-statistics are in parenthesis. The critical value of $\alpha = .10$ is 1.69 under the null hypothesize that the estimated coefficient is positive.

The estimated relationships between risk preference and the standard deviations appear to be insignificant rather than negative as hypothesized.

If risk preferring or less risk averse farmers manage the farm so that higher average returns are generated, it does not appear that the standard deviations or variability of those returns are necessarily increased.

In fact, as shown in Table 4, there is a definite negative linear relationship between the average rate of return on equity and the standard deviation. This group of farmers who managed to generate high average return rates in the process also reduced the variability of those return rates as measured by the standard deviation.

Table 4. Linear Relationship between Standard Deviations and Averages of Three Performance Variables on 41 Dairy Farms

Dependent Variable	Intercept	Slope (Average)	$\bar{R}^2$
Rate of return (standard deviation)	.0732 (8.85)*	-.334 (-2.64)	.13
Rate of return without appreciation (standard deviation)	.0819 (6.13)	-.546 (-3.38)	.21
Labor and management income (In $10,000) (standard deviation)	1.288 (9.36)	.230 (3.43)	.21

* t-statistics are in parenthesis. The critical value for $\alpha = .05$ is 1.69 under the null hypothesize that the estimated coefficient is equal to zero.

Although not verified, one explanation for this relationship may be the selection of a debt leverage ratio which can have an enormous impact on rates of return to equity. As shown by Kauffman and Tauer, the optimal leverage ratio for dairy farms varied considerably over this 10 year period at a rate of adjustment beyond the operational ability of farmers (at least to decrease leverage). Farmers with either an extremely high or low leverage ratio saw large variability in their rates of return to equity as real interest rates

ranged from negative values to unprecedented highs, yet their average return over the period may have been mediocre. In contrast, farmers with medium leverage ratios experienced less variable and higher return to equity rates.

The linear relationship between the average labor and management income and the standard deviation is positive and significant, reflecting the fact that farmers with higher incomes also tend to experience more variability in those incomes. Table 3 also shows that risk averse farmers not only have lower incomes, but also less variable incomes, although only one of the two coefficients are statistically significant.

Using the results at $30,000 annual income (which includes ownership as well as labor and management income) in Table 3, a risk neutral farmer would expect labor and management income of $15,350, with risk as measured by standard deviation of $16,870. A moderately risk averse farmer with an absolute risk aversion coefficent of .00035 (Group 5) would expect labor and management income to be lowered to $14,328 but risk (standard deviation) also lowered to $15,642. The trade-off between income and risk for these dairy farmers can be readily obtained from the linear relationship shown in Table 4. In order to obtain another $1,000 of income the farmer must be willing to assume another $2,300 in standard deviation in his or her income.

Summary and Conclusions

This article measures the relationship between risk preferences and long-run performance of a dairy farm. It is generally believed that greater aversion to risk leads to farm decisions that results in lower but more stable return or income. That belief is generally supported by the evidence in this paper although the role of risk preferences on average return and variability of return appears to be minor.

Of a group of dairy farmers that successfully completed a risk preference survey in 1983, 41 were found to have participated in the New York farm business summary each of 10 years from 1974 through 1983. The risk survey and the 10 years of summary records provided the data for this study.

The farmers' Pratt-Arrow absolute risk aversion coefficient was used as their measure of risk aversion. This had been measured using the interval approach (stochastic dominance with respect to a function). The farm record data were used to compute the average rate of return to equity with and without appreciation from the 10 years of annual data, as well as the standard deviation. An average labor and management income and standard deviation were also computed.

Linear regressions of average returns and income on risk coefficients produced a negative relationship, supporting the hypothesis that aversion to risk results in lower returns and income. Regression of standard deviation of returns on risk preference produced a positive rather than negative relationship, although the relationship with the income standard deviation was negative as expected. An explanation is that farmers with high average return rates experienced reduced variability in those rates over the 10 year period. This may have been due to the extreme range in interest rates during the period which lead to low averages but high standard deviations for highly or non-leveraged farmers.

References

Anderson, Jock R., John L. Dillon and Brian Hardaker. Agricultural Decision Analysis. Ames: Iowa State University Press. 1977.

Binswanger, Hans P. "Attitudes Towards Risk: Experimental Measurement in Rural India." American Journal of Agricultural Economics 62(1980): 395-407.

Boehlje, Michael D. and Larry Trede. "Risk Management in Agriculture." Journal of the American Society of Farm Managers and Rural Appraisers 41(1977):20-29.

Halter, A. N. and R. Mason. "Utility Measurement for Those Who Need to Know." Western Journal of Agricultural Economics 3(1978):99-109.

Kauffman, Jonas and Loren Tauer. "Successful Dairy Farm Debt Management Strategies." Paper presented at the American Agricultural Economics Association Meetings, Iowa State University, Ames, Iowa, August 4-7, 1985.

King, Rob P. and Lindon J. Robison. "Implementation of the Interval Approach to the Measurement of Decision Maker Preferences." Michigan State Agr. Exp. Sta. Res. Rpt. 418, 1981.

Ramaratnam, S. Sri, David A. Bessler and M. Edward Rister. "The Temporal Nature and 'Interdependence' of Agricultural Producers' Risk Attitudes and Subjective Beliefs: A Texas Example." Paper presented at the American Agricultural Economics Association Meetings, Cornell University, Ithaca, New York, August 5-8, 1984.

Smith, Stuart F. and Linda D. Putnam. "Dairy Farm Management Business Summary: New York, 1983." A.E. Res. 84-10, Dept. of Ag. Econ., Cornell University, 1984.

Tauer, Loren W. "Risk Preferences of Dairy Farmers." North Central Journal of Agricultural Economics 8(1986):7-15.

Wilson, Paul N. and Vernon R. Eidman. "An Empirical Test of the Interval Approach for Estimating Risk Preferences." Western Journal of Agricultural Economics 8(1983):1970-82.

Young, Douglas, William Lin, Rulon Pope, Lindon Robison, and Roger Selley. "Risk Preferences of Agricultural Producers: Their Measurement and Use." In Risk Management in Agriculture: Behavorial, Managerial, and Policy Issues. Univ. of Illinois, AE-4478, July 1979, pp. 1-28.