THE EFFICIENCY OF THE FAMILY DAIRY FARM OVER ITS LIFE CYCLE

Loren W. Tauer

ABSTRACT

This paper presents empirical measures of the efficiency of the New York family dairy farm over its life cycle. The increase and then decrease in farm efficiency with age is only minor. Factors not correlated with age are much more important in determining efficiency. Exiting farmers who appear not to have children to take over the family farm are managing and maintaining the farm as well as exiting farmers who have potential future farming children.

INTRODUCTION

The life cycle of the family farm has been presented and discussed in various publications and articles (Brake and Wirth, Thomas and Boehlje). It is based on the fact that farming is characterized by an individual entrepreneur rather than a management team. Thus, the farm firm frequently exhibits a life cycle that parallels the life cycle of the entrepreneur. The farmer-entrepreneur and his farm will pass through at least three stages during his farming career. These have been referred to as the entry stage, the growth stage, and the exit stage (Boehlje). One publication implies in a graph that entry and low efficiency typically occurs between ages 20 to 25, peak efficiency is reached somewhere between the ages of 35 to 50, and disinvestment and low efficiency occurs between the ages of 60 to 70 (Harl). Yet, very little empirical evidence has been presented to determine or measure the efficiency of the family farm over its life cycle. Although many of us can recall at least one family farm where the farm operation deteriorated as the entrepreneur aged, we can also recall situations where the farm continued to prosper. The purpose of this paper is to present some empirical measures of efficiency of the New York family dairy farm over its life cycle.

The farmer in the entry stage might display low but increasing efficiency. The beginning and usually young entrepreneur will make management errors because of inexperience, although he may have better technical training than the experienced farmer. The farm unit will also generally be small and of insufficient size to enjoy any economies of size that may exist (Madden). During the growth stage the entrepreneur may display improved managerial ability as his experience grows. The farm unit also becomes larger and unit costs may decrease. These factors may lead to increased efficiency.

During the exit stage efficiency may fall. Obviously, the physical capacity of the entrepreneur will be diminishing at this time. However, in today's capital intensive agriculture, physical strength and even endurance is not as important as it once was. The farmer may voluntarily slow down, often with encouragement from his spouse, realizing he can afford any resultant decrease in efficiency. The farmer may also become more conservative in his decision making, resulting in lower risk but also lower return actions. Another factor leading to lower efficiency may be that the planning horizon of the entrepreneur close to retirement is shortening. The shrinking planning horizon will discourage the entrepreneur from making the investments and business changes necessary to ensure the survival or viability of the operation beyond his retirement. Long-term and intermediate-term assets may not be replaced to maintain the efficiency of the farm beyond the planning horizon. Also, if economies of size require a successively larger farm over time, the older farmer may not make the required size increase because of reluctancy to assume new debt commitments, work harder, or hire labor.

A number of factors may negate or eliminate any reduction in efficiency during the exit stage. The planning horizon of the farmer may extend beyond his retirement date. He may have a child who will take over the family farm and wants to insure that the child will receive a viable, competitive farm when he retires. Whether or not a child will operate the family farm, the entrepreneur may realize that the sale or rental value of the farm at his retirement will depend on its value as a viable farm. However, since many farms are not transferred as a complete unit or are used for an entirely different enterprise, the full economic value of investments may not be realized at retirement.

EVIDENCE FROM THE AGRICULTURE CENSUS DATA

The 1978 Census of Agriculture provides a summary description of farmers in New York by age group. Some characteristics of New York farmers under age 65 whose principal occupation is farming are listed in Table 1. Farmers whose major occupation is not farming were excluded to eliminate hobby farmers and part-time farmers. Farmers over age 65 were excluded because, although farming may be their major occupation, many are retired and collecting social security.

The number of dairy farms in each age group can be compared to the expected number of dairy farms in each age group, where the expected number is the number of farms by age group, divided by total farms, multiplied by the total number of dairy farms. For example, the expected number of dairy farms in age groups 45-54 is 6,413 divided by 22,195 multiplied by 13,242 or 3,827. A chi-square test indicates that there is a statistically significant difference between age and the number of dairy farms. Fewer dairy farmers are under 25, and 55 to 64 than would be expected. Although not shown in Table 1, statistically more of the older farmers are general livestock, beef, field crop, and fruit farmers. More of the

---

The author is Assistant Professor, Department of Agricultural Economics, Cornell University.

The author wishes to thank John R. Brake and George L. Casler for their comments.

Table 1: Characteristics of New York Farmers under Age 65 Whose Principal Occupation is Farming

Characteristic	Age under 25	25-34	35-44	45-54	55-64
Farms	604	3,392	5,028	6,413	6,758
Dairy farms	313	2,189	3,209	4,007	3,524
Expected	358	2,026	3,006	3,827	4,026
Difference	-45	163	203	180	-502
				$x^2 = 103.5$*	
Farms with 1-4 cows	20	63	116	149	253
Expected	14	99	146	182	160
Difference	6	-36	-30	-33	93
				$x^2 = 81.9$*	
Sole proprietors	534	2,866	4,353	5,376	5,473
Expected	502	2,846	4,223	5,376	5,655
Difference	32	20	130	0	-182
				$x^2 = 12.0$*	
Live on farm	442	2,829	4,322	5,720	5,959
Expected	520	2,949	4,375	5,570	5,859
Difference	-78	-120	-53	150	100
				$x^2 = 35.0$*	
No off-farm work	373	2,289	3,480	4,541	4,903
Expected	421	2,385	3,538	4,504	4,738
Difference	-48	-96	-58	37	165
				$x^2 = 16.3$*	
Female operators	17	120	253	359	395
Expected	31	175	260	331	348
Difference	-14	-55	-7	28	47
				$x^2 = 32.5$*	
Part owner	388	2,762	4,690	6,178	6,592
Expected	556	3,153	4,678	5,956	6,265
Difference	-168	-391	12	222	327
				$x^2 = 124.6$*	
Full owner	159	1,049	1,913	2,738	3,644
Expected	257	1,454	2,157	2,746	2,889
Difference	-98	-405	-244	-8	755
				$x^2 = 375.1$*	

Source: 1978 Census of Agriculture.

*Significantly different at the .10 level or less.

younger farmers are cash grain and field crop farmers.

The 1974 Agricultural Census also indicates statistically fewer dairy farmers than expected in the 55-64 age group, but the number of dairy farmers in the under 25 age group is within expectations. Thus from 1974 to 1978, more younger farmers than normal have become crop farmers. It appears that many older farmers continually leave the dairy business and shift to other farm enterprises. This shift may diminish their efficiency if they move to an enterprise in which they are inexperienced. It is highly unlikely, however, that they would shift to an enterprise in which they did not have prior, although possibly limited experience.

Because the remaining data represent all types of farms, and a disproportionately larger number of dairy farmers are in the middle age groups, any remaining conclusions reached must pertain to farms in general and not specifically to dairy farms. A smaller number of the older farmers are sole proprietors than would be expected. More are involved in partnerships and corporations. The census data may be misleading in this regard, however, since any junior partners involved in these partnerships are not included in the lower age groups because the principal partner completes the census form. A larger proportion of the older farmers than expected live on the farm that they operate and more of them report no off-farm work. A larger proportion of the older operators are women, reflecting the higher mortality rate of men. Finally, as expected, there is a positive relationship between age and part or full ownership of the farm.

Some average measures of efficiency from the census data can be computed. Any differences between age groups cannot be statistically tested, however, because no sample standard deviations are published. Although some may view the census data as the population, and thus differences can be ascertained without statistical testing, the data should be more correctly viewed as a sample drawn at a point in time. Estimating a functional relationship between the variables and age using group data was ruled out because there were only 5 age groups.

Visual inspection of the sample in Table 2 shows that farm size and value increases up to the age group 45 to 54 and then decreases. Cows per farm increases to age group 35 to 44 and then decreases. The lower cows per farm in the extreme age groups could be the result of some families having just one family milk cow. This is surmised since a higher proportion of the younger and older farmers have only 1 to 4 cows on the farm (Table 1). Milk receipts per cow peak at the 35 to 44 age group of the sample. Of course, if the extreme age groups tend to have more families with just a house cow, that milk production is not included in milk receipts, thus lowering milk receipts per cow. Total crop and livestock receipts per crop acre peak at age 45 to 54 of the sample. This could be an indication of an efficiency peak but could also be a reflection of farm enterprise selection. There appears to be a peak in alfalfa and grass yield per acre at the

Table 2: Selected Measures of Efficiency for New York Farmers under Age 65 Whose Principal Occupation is Farming

Measure	Age				
	under 25	25-34	35-44	45-54	55-64
Farm size (acre)	217	282	319	321	280
Farm value ($)	143,694	178,151	204,360	214,686	174,232
Cows per farm	44	55	60	59	56
Milk receipts per cow ($)	1,082	1,176	1,223	1,201	1,175
Total receipts per crop acre ($)	274	339	363	376	353
Alfalfa yield per acre (ton)	2.33	2.42	2.54	2.54	2.43
Grass yield per acre wet (ton)	5.26	4.68	4.94	5.21	5.14
Corn yield per acre (bu.)	80	88	87	87	87

Source: 1978 Census of Agriculture

*Differences between the age groups could not be statistically tested because no sample standard deviations were available.

45 to 54 age group, although the under 25 age group has the highest grass yield. Corn yield appears to be flat over the age groups except for the under 25 age group.

EVIDENCE FROM FARM BUSINESS SUMMARY DATA

The 1980 New York Dairy Farm Business Summary data (Smith) were used to examine the relationship between age and measures of size, efficiency, and future viability. Although the data are cross sectional, any change in efficiency because of age should be manifested. Only sole proprietors who had less than 12 months of paid or unpaid family labor were included in the analysis. This eliminated partnerships and sole proprietorships that may have family partnership characteristics. There were 349 observations.

Using farm business summary data is not without problems. Participation in the summary is voluntary which may lead to biases. Participants in the summary may have above average managerial ability, based upon the assumption that participation in the summary is an indication of good management, and on the fact that average milk production per cow and other efficiency measures of the summary participants tend to be higher than the state average (Dunne). However, survey data may have the same inherent bias problems as farm business summary data, especially when the survey response rate is low. Completing a survey requires initiative on behalf of the respondent. The same initiative that motivates a survey recipient to respond may motivate that individual to complete a farm business summary. Even if the summary participants are good managers, their efficiency may improve or deteriorate with age. A beginning operator with good management skills may increase his efficiency over time. Likewise, after a peak in efficiency a good manager may have a decrease in efficiency. But, farmers experiencing major decreases in efficiency may drop out of the summary in midcareer, leaving higher efficiency farmers, which would be displayed as a smaller reduction or even an increase in efficiency with age.

A number of farm variables were regressed on age using linear, quadratic, and cubic functions. A linear function allows either a level, increasing, or decreasing relationship. A quadratic function allows an increasing and then decreasing relationship, or vice versa. A cubic function allows the initial increasing relationship to occur at an increasing rate. Obviously, numerous variables affect efficiency, but if those variables are correlated with age, such as, possibly, management skills or farm size, the estimated age coefficient will be biased to reflect that correlation. Homoscedasticity was confirmed by visual inspection of residuals.

Many of the linear functions were statistically significant (Table 3). Fewer of the quadratic functions were statistically significant (Table 4). Since few of the cubic equations were statistically significant, and the ones that were closely approximated their quadratic counterpart, they are not listed. Even when the functional relationship was statistically significant, in most cases age explained only 2 percent of the variation in the dependent variable. Hence, other factors not correlated with age are relatively more important in explaining efficiency.

There is a statistically significant relationship between cows per farm and age. The linear function shows that cows per farm increase with age, but the quadratic function indicates that numbers increase to age 50 where the average farm has 74 cows and then numbers decrease to 63 cows at age 65 (Table 5). If economies of size exist, the middle age group should be able to exploit them. The younger farmers are probably restricted by capital constraints in reaching the larger herd size. It is assumed that the older farmers have either decreased their cow numbers or have never reached the large size because of their own management decision, and not because of capital restrictions.

There is no apparent relationship between age and either farm assets per man or farm assets per cow. So, although a change in cow numbers occurs with age, that change occurs with the necessary changes in assets. However, there is a relationship between age and labor efficiency. Cows per man reaches a peak of 29 between ages 30 to 40, and milk per man reaches a peak of 415,905 pounds at age 40. Both decrease substantially after age 40. No relationship was established between age and milk production per cow--a common measure of efficiency in dairy farming.

Forage yield per acre (all forage on a dry matter basis) also exhibits a strong increase and then a decrease with age. However, there is no relationship between feed cost per 100 pounds of milk produced, which includes the cost of producing and purchasing feed, and age. This indicates that farmers probably acquire more productive crop land as they age, yet the younger farmers are cost efficient in their use of less productive land. Older farmers may relinquish control of high quality cropland, or they may be less yield efficient in the acreage they retain, yet they still appear to be cost efficient. However although not significant, the feed cost equations do exhibit an increase in cost at the higher ages which could be a reflection of lower yields at the higher ages.

It is interesting that both return to assets and return to equity first decrease and then increase with age. Since return on equity is lower than return to assets at all age levels, the cost of debt exceeds the earning from debt. The relatively high interest rates of 1980 directly affected returns to equity but not returns to assets. (The rate of interest, however, may influence the amount of assets used in the business.) The middle aged farmers had the largest differential between return on assets and return to equity, reflecting their greater use of debt.

It may appear that the younger and older farmers are more efficient in the use of assets as compared to their less efficient use of labor. However, what could be occurring is that the younger farmer is constrained by his use of capital but not his labor, resulting in greater returns to capital and lower returns to labor. The older farmer may not be constrained by either; he can hire labor or borrow, but he uses capital relatively more efficiently than labor. The

Table 3: Linear Regression of Selected Dairy Farm Variables on Age

Dependent Variable	Intercept Coefficient	Age Coefficient	F Value	R^2
Cows per farm	47.31 (4.54)*	.5040 (2.03)*	4.10*	.01
Farm assets per man	185,606.1 (13.36)*	-288.3 (-.87)	.76	.00
Farm assets per cow	5,758.7 (14.28)*	10.8 (1.12)	1.25	.00
Cows per man	31.62 (16.87)*	-.0760 (-1.70)*	2.89*	.01
Milk per man	456,436.9 (15.04)*	-1278.6 (-1.77)	3.12*	.01
Milk per cow	14439. (27.92)*	-7.280 (-0.59)	.35	.00
Forage yield per acre	2.455 (10.09)*	.0152 (2.61)*	6.82*	.02
Feed cost per 100 lbs. milk	4.51 (18.37)*	.0002 (.04)	0	.00
Return on assets	.17175 (12.41)*	-.00076 (-2.29)*	5.25*	.02
Return on equity	.17350 (5.14)*	-.00177 (-2.19)*	4.81*	.01
Labor, management, and ownership income per cow	607.5 (6.34)*	1.700 (.74)	.55	.00
New machinery per cow	310.0 (7.62)*	-1.861 (-1.92)*	3.67*	.01
New real estate per cow	513.5 (4.15)*	-7.51 (-2.55)*	6.48*	.02

Student t values are in parentheses.

*Significantly different from zero at the .10 level or less.

Table 4: Quadratic Regression of Selected Dairy Farm Variables on Age

Dependent Variable	Intercept Coefficient	Age Coefficient	Age Squared Coefficient	F Value	R^2
Cows per farm	-31.0 (-.80)	4.3315 (2.35)*	-.04446 (-2.10)*	4.27*	.02
Farm assets per man	124,929.8 (2.41)*	2678.0 (1.09)	-34.45 (-1.21)	1.12	.01
Farm assets per cow	6,148.1 (4.08)*	-8.3 (-.12)	.22 (.27)	.66	.00
Cows per man	19.31 (2.77)*	.5261 (1.59)	-.0070 (-1.83)*	3.13*	.02
Milk per man	230,426. (2.04)*	9770.483 (1.82)*	-128.3374 (-2.08)*	3.74*	.02
Milk per cow	12447.2 (6.45)*	90.1148 (.98)	-1.13126 (-1.07)	.75	.00
Forage yield per acre	.6056 (.67)	.105587 (2.46)*	-.001050 (-2.12)*	5.70*	.03
Feed cost per 100 lbs. milk	5.85 (6.38)*	-.06485 (-1.49)	.000756 (1.51)	1.14	.01
Return on assets	.2357 (4.56)*	-.0039 (-1.58)	.00004 (1.29)	3.46*	.02
Return on equity	.41491 (3.30)*	-.01357 (-2.27)*	.000137 (1.99)*	4.42*	.02
Labor, management, and ownership income per cow	1073.0 (3.00)*	-21.0576 (1.24)	.26432 (1.35)	1.19	.01
New machinery per cow	458.41 (3.02)*	-9.1166 (-1.26)	.08427 (1.01)	2.35*	.01
New real estate per cow	582.25 (1.26)	-10.8679 (-.49)	.03903 (.15)	3.24*	.02

Student t values are in parenthesis.

*Significantly different from zero at the .10 level or less.

Table 5: Values of Selected Dairy Farm Variables as a Function of Age

Variable	Function	Age 25	30	40	50	60	65
Cows per farm	linear	60	62	67	73	78	80
	quadratic	50	59	71	74	69	63
Cows per man	linear	30	29	29	28	27	27
	quadratic	28	29	29	28	26	24
Milk per man (lbs.)	linear	424,472	418,079	405,293	392,507	379,721	373,328
	quatratic	394,477	408,037	415,905	398,107	354,640	323,282
Forage yield per acre (ton)	linear	2.84	2.91	3.06	3.22	3.37	3.44
	quadratic	2.60	2.83	3.15	3.26	3.16	3.03
Return on assets (%)	linear	15.28	14.90	14.14	13.38	12.62	12.24
	quadratic	16.32	15.47	14.37	14.07	14.57	15.12
Return on equity (%)	linear	12.93	12.04	10.27	8.50	6.73	5.85
	quadratic	16.13	13.11	9.13	7.89	9.39	11.17
New machinery per cow ($)	linear	263	254	236	217	198	189
	quadratic	283	261	229	213	215	222
New real estate per cow ($)	linear	326	288	213	138	63	25
	quadratic	335	291	210	136	71	41

allocation or management of labor and capital by age, however, does not appear to affect the labor, management, and ownership income per cow; there is no significant difference with age.

A negative relationship exists between age and both new machinery per cow and new real estate per cow, although the quadratic equation suggests that new machinery per cow increases slightly in the later years. Of course, an increase in cow numbers permits the middle age farmers to spread new investments over more cows leading to a reduction in investment per cow. However, although not shown, there was also a negative relationship between total new investment and age. The reduction in new real estate per cow with age is simply the result of younger farmers purchasing real estate instead of renting. A high new machinery per cow at low ages also indicates that these farmers are building up their machinery complement. The fact that the older farmers are making substantial machinery purchases dispels any idea that they may not be replacing and upgrading their machinery as they reach retirement age.

The farm business data that were used in the analysis excluded farms that had more than 11 months of paid or unpaid family help. However, older farmers who have children who are waiting to take over the family farm may make different business decisions and have higher efficiencies. than farmers without children available to continue the business. In order to test this hypothesis, farmers (sole proprietors) who were over 50 years of age were separated into 2 groups. The first group had family paid or unpaid labor of 12 months or more. Some of this family labor may be provided by spouses, but it was assumed that the majority was provided by children. The second group had family paid or unpaid labor of less than 12 months. This group may have had some family labor but since family labor was less than 12 months, it was assumed that these children were not being groomed for or interested in taking over the family farm. The total sample size was 94 farms.

Statistical comparisons of the two subsamples were performed by analysis of variance using the same independent variables as were used in the regression analysis. Only three variables were significantly different at the 10 percent level. Farm assets per man were $168,091 with no major family help, $144,109 with major family help. Cows per man were 27 with no major family help and 23 with major family help. Milk per man was 374,637 pounds with no major family help, 333,161 pounds with family help. None of the other measures of efficiency were significantly different. Thus, because the farms with major family help had more labor, the variables that were measured on a man basis were lower, but the

other efficiency variables were not any different. Dividing the sample differently, into farmers who had any family help and those who did not have any family help at all produced similar results. Thus it must be concluded that efficiency was not noticeably different between those families that had potential future farmers compared to those families that did not.

CONCLUSION

This paper looked at Agricultural Census Data and Farm Business Summary Data to see if efficiency varied over the life cycle of the New York family dairy farm. The evidence supports the existence of different efficiencies over the life cycle, but the increase and then decrease in efficiency with age is only minor. Other factors are much more important than age in determining efficiency. Also, older farmers who appear not to have children to take over the family farm are managing and maintaining the farm as well as those older farmers who do have children who might take over the family farm.

The implication is that the farm family in general does not have to be overly concerned about coordinating the exit and entry of the older and younger farmer in order to maintain the efficiency of the family farm. Reasons other than efficiency must exist before the multigenerational family dairy farm should be established. The absence of major changes in efficiency over the life cycle also dispels any concern that policy makers may have concerning any change in the age structure in farming and productivity.

REFERENCES

Boehlje, Michael, "The Entry-Growth-Exit Processes in Agriculture," Southern Journal of Agricultural Economics, July 1973, pp. 23-36.

Brake, J. R. and M. E. Wirth, "The Michigan Farm Credit Panel: A History of Capital Accumulation," Michigan State University Agri. Exp. Sta. Res. Report 25, East Lansing, Michigan, 1964.

Dunne, James F., "Estimating the Use Value of Agricultural Land for Farm Assessments in New York State," Ph.D. Dissertation, Dept. of Ag. Econ., Cornell University, 1981.

Harl, Neil E., Farm Estate and Business Planning, Skokie, Illinois, Century Communications Inc., 1982 (Seventh Edition).

Madden, J. Patrick, "Economies of Size in Farming: Theory, Analytical Procedures, and a Review of Selected Studies." AER-107, U.S. Dept. Agr., Econ. Res. Serv., February 1967.

Smith, Stuart F., "1980 Dairy Farm Business Summary for New York," A.E. Res. 81-10, Dept. of Ag. Econ., Cornell University, September 1981.

Thomas, Kenneth H. and Michael D. Boehlje, "Farm Business Arrangements: Which One For You?" North Central Regional Extension Publication 50, 1976.

U.S. Depatment of Commerce, Bureau of the Census, 1978 Census of Agriculture, Volume 1, Part 32, April 1981.