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THE EFFICIENCY OF THE FARMER AT VARIOUS AGES

by

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Abstract

A farm production function was estimated to determine if successive increases in age have an impact on efficiency. Results indicate that farmers under age 25 operate on a different production function than do older farmers. The younger farmers are less efficient in the use of all inputs except real estate.

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The family farm has typically been created and later dissolved with each new entrant into farming. During his farming career the entrepreneur and his farm pass through at least three stages: the entry stage, the growth stage, and the exit stage. Research on the life cycle of the family farm implies that the entry stage entails low efficiency, mid-career brings a peak in efficiency, and old age brings a decrease in efficiency (Boehlje). Yet, very little empirical evidence has been presented to determine or measure the efficiency of a farmer over his lifetime. This article presents empirical estimates of production function for farmers of various ages to determine if the efficiency of a farmer does change with age.

The farmer in the entry and growth stages might display increasing efficiency with improved managerial ability and increased farm unit size. Efficiency may fall later in life because of diminishing physical capacity of the operator, more conservative decisions and actions, voluntary slow down, a shortened planning horizon, and reluctancy to expand even if new technology requires a successively larger farm unit over time. Mitigating these conditions is the desire by many older operators to maximize their retirement income from the sale or rental income of their farm and to leave a viable farm business to their heirs.

The age distribution of farmers has attracted the attention of researchers, particularly when a completed census indicated that there may be an insufficient number of young farmers to replace older farmers (Clawson). Kanel looked at the average size and gross farm income by age cohort using 1950 and 1959 census data. He attributed differences between cohorts to two causes. One cause is based on factors such as changes in technology and economic conditions favoring increases in farm size which affects all age groups. The second cause is the life-cycle pattern with increasing farm size in the earlier stages and decreasing size in the later stages of a farmer's career. Earlier studies based on survey data also found a cyclical relationship between the age of farmers and size of the farm, use of some inputs, and output (Long; Heady, Back, and Peterson). These studies covered an era when farming was more labor intensive then it is presently and hence the physical capacity of the operator was more important. Recently, Tauer used dairy farm business summary data to look at efficiency measures as a function of age. He concluded that some efficiency measures, particularly labor measures, exhibited a life-cycle pattern, but that age explained very little of the differences in efficiency from farm to farm.

Researchers have estimated farm production functions to ascertain the return to factors such as education (Furtan and Bollman), racial differences (Huffman), and research expenditures (Bredahl and Peterson). These studies generally used county or regional census data to construct an average farm for each region, and then used these data to fit farm-level production functions. None explicitly included age in the estimated function. Griliches implicitly entered age as an input into the production function by reducing operator labor input by up to 60 percent if the operator was over 65 years of age.

Empirical Data

To examine the hypothesis that successive increases in age do have an important impact on production efficiency, a farm-level Cobb-Douglas production function was estimated using data from the 1978 Census of Agriculture. For each state, data from operators who indicated that their major occupation is farming are summarized by age of the operator into six age intervals. These are: under 25 years of age, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, and 65 years of age and older. These data were used to construct an average farm for each state for each age group. Since the published aggregates are arithmetic rather than geometric sums, the computed averages are also arithmetic, although geometric averages are more appropriate for a Cobb-Douglas function (Moroney). Only farmers who indicated farming as their major occupation were used, thus eliminating hobby and recreational farmers. Observations from Alaska, Hawaii, and Rhode Island were not used because of insufficient numbers.

Researchers have augmented census data with other data sources for a more concise measure of the variables (Huffman). However, for this study, the census was the only data source available where data were differentiated by age of the operator. The typical assumptions of profit maximization, random disturbances of output due to weather, and no omitted variables are made.

Unfortunately, the data include partnerships and corporations as well as sole proprietorships. Since only the age of the principal operator is recorded, it is not known in what age categories parentchild businesses might be located. Since the percentage of multi-owner businesses does not differ significantly by age (Table 1), it is assumed that there is no bias by age interval.

Table 1. Farm Operators by Age Groups Whose Major Occupation is Farming, United States Census, 1978

Age of Operator	Number of Farm Operators	Partnerships or Corporations	Percent of Total as Partnerships or Corporations
Under 25	47,825	7,277	15.2
25-34	156,196	27,555	17.6
35-44	200,188	30,331	15.2
45-54	288,276	44,750	15.5
55-64	346,770	53,205	15.3
Over 65	286,098	32,943	11.5
Total	1,325,353	196,061	14.8

The dependent variable used for the regression analysis (y) was the sum of the market value of agricultural products sold plus income from machine work, custom work, and other agricultural services. The value of home-consumed products was not available by age group. It is possible that older operators have larger families leading to greater consumption, or that older operators produce more of their own consumption compared to younger operators. However, the median home consumption for the 50 states in 1978 was only .9 percent of total farm receipts (this includes home consumption by part-time farmers) so any slight difference by age should have little influence on the results (USDA, 1980).

The independent variables included the average value of land and buildings per farm (x_1). This is a stock rather than a flow variable. This variable was used rather than acres to incorporate a quality as well as a quantity measure of land, and to include the value of livestock buildings. Likewise, the estimated value of all machinery and equipment was used as a variable (x_2). Some selected machinery and equipment data are available, but they are not concise enough to impute rental values.

Farm production expenses were grouped into categories to reduce multicollinearity. Grouped together as livestock expenses (x_3) were livestock and poultry purchases, feed for livestock and poultry, and animal health costs. These items would be expected to be complements and thus highly correlated. Grouped as crop expenses (x_4) were fertilizer, chemicals including lime, and seed, bulb, plant, and tree purchases. All energy and petroleum expenses (x_5) were treated as one variable because of their high degree of substitutability. Grouped together as hired labor and custom expenses (x_6) were hired farm labor, contract labor, and custom work hired.

No family labor data were available unless the family labor was paid a wage, in which case it would be included as labor expense. The only data on operator labor are the number of days of work off the farm grouped by number of respondents into 4 categories of none, 1 to 99 days, 100 to 199 days, and 200 days or more. An average composite of days worked off the farm (x_7) was compiled by weighting the number of respondents in each of the four groups by their respective means; 0 days, 50 days, 150 days, and 250 days, and then dividing by the total number of respondents. The estimated coefficient for this variable should be negative, reflecting the opportunity cost of working off the farm. There was no objective way to derive a measure of operator labor input from these data.

Emprirical Results

A Cobb-Douglas function in log linear form was fitted to the 252 observations (47 states x 6 age groups) by ordinary least squares. Five dummy variables were introduced to allow the intercept and the input coefficients to vary for each of the six age groups. The resultant model consisted of 47 variables and an intercept. Heteroskedasticity existed since the grouped data had unequal numbers, but was not considered severe. A second model was fitted using all input variables and selected dummy intercepts and dummy slope variables. The selection was based on the t ratios of the first equation, using a significance level of 10 percent.

The coeffcients of the second equation are shown in Table 2. The null hypothesis that the variables included in the first equation but excluded in the second equation were jointly equal to zero was tested (Kmenta, p. 370). The computed F value was .64, so the null hypothesis could not be rejected. The second equation indicates that younger farmers, under age 25, operate on a different production function than older farmers. Surprisingly, farmers over age 64 are not shown to be on a different production function than farmers 25 to 64 years of age.

The marginal products at the means of the inputs for farmers over and under age 25 are shown in Table 3. The marginal product of real

Table 2. Regression Coefficients of Cobb-Douglas Agricultural Production Function, Census Data, 1978

Input	Estimated Coefficient	t values $Ho:B_1 = 0$
Real Estate (inventory)	.037	1.78
D25 * Real Estate	.256	5.84
Machinery (inventory)	.248	5.79
D25 * Machinery	-.748	-10.42
Livestock	.299	19.60
D25 * Livestock	-.172	-6.06
Crop	.186	9.10
Energy	.136	3.02
Hired Labor and Custom	.197	10.71
Off-Farm Work	-.040	-1.85
Intercept	.709	2.71
D25	6.255	9.41
R^2 = .96		

estate is higher for the younger farmers than the older farmers, but the marginal product of machinery inventory is lower for the younger farmers, which is negative. Farmers under age 25 undoubtedly are more restricted than older farmers in their ability to acquire or obtain access to land, leading to a higher marginal product for real estate. A 1 percent marginal product (gross) per unit value of real estate for older farmers may appear low, but the computed average product (gross) of 18 percent is much higher than the long-run current return (net) of

4 percent that had been previously calculated on productive assets (Melichar). The fact that the marginal product is only 1 percent should not be surprising when it is realized that this return includes only current return and no capital appreciation. Since capital appreciation of farm real estate in itself was often greater than the cost of owning real estate during the late 1970s, farmers may have purchased additional real estate to the point where the marginal product of current return was close to zero. It is also not surprising that younger farmers who might be constrained in acquiring farmland experienced negative marginal products of additional machinery ownership. Their machinery to real estate ratio may simply have been too high.

Table 3. Marginal Products of Inputs, 1978

	Geometric Mean	Marginal Products	
		Farmer under age 25	Farmer over age 25
Real Estate (inventory)	$328,641	$ .05	$ .01
Machinery (inventory)	41,817	-.62	.34
Livestock	14,957	.45	1.16
Crop	6,320	1.57	1.71
Energy	3,534	2.05	2.23
Hired Labor and Custom	5,016	2.10	2.28
Off-Farm Work	34 days	-62.77	-68.27

The computed marginal products of the other inputs are also lower for the younger farmers, especially the marginal product of livestock expenditures. The lower marginal product, however, may be the result of a deficiency in the data. The dependent variable, sales and miscellaneous income, was not adjusted for inventory changes because inventory levels were not available by age group. Initially it was believed that this omission would not create substantial problems because inventory changes should balance out on a state basis for the average of each age group. Even if average inventory changes did not equal zero, it was not expected that any age group would display an inventory change significantly different from any other age group. This may not be the case for farmers under age 25 who are building their breeding livestock inventory by reducing sales relative to their livestock expenses. Any reduced sales resulting from building livestock inventory will bias the marginal products of the other inputs, including real estate and machinery, because this increase in value is not reflected in cash sales.

If available, the inclusion of inventory changes could have led to the conclusion that the production function of the under 25 age group is not subtantially different than for the over 25 age groups. However, the fact that the marginal product of real estate is so much higher and the marginal product of machinery so much lower for the under 25 year age group, makes it difficult to imagine that the inclusion of livestock inventory would significantly alter that relationship. It can be concluded that the under 25 age group does operate on a different production function than older farmers, although it is impossible to ascertain the true coefficients of that production function.

It is interesting that an additional day of off-farm work for the older farmer will reduce agricultural gross revenue by $68. Since this is gross rather than net revenue, the opportunity cost of off-farm work at the margin is something less than $68 a day, or for an 8-hour day, less than $8.50 an hour. This is not a large opportunity cost, especially considering the income-risk reduction that off-farm work may provide to a farmer.

Conclusion

This study used agricultural census data to determine if farmers of different age groups operate on different production functions. Because the data have limitations, the results are not conclusive. The results indicate that farmers under age 25 operate on a slightly different production function than do older farmers. The younger farmers have too little real estate and too much machinery, a result that is not surprising considering the impediments that younger farmers face in the real-estate market and the lumpiness of machinery purchases. The evidence does not indicate that farmers over age 64 operate on a different production function from that of their middle-aged neighbors.

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