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FINANCIAL INDICATORS EVINCE ECONOMIES AND DISECONOMIES
OF SIZE IN U.S. FARMING

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Abstract

Agricultural policy makers and economists in the United States have discussed the subject of economies of size for a long time. Most of the studies, which are normative in nature, indicate economies of size; they fail to analyze the range of diseconomies of size. This paper applies financial tools to measure the profitability of farm size groups. Data from tax returns for most U.S. agricultural corporations, by size groups, indicate diseconomies of size in the large farms. The analysis provides evidence that the U-shaped long run average cost curve holds in the U.S. farm sector.

Financial Indicators Evince Economies and Diseconomies
of Size in U.S. Farming

Farm size, economies of size and the structure of the American agriculture are widely discussed as agricultural policy issues in the literature of agricultural economics.¹ Many research studies postulate that economies of size are the main reason for the ongoing trend toward farm expansion in the United States.

Most of the studies on economies of size are normative in nature. Some studies, on the other hand, criticize the normative procedure. In this paper an attempt is made to follow a different approach--to analyze financial indicators of farm size groups, using data drawn from a large sample of farms. Financial ratios are used for cross section comparisons of the actual performance of various size groups. An additional tool is used to summarize the series of financial ratios--the relation of weighted to arithmetic means of the financial ratios which indicates the existence of economies or diseconomies of size.

The two sets of financial data analyzed provide puzzling results: 1) Diseconomies of size are indicated by an analysis of tax returns data of most U.S. agricultural corporations; these corporations are mainly large farms. They produce about 25 percent of the total farm production. 2) On the other hand, economies of size are indicated from aggregate data analysis of the entire U.S. farm sector. Data for the latter analysis are derived from censuses, surveys and subjective judgement. Reconciliation of these contradictory findings is suggested by viewing the latter observations as representing the left side (the downward-sloping section) of the long run average cost curve, and viewing the former observations as representing the right side (the upward-sloping section) of the curve. In other words, there

are, presumably, economies of size in some or all of the smaller farms and diseconomies of size in some or all of the larger farms.

I. Bird's-Eye View on the Literature

In a recent study, Harald R. Jensen (1982) provided an excellent review of those studies on economies of size in U.S. farming which were published during the 1970s. The review mentioned that many studies indicate economies of size. Jensen provides the following list of explanations of or sources for economies of size (p. 11):

1. Ability to spread total fixed costs (costs that do not vary with output) over larger outputs.
2. Volume sufficient to justify the substitution of mechanization and automation for labor.
3. More proficient management from concentration on one or few production activities--specialization.
4. More skillful workers as a result of training for specialized rather than diversified tasks--division of labor.
5. New technology that changes the substitution relationships among inputs and creates a difference in the returns to resources and costs per unit of output as output is increased. . . .
6. Marketing economies due to lower input prices stemming from volume buying and/or due to higher product prices resulting from larger volume sales or from bypassing some intermediate stage(s) in the marketing process.
7. External economies in the form of improved transportation facilities; ready access to banking and credit institutions; publicly supported research and education output; improvements in machinery, equipment, chemicals and computer technology and stability in government programs favoring larger farming units.

Many papers suggest that the existence of economies of size explains the trend of increasing farm size in the U.S.A. There are papers, on the other hand, suggesting other factors that may explain this trend in farm size.

Among these factors are public policies, desires for power and status, norms of society and returns to investment in land (Raup, 1978, Stanton, 1978).

Despite the difference in opinions, both types of papers indicate the need for further research in this subject.

A large number of studies on economies of size are normative in nature. These studies analyze the effect of a technical change in a given factor on farm returns, using "economic-engineering" or "synthetic firm" approach with survey data. For example, many studies use engineering input-output coefficients in a budgeting or linear programming framework. For a list of such studies see Stanton, 1978, p. 729. Some studies criticize this approach. For example, Carter and Johnston (1980) claim that most studies focus only on technical economies of size. Holland (1978) claims that most studies familiar to him assume yields to be in variant with farm size and machinery to be in fixed complements. Gardner and Pope (1978) argue that it is too much to attribute the increases in productivity and farm size to technical change. Madden and Partenheimer (1972) claim that most studies deal exclusively with technical economies of size in a static framework.

One of the problems in these normative studies is that only the effect of a change in a given factor is analyzed. But in real life situations it is presumably impossible to separate the effect of the various factors on the final outcome. The effect of all factors together can be measured by the actual profits of the farm, as suggested in this paper.

II. Background on Economies and Diseconomies of Size in Farming

Harald R. Jensen (1982) suggests that major emphasis be placed on technological change over a relatively long period of time for explaining economies of size. Jensen quotes Samuelson (1976, p. 28) on this subject:

Increasing returns to scale or so-called economies of mass production are often associated with one of the following advances: (1) use of non-human and non-animal power sources (water and wind power, electricity, turbines and internal combustion engines, internal nuclear energy), (2) the use of automatic, self-adjusting mechanisms (lathes, jigs, servomechanisms), (3) the use of

standardized, interchangeable parts, (4) the breakdown of complex processes into simple, repetitive operations, (5) the specialization of function and division of labor, and many other technological factors as well. The auto production assembly line and historical development of textile spinning and weaving exemplify these diverse factors.

A similar trend takes place in agriculture, causing structure changes such as 1) increase in farm size; 2) expansion of services to farming, e.g., providing inputs and processing outputs; 3) reduction in farm labor; and 4) increase in the intensification of structures and equipment in farm operations. The last point is of major importance in the conventional explanation of economies of size in farming--the increased expenses related to structures and equipment are spread over larger output.

The last point can be shown by a superficial check of few available aggregate data for the U.S. farm sector, as follows. First, time-series data are checked. The ratio of yearly investment, termed "capital expenditure," in structures and equipment (excluding operators' dwellings) to gross income from farming increased from about 5 percent in the beginning of the century to about 12 percent in the 1970s and 1980s. Similarly, the share of depreciation² in total production expenses less interest, increased from about 10 percent in 1940-41 to about 17 percent in 1980-81. (Source: USDA, 1982, pp. 57, 64, 65, 67.)

Second, cross-section data are checked. Two ratio measures of equipment (machinery and motor vehicles) are calculated for various size groups, in a given year: 1) the share of equipment in total assets, 2) the ratio of equipment value to gross receipts. These ratios for 1982's data are presented in Table 1. The figures in Table 1 show that the first ratio, the share of equipment out of total assets, varies relatively slightly over the various size groups; whereas the ratio of equipment to gross receipts decreases considerably with the increase in farm size. This may suggest that the

Table 1: Ratios Measures for Equipment In Farms by Size Group
Aggregate Data for the U.S. Farm Sector, 1982

		Volume of Sales (Dollars)							
	All Farms	Under 5,000	5,000 to 10,000	10,000 to 20,000	20,000 to 40,000	40,000 to 100,000	100,000 to 200,000	200,000 to 500,000	Over 500,000
Equipment to total assets ^a	0.111	0.126	0.127	0.121	0.122	0.122	0.111	0.099	0.077
Equipment to gross income ^b	0.66	1.37	1.36	1.21	1.13	0.95	0.73	0.51	0.18

Source of data: USDA (1983, pp. 90, 130, 135).

a Values not include farm households, are for January 1982.

b Equipment values include farm households, are for January 1982.

technical improvements are used by all the farms, but the larger farms are utilizing these improvements more completely and efficiently.

The ratios in Table 1 indicate considerable economies of size in the usage of equipment. It can be hypothesized, however, that these economies of size are accompanied by diseconomies of size in other factors. This point is suggested in some papers, for example: Madden and Partenheimer, 1972; Raup, 1978; and Stanton, 1978.

A conceivable reason for diseconomies of size in farming is its unique production process. The main productive resources--soil and livestock do not always consist of homogeneous units, and their level of productivity is strongly affected by variations in climatic conditions, pests, diseases, etc. This means that the nature of agricultural production differs from other production processes; it requires more attention, closer monitoring of the productive resources, flexibility in current operations, early discovery of and quick response to changing physical conditions, etc. These aspects of agricultural production imply that yields and variable inputs may suffer from diseconomies of size.

Unfortunately, there is not much evidence on diseconomies of size in farming. The reason may be that "agricultural economists have given much more emphasis to economies of size than to diseconomies," as is pointed out by Bernard F. Stanton in his "Perspectives on Farm Size" (1978, p. 729). On the other hand, a review of 98 studies on economies of size in agricultural marketing plants (French, 1977, Table 3) shows that in 11 cases there were diseconomies of size.

III. Method of Analysis

In an excellent review of studies on economies of size, J. Patrick Madden (1967, p. 17) states, "Most studies of economies of size show average total cost to be less than average revenue on the farms studied, leaving a profit which is sometimes rather large, particularly among very big farms." This means that if there are economies of size, the results should appear in the profit figures of the farms analyzed.

Our analysis proposes to confront the problem of economies of size by following a positive approach; that is, by measuring the recorded end-results in farms of various sizes. The actual costs and profits of farms, by size groups, are analyzed using ratios and indicators that are derived from financial statements.

Financial statement analysis or ratio analysis is used extensively in business at the micro level for measuring relative performance--in time-series and cross-section comparisons. Ratio analysis is also used in research on the macro level (see, e.g., Foster, 1978; Barry, Hopkins and Baker (1979); and Penson and Lins, 1980).

The use of ratio analysis for measuring the end result of economies of size requires the availability of financial statements for the farms which are to be analyzed. In other words, availability of financial statements for a sample of farms of various sizes, in a given area with the same type of enterprise, provides a good basis for such an analysis.

Another way to use ratio analysis is to apply the procedure to a large sample or to the whole population of firms by size groups. In this case the effect of the type of the firm's production may affect the results in addition to the size of the firm. The results may, nevertheless, provide interesting insight into the study of economies of size. For example, Shashua and

Goldschmidt (1983, p. 332) show that published results of aggregate financial ratios for 1,200 to 1,600 companies in the USA provide evidence that the larger companies have lower returns on resources. A similar analysis of size groups in the farm sector, as carried out in this paper, provides interesting information on the profitability of the size groups; that is, on the final criterion of economies of size.

Ratio analysis implies calculating a ratio for every size group, thus providing a series of ratios for each year. To overcome the bulkiness in reporting the ratios, we use the following simple tool to demonstrate a rough indication of economies of size in a condensed form.

Shashua and Goldschmidt (1975) show that the relation between weighted and arithmetic means for a given sample of firms indicates the existence of economies or diseconomies of size. In ratio analysis, the arithmetic mean is the average of the financial ratios over all the firms. The weighted mean is computed by summing the numerator of the ratio for all the firms, summing the denominators for all the firms, and dividing the aggregate numerator by the aggregate denominator. A higher weighted mean relative to the arithmetic mean indicates that the correlation between the ratio and the denominator of the ratio (which indicates the scale of the variable under analysis, say sales) is positive. In other words, a ratio of the weighted mean to the arithmetic mean³ that is larger than one indicates economies of size, and vice versa.

The tool of weighted-to-arithmetic means is applied in this paper to size groups. For this purpose, each size group, in aggregate, is considered as a "firm" for which a financial ratio is measured. The results of this application provide, in "ball park" figures and in a condensed form, the additional information on economies of size that we seek.

IV. Data Used

We found two sources of data on financial statements for the U.S. farm sector, which are presented for size groups. The data from these sources are analyzed in the next two sections. The first source of data consists of processed results of tax returns of corporations, provided by the U.S. Treasury, Internal Revenue Service (IRS), and published annually by Leo Troy in the Almanac of Business and Industrial Financial Ratios (Troy, 1978-1983). The second source of data consists of estimates by the Economic Research Service (ERS), U.S. Department of Agriculture, and published annually in the Economic Indicators of the Farm Sector--Income and Balance Sheet Statistics (USDA, 1982-1983).

The IRS data is derived from the tax returns of corporations. It is published as ratios for several size groups within a given industry. One set is computed for all the corporations in the industry; another is computed for only those corporations that have net income. The classification of size groups is according to the level of the book value of assets.

We make use of the IRS data for the agricultural production corporations for five accounting periods, the latest available being for the period July, 1978 to June, 1979. The available data suggests that these corporations are large in size and presumably are included among the three largest size groups in the classification of the ERS (USDA, 1983). The share of these corporations in total agricultural production is relatively large. Some details on the share of these corporations in the U.S. farm sector are presented in Table 2.

The ERS data are published in aggregates for several size groups within the farm sector. These financial figures are based on censuses, surveys, indirect data and subjective judgements. The data are comprehensive but have

Table 2: Share of Analyzed Corporations in U.S. Farm Sector
Rounded Figures, 1978 and 1974

	<u>1974</u>	<u>1978</u>
Number of corporations	37,000	50,000
Share of corporations in farm sector ^a	1%	1.5%
Total receipts of corporations (billion dollars)	19	33
Share of corporations in farm sector	20%	25%
Average receipt per corporation (million dollars) ^b	0.52	0.65
Share of corporations in three largest size groups ^c		
In number of farms	25%	25%
In receipts	40%	45%

a Source: Simunek and Poirier (1983, p. 84).

b Source: Troy (1978 and 1983), for 7/1974 to 6/1975 and 7/1978 to 6/1979, respectively.

c Groups of \$100,000 sales value and over; rough estimates.
Source: Troy (1978 and 1983) and USDA (1983, pp. 84, 89).

normative qualities. When new information is received, the figures are changed accordingly. For example, based on the 1978 Census of Agriculture, the series of financial figures for the various size groups, from 1970 on, have been changed. The classification of size groups is according to the level of sales value. We make use of two sets of data--one from the latest set, for the years 1979-1982; and one from the earlier set, for the years 1974 and 1978.

Both sources of data have a common limitation--the data enable calculating financial ratios for only aggregate size groups, disregarding variations within the group and disregarding type of production and geographical area. If there is a correlation between size group and type of production or area, the financial results of each size group may be affected by these factors. If such a correlation exists, the results of the analysis do not show the pure effect of economies of size but a mixture of the effect of economies of size and of other factors.⁴ Nevertheless, even in this case, the results may reveal interesting information.

The IRS data have an additional limitation--there are no figures on current replacement cost of depreciation, assets and equity which are available in the ERS data.

V. Diseconomies of Size in Agricultural Corporations

Financial ratio analysis is used here to measure economies of size with respect to expenses and earnings in the U.S. agricultural production corporations. Two sets of IRS data are considered: 1) for only those corporations that have net income (Tables 3 and 4 and Appendix A); and, 2) for all corporations--those with and without net income (Appendix B).

Consider first the IRS data for only those corporations that have net income. The ratios for the accounting period July, 1978 to June, 1979, which is the last period for which data were published, are presented in Table 3. The figures in Table 3 show that there are economies of size in the fixed cost items; i.e., compensation of officers, repairs, rent, property taxes and depreciation. The figures show, on the other hand, that there are diseconomies of size in the ratio of variable (or, operating) costs to sales. These diseconomies of size overwhelm the economies of size in the fixed costs, thus causing overall diseconomies of size as shown by the earnings ratios (profit before tax and EBIT to sales). The widely used measure of EBIT--that is, earnings before interest and tax--shows the total returns to assets disregarding the firm's level of debt. The ratio of EBIT to sales overcomes possible variations in the ratio of interest to sales that may result from variations in the share of debt out of total capital, and from the effect of inflation on the nominal interest (see Footnote 2).

To verify these results, data for earlier accounting periods and for an additional set of data are considered. First, the results of two earnings ratios for the corporations with net income are presented in Appendix A. Secondly, the results of applying the tool of weighted-to-arithmetic means for the corporations that have net income are presented in Table 4. Thirdly, the results of the weighted-to-arithmetic means, for all the corporations--with and without net income--are presented in the top of Appendix B.

The figures in Appendix A, in Table 4 and in the top of Appendix B show the same direction of results as shown in Table 3; that is, there are economies of size in the fixed cost items, but there are diseconomies of size in the variable inputs. The overall effect, as measured by the profitability of the size groups, indicates diseconomies of size.

Table 3: Ratios of Expenses and Earnings to Sales for Size Groups
U.S. Agricultural Production Corporations with Net Income^a
Data from Tax Returns, Accounting Period 7/1978 to 6/1979

	Total	Volume of Assets (Thousands Dollars)						
		Zero Assets	Under 100	100 to 250	500 to 1,000	1,000 to 5,000	5,000 to 10,000	10,000 to 25,000
Number of corporations	32,072	1,393	6,223	7,979	5,186	2,865	177	80
Total receipts (million \$)	25,571	215	626	1,310	3,870	6,459	2,206	1,724
<u>Ratios to Sales</u>								
Cost of operations	72.9%	56.7%	52.0%	55.8%	71.1%	74.6%	82.2%	80.3%
Compensation of officers	2.3	1.9	5.0	7.5	3.1	2.2	0.8	0.8
Repairs	1.8	3.4	3.6	3.1	2.4	1.7	0.9	1.1
Rent on business property	2.2	3.7	6.0	4.2	2.7	2.0	0.6	0.5
Taxes (excl. Federal tax)	2.1	3.1	3.8	3.4	2.0	1.8	1.0	1.6
Depreciation	3.8	7.3	5.9	7.5	5.3	3.8	1.9	2.4
Net profit before tax	1.3	6.0	4.3	5.2	0.9	1.7	1.0	0.8
EBIT ^b	4.0	11.8	6.4	8.4	4.3	4.7	3.1	3.1

Source: Troy (1983, p. 3).

a Only corporations with net income are included; corporations without net income are excluded. (Data for all the corporations are presented in Appendix B.) The following expense items are not reproduced: bad debts, interest, advertising, pensions and other expenses. Data for size group 250 to 500, and for size groups over 25,000, are not published to avoid possibility of disclosure.

b EBIT is earnings before interest and tax; it represents returns to total capital.

Table 4: Indicators of Economies of Size^a
U.S. Agricultural Production Corporations with Net Income^b
Data from Tax Returns, Accounting Periods 1974/75 to 1978/79

	Accounting Period				
	74-75	75-76	76-77	77-78	78-79
Number of corporations	22,149	24,984	24,790	28,241	32,072
Total receipts (million \$)	12,275	17,812	18,562	20,977	25,571
<u>Indicators</u>					
Cost of operations	0.97	0.95	0.97	0.96	0.93
Compensation of officers	1.07	1.35	1.33	1.43	1.32
Repairs	1.08	1.19	1.13	1.15	1.29
Rent on business property	1.11	1.21	1.03	1.52	1.28
Taxes (excl. Federal tax)	1.00	1.03	1.01	1.03	1.14
Depreciation	1.06	1.18	1.14	1.13	1.28
Net profit before tax	0.91	0.51	0.38	0.43	0.46
EBIT ^c	0.95	0.69	0.64	0.73	0.67

Source of data: Troy (1978-1983).

- a Indicator is the ratio of weighted to arithmetic means for the returns ratios for size groups, and vice versa for expenses ratios. Indicator larger than one provides evidence on economies of size, and indicator smaller than one--diseconomies
- b Only corporations with net income are included; corporations without net income are excluded. (Data for all the corporations are presented in Appendix B.)
- c EBIT is earnings before interest and tax; it represents returns to total capital.

VI. Observations on the Whole Farm Sector

Financial ratio analysis is also used to measure economies of size in the entire U.S. farm sector, using ERS aggregate data. These data, as mentioned earlier, have, to some extent, normative qualities. The series do not include information on individual cost items, but include figures on assets and equity. Three financial ratios for the year 1982 are presented in Table 5, showing definite economies of size in all ratios. Because of the nature of the data, the same results are found for earlier years and in other studies. ⁵

We are faced with a dilemma because the two analyses--that when IRS data are used and that when ERS data are used--indicate contradictory results. This brought us to check also two earlier sets of aggregate data for the farm sector: one from the ERS series and one from the 1974 Census of Agriculture. Three financial ratios for the year 1978 and one financial ratio for the year 1974 are presented in Table 6. The figures in Table 6 indicate economies of size up to the size group of \$40,000-\$100,000 sales value. The largest size group, which consists of over 50% of the sales value of the farm sector, shows lower performance in the ratios of expenses to gross income (the complement is profit to sales) and net income to equity. These results do not conform to those in Table 5.

The IRS data for the agricultural corporations cover mainly the larger farms (see Table 2). Thus, the results for the corporations should be compared with only a fraction of the results for the ERS data. The results should be compared with those for the larger size groups, where the corporations comprise a considerable share. We are inclined to consider the results for the corporations (which are based on authentic reports to the IRS) as more reliable than the comparable results drawn from ERS aggregate data for the large size groups.

Table 5: Financial Ratios for Size Groups
Aggregate Data for the U.S. Farm Sector, 1982^a

		Volume of Sales (Dollars)							
	All Farms	Under 5,000	5,000 to 10,000	10,000 to 20,000	20,000 to 40,000	40,000 to 100,000	100,000 to 200,000	200,000 to 500,000	500,000 and over
Number of farms (thousands)	2,400	824	331	281	273	392	186	87	25
Total receipts (billion \$)	149.6	2.4	2.9	4.7	9.1	28.7	28.7	28.2	44.8
<u>Ratios</u>									
Gross income to assets	15%	3%	6%	8%	9%	12%	14%	18%	42%
Expenses to gross income	90	212	138	120	107	98	91	87	70
Net income to equity	2.8	-1.0	-0.8	-0.5	0	0.9	2.1	3.6	19.0

Source of data: USDA (1983, p. 88).

a Data exclude households. Assets and equity values for January 1982. Net income from farm source.

Table 6: Financial Ratios for Size Groups
Aggregate Data for the U.S. Farm sector, 1978 and 1974

		Volume of Sales (Dollars)						
	All Farms	Under 2,500	2,500 to 5,000	5,000 to 10,000	10,000 to 20,000	20,000 to 40,000	40,000 to 100,000	100,000 and over
A. <u>1978</u> ^a								
Number of farms (thousands)	2,672	919	279	281	296	323	390	187
Gross income (billions \$)	124.9	3.8	2.1	3.4	6.2	12.5	30.6	66.3
<u>Ratios</u>								
Gross income to assets	18%	5%	6%	9%	11%	13%	18%	28%
Expenses to gross income	79	58	75	73	72	70	72	85
Net income to equity	4.5	2.0	1.7	2.4	3.4	4.6	6.6	5.1
B. <u>1974</u> ^b								
Expenses to gross income	75%		131%	81%	71%	67%	67%	78%

a Source of data: USDA (1979, pp. 52-56) and Evans (1979, p. 20). Data include farm households. Assets and equity values for January 1978.

b Source: 1974 Census of Agriculture, Vol. II, Part 4, Table 5 (USDC 1978).

VII. Conclusions

Two sources of data are used in this paper to derive financial ratios for farm size groups. Both sources have the limitation that the derived financial ratios are affected by the size of the farms and by other factors such as type of production and location in the case where these factors are correlated with farm size. A superficial check indicates that the farms in the largest size group have a higher share of vegetables and fruits and a slightly higher share of livestock than the other size groups (see Footnote 4). In any case, indication of economies or diseconomies of size, irrespective of type of production, provides interesting information to policy makers and to researchers. Our analysis of the authentic data for the agricultural production corporations indicates the following three interesting points.

First, there are economies of size in the utilization of fixed inputs such as structures and equipment, and management. These findings are in line with the findings of many studies on economies of size.

Second, there are diseconomies of size in the ratio of variable inputs to output. This phenomenon can be caused by several factors. One possible explanation is that there is a correlation between farm size and type of production; for example, livestock may be raised by larger farms whereas field crops occur in smaller farms. Another possible explanation is that the level of efficiency is decreasing with size because of the unique agricultural production process. This point is sometimes mentioned in the literature. For example, Holland (1979, p. 942) claims that "agricultural output (measured as total revenue) per acre tends to fall as farm size increases." Raup (1978, p. 305) claims that "farm land buyers...shift attention from efficiency and productivity criteria to a search for rewards in the form of farm expansion,

agglomeration, and land value appreciation." Heady and Krenz (1962; cited by Stanton, 1978, p. 731) claim that a factor which can result in rising per unit costs is the untimeliness element of field operations. On the other hand, Olson (1956, p. 57) claims that "diseconomies caused by increasing variable costs receive scant attention" in studies on economies of size.

Third, the diseconomies of size in the variable inputs overwhelm the economies of size in the fixed inputs, causing an overall diseconomies of size as measured by the two ratios of earnings to sales.

Noting that some studies revealed diseconomies of size in agricultural services (agricultural marketing plants, French, 1977, Table 3; food processing plants, Greig, 1973, Table 1), we analyzed available tax return data pertaining to corporations in agricultural services, forestry and fishing. The findings, which are presented in the bottom of Appendix B, show the same direction of results as those for the agricultural production corporations (Table 4) the end result being diseconomies of size.

Contrary to the evidence on diseconomies of size in the agricultural corporations, the aggregate data for the whole farm sector shows economies of size. A plausible reconciliation of these contradictory findings is suggested as follows. Economies of size in small scale farms is evidenced in most studies and is shown in all the sets of ERS aggregate data for the U.S. farm sector. On the other hand, by analyzing authentic data for a considerable portion of the large scale farms (the agricultural corporations), we discover evidence of diseconomies of size. Combining these evidences and results can be seen as indicating the well-known U-shaped, long-run-average-cost curve of economic theory.

In summary, we applied financial management tools to two comprehensive samples of data for measuring economies of size in the farm sector. The

analysis provides evidence that the U-shaped long-run-average-cost curve holds for the U.S. farm sector. The evidence relates to size groups, irrespective of the type of production and geographical area. Our findings call for additional research on economies of size, especially pertaining to the farms at the upper end of the size scale.

Footnotes

1. For perspective articles on this subject, see, e.g., Stanton (1978) and Raup (1978). For collection of papers see, e.g., U.S. Department of Agriculture (1979a); Ball and Heady (1972); and Heady, Johnson and Hardin (1956).
2. The interest expenses embody an inflation premium for the decline in the purchasing power of the debt capital. The level of this premium changes over time (depending on the expected level of inflation and on institutional factors), therefore interest should not be included in time-series comparisons of costs.
3. Shashua and Goldschmidt (1975) show that

$$I = 1 + r c_t c_x$$

where $I = \frac{M_w}{M_a}$ = ratio of weighted to arithmetic means,

$$M_w = \frac{\sum Y_i}{\sum X_i} = \text{weighted mean,}$$

$$M_a = \frac{\sum F_i}{n} = \text{arithmetic mean,}$$

$$F_i = \frac{Y_i}{X_i} = \text{a financial ratio for the } i \text{ th firm } (i=1\dots n)$$

r = correlation coefficient between F and X

c = coefficient of variation, which is always positive.

For applications of this tool see Shashua and Goldschmidt (1983, pp. 68, 263, 327).

4. A superficial test of data from the 1978 Census of Agriculture shows that the upper size group has a significantly higher share of vegetables and fruits and a slightly higher share of livestock compared to the four succeeding lower size groups. The share of these enterprises among the latter four groups is of a similar order of magnitude.
5. Indicators of economies of size for the U.S. aggregate data are as follows; where indicator is the ratio of weighted to arithmetic mean for the returns ratios for size groups, and vice versa for expenses ratios. Indicator larger than one provides evidence on economies of size, and indicator smaller than one--diseconomies (Source: USDA, 1983, pp. 85-88).

	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
Gross receipts to assets	1.04	1.04	1.09	1.08
Expenses to sales	1.23	1.27	1.29	1.28

Indicators for the net returns to equity are meaningless because of the negative ratios for the small size groups.

Similar direction of results have been found in earlier studies, using ERS data. For example, Hottel and Reinsel (1976), who applied ratio analysis to aggregate data of farms by size group for the year 1970; and Miller, et al. (1981), who analyzed estimated average production costs of field crops.

Appendix A: Earning Ratios for Size Groups
U.S. Agricultural Production Corporations with Net Income ¹
Data from Tax Returns, Accounting Periods 1974-75 to 1978-79

		Volume of Assets (Thousands Dollars)											
Total	Zero Assets	Under 100	100 to 250	250 to 500	500 to 1,000	1,000 to 5,000	5,000 to 10,000	10,000 to 25,000	25,000 to 50,000	50,000 to 100,000	100,000 to 250,000	250,000 and over	
A. Accounting Period 7/78 to 6/79													
Number of corporations	32,072	1,393	6,223	7,979	***	5,186	2,865	177	80	***	***	***	***
Total receipts (millions \$)	25,571	215	626	1,310	***	3,870	6,459	2,206	1,724	***	***	***	***
Net profit before tax to sales	1.3%	6.0%	4.3%	5.2%	***	0.9%	1.7%	1.0%	0.8%	***	***	***	***
EBIT to sales	4.0	11.8	6.4	8.4	***	4.3	4.7	3.1	3.1	***	***	***	***
B. Accounting Period 7/77 to 6/78													
Number of corporations	28,241	666	7,504	7,389	6,350	3,739	2,382	131	54	***	***	4	3
Total receipts (millions \$)	20,977	1,620	645	1,259	2,154	2,386	5,496	1,465	1,325	***	***	748	2,825
Net profit before tax to sales	1.0%	0.5%	4.3%	7.4%	1.8%	2.2%	0.2%	2.2%	#	***	***	8.6%	#
EBIT to sales	3.5	2.0	6.3	9.9	4.7	5.9	3.2	4.3	2.0	***	***	9.9	1.3
C. Accounting Period 7/76 to 6/77													
Number of corporations	24,790		6,750	6,892	5,786	3,221	1,964	112	48	7	4	6	***
Total receipts (millions \$)	18,562		848	1,325	2,569	2,629	4,581	1,168	918	613	365	3,545	***
Net profit before tax to sales	1.0%		9.1%	4.3%	2.0%	2.7%	0.1%	0.4%	#	1.0%	#	#	***
EBIT to sales	3.3		11.6	6.3	4.1	5.5	2.8	3.0	2.7	2.4	3.7	1.3	***
D. Accounting Period 7/75 to 6/76													
Number of corporations	24,984		7,479	7,371	5,184	3,231	1,537	114	49	7	5	7	***
Total receipts (millions \$)	17,812		701	1,452	2,138	2,525	4,532	1,235	1,200	362	389	3,279	***
Net profit before tax to sales	1.8%		9.2%	4.8%	4.5%	3.7%	1.5%	#	1.0%	3.1%	#	#	***
EBIT to sales	4.2		11.7	7.2	7.0	6.9	3.7	2.5	3.3	5.4	5.7	1.8	***
E. Accounting Period 7/74 to 6/75													
Number of corporations	22,149		6,600	6,815	4,869	2,477	1,279	61	36	6	3	3	***
Total receipts (millions \$)	12,275		725	2,014	1,969	1,609	3,373	560	658	317	313	737	***
Net profit before tax to sales	3.2%		7.7%	3.1%	5.3%	5.4%	1.2%	2.0%	#	#	5.8%	3.3%	***
EBIT to sales	5.7		9.0	5.0	8.0	8.6	3.5	5.1	2.5	3.2	9.4	5.3	***

Source: Troy (1978-1983).

a Only corporations with net income are included; corporations without net income are excluded. (Data for all the corporations are presented in Appendix B.) *** means suppressed data by the IRS to avoid possibility of disclosure.

Appendix B: Indicators of Economies of Size ^a
U.S. Agricultural Corporations
Data from Tax Returns, Accounting Periods 1974/75 to 1978/79

	Accounting Period				
	74-75	75-76	76-77	77-78	78-79
<u>A. Production Corporations with and without Net Income</u>					
Number of corporations	37,314	39,623	42,293	46,315	50,242
Total receipts (million \$)	19,413	22,549	24,967	27,972	32,839
<u>Indicators</u>					
Cost of operations	0.98	0.98	0.98	0.97	0.93
Compensation of officers	1.15	1.29	1.27	1.35	1.74
Repairs	1.14	1.13	1.16	1.16	1.35
Rent on business property	1.16	1.14	1.12	1.21	1.55
Taxes (excl. Federal tax)	1.07	1.01	1.01	1.05	1.24
Depreciation	1.07	1.11	1.13	1.10	1.34
<u>B. Services, Forestry, and Fishing Corporations with Net Income ^b</u>					
Number of corporations	9,351	8,344	11,015	10,199	
Total receipts (million \$)	4,754	3,729	5,163	6,488	
<u>Indicators</u>					
Cost of operations	0.95	0.98	1.02	0.90	
Compensation of officers	1.34	1.08	0.89	1.05	
Repairs	1.18	1.13	1.04	1.30	
Rent on business property	1.29	1.01	1.00	1.14	
Taxes (excl. Federal tax)	1.13	1.05	0.89	1.24	
Depreciation	1.12	1.06	0.95	1.19	
Net profit before tax	0.61	0.91	0.88	0.71	
EBIT ^c	0.76	0.93	0.90	0.65	

Source: Troy (1978-1983).

a Indicator is the ratio of weighted to arithmetic means for the returns ratios for size groups, and vice versa for expenses ratios. Indicator larger than one provides evidence on economies of size, and indicator smaller than one--diseconomies.

b Accounting period 78-79 omitted because of inconsistent data.

c EBIT is earnings before interest and tax; it represents returns to total capital.

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