



4-1983

Costs of Operation of Tennessee Livestock Auction Markets

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BACKS

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Kimberly Spielman, Dan McLemore,
and Glen Whipple

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Bulletin 620
April 1983

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Costs of Operation of Tennessee Livestock Auction Markets

by Kimberly Spielman, Dan McLemore,
and Glen Whipple*

INTRODUCTION

Auction markets are an important part of the Tennessee livestock industry. During 1980, auctions provided sales locations for 1.4 million head of livestock in the State. Approximately 722,000 cattle, 233,000 calves, 414,000 hogs, and 3,400 sheep were sold through Tennessee auctions in 1980 [5.]

The efficiency of the livestock marketing system depends to a large extent upon how efficiently livestock auction markets perform their function. Inefficient resource utilization may lead to excessive operating expenses for auctions. These high costs must be borne by some segment of the livestock-meat system. High costs incurred by auction operators may lead to increased tariff rates. These higher tariffs may reduce returns to producers who sell livestock at auctions and increase costs of livestock to the buyer.

Previous research indicated that livestock auction markets typically incur lower per head costs as the number of livestock sold is increased. That is, significant economies of size may be achieved by expanding volume. However, too many markets often exist in a given geographic area for any firm to handle enough volume to capture these available economies [1,8].

A 1968 study of Tennessee auction markets by Hicks and Badenhop concluded that "Tennessee has too many markets to develop an efficient, low-cost livestock auction system" [2, p. 24]. To create a more efficient market system, Hicks and Badenhop recommended that the then current number of 74 auctions be reduced to a maximum of 35, with 18 being the preferred number [2].

By 1980, auction market numbers had not been reduced significantly with 63 livestock markets still in operation. Of these, 34 markets sold less than 20,000 head of livestock, 18 markets sold 20,000-50,000 head, and only six auctions handled more than 50,000 head in 1980. Thus, the small (less

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than 20,000 hd.) markets comprised 59 percent of all auctions, yet they handled only 24 percent of the livestock sold through auctions. The intermediate-sized markets, 31 percent of the total number of auctions, sold 40 percent of all livestock. The six large (greater than 50,000 hd.) markets accounted for only 10 percent of the markets but sold 36 percent of all livestock sold through auctions [5].

Based upon these data, auctions appear to be an area where the efficiency of the total marketing system might be improved. Little research has been conducted within the past decade to compare the efficiency of small markets with large markets. If economies of size exist, these economies may not be realized by the many small auctions in operation in Tennessee.

OBJECTIVES

The purpose of this study was to conduct a cost analysis of Tennessee livestock auction markets to determine the degree of operational efficiency. Specific objectives were to:

1. Determine the typical cost structure of various size categories of auctions to identify sources of firm efficiency.
2. Identify the relationship between specific costs of operation and market volume.
3. Determine the current rates of return to market operators.
4. Estimate a long run average total cost function for the industry to determine whether economies of size exist in Tennessee auctions.

SOURCE OF DATA

Data for the cost analysis of Tennessee livestock auction markets were gathered from the Packers and Stockyards Administration Form 130 for 1978 and 1980. All auctions in operation in Tennessee are required to file this report annually with the Memphis area office of the Packers and Stockyards Administration, U.S. Department of Agriculture [3].

The Form 130 is an annual report which includes a balance sheet of assets and liabilities, reconciliation of net worth, summary of income statements, a separate income statement for the auction activity, detail of market support activity and dealer operations, and volume of livestock handled during the year. The name and address of each auction operator were deleted from the data to insure confidentiality of the accounting records. A total of 101 usable observations was available for this study, with 55 observations for 1978 and 46 for 1980.

The measure of output used to determine market volume was an Animal Marketing Unit (A.M.U.). Animal marketing units classification requires that heterogenous livestock species must be converted to a common unit of measure, A.M.U. The cost of handling and selling each species varies, and the proportion of different types of livestock sold varies among markets. Therefore, a unit of each species of livestock must be expressed as equivalent to the other species. The standard A.M.U. is defined by USDA as one cow or

one calf or three hogs or four sheep or one horse [4, p. 7]. These values were determined by equating the amount of pen space and handling costs for each type of livestock [4, p. 5].

DETERMINATION OF SPECIFIC AVERAGE COST-VOLUME RELATIONSHIPS

Specific average cost-volume relationships were derived for various size categories of auction markets. By examining the composition of the cost structure, inefficient areas of market operation may be identified. Each component cost was expressed in average figures by dividing total expense by volume of livestock handled to yield the cost incurred for each A.M.U.

Markets were divided into seven size categories according to the number of A.M.U.'s handled. Parameters of these categories and the number of auctions in each category are shown in Table 1.

Table 1. Number and Average Volume for Livestock Auction Markets by Size Group, Tennessee, 1978 and 1980.

Size Group	Volume Handled Per Year (A.M.U.)	1978		1980	
		Number of Markets	Average Volume Handled (A.M.U.)	Number of Markets	Average Volume Handled (A.M.U.)
I	Less than 9,000	7	5,814	14	5,840
II	9,000 - 17,999	15	13,810	14	13,115
III	18,000 - 26,999	13	21,648	5	20,892
IV	27,000 - 35,999	4	31,244	6	32,276
V	36,000 - 44,999	5	39,455	2	40,711
VI	45,000 - 53,999	7	51,453	3	46,046
VII	54,000 or more	4	75,412	2	69,702

Expenses were classified as either fixed or variable costs. Fixed costs were composed of: total depreciation, taxes (excluding income taxes), insurance other than unemployment, legal fees, interest, and licenses and premiums. Variable costs included: unemployment insurance, salaries, rent, utilities, travel and auto, advertising, supplies, bad debts, trucking, maintenance, labor, and miscellaneous expenses. Average fixed costs, average variable costs, and average total costs were calculated for each year of operation and for the two years combined.

RESULTS OF THE DESCRIPTIVE COST ANALYSIS

Fixed Costs

During 1978, the largest average fixed costs were reported by markets handling less than 9,000 A.M.U.'s per year. The smallest fixed costs were in-

curred by markets handling 54,000 or more A.M.U.'s (Table 2). There was a significant cost difference realized by the large markets, as costs per A.M.U. fell from \$1.12 for Group I to \$0.348 for Group VII.

Table 2. Average Fixed Costs for Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980 (Actual Dollars Per A.M.U.)

Year	Size Group	Mean	Standard Deviation	Range
----- dollars per A.M.U. -----				
1978	I	1.120	.431	0.64-1.92
	II	0.808	.370	0.18-1.35
	III	0.529	.178	0.12-0.72
	IV	0.949	.410	0.47-1.44
	V	0.489	.232	0.25-0.79
	VI	0.582	.250	0.18-0.80
	VII	0.348	.216	0.15-0.63
	All	0.701	.373	0.12-1.92
1980	I	1.261	.811	0.18-2.93
	II	0.823	.339	0.22-1.59
	III	1.162	.526	0.60-1.90
	IV	0.787	.330	0.48-1.26
	V	1.318	.435	1.01-1.63
	VI	0.812	.053	0.76-0.87
	VII	0.254	.018	0.24-0.27
	All	0.984	.579	0.18-2.94
1978 & 1980	All	0.830	.496	0.12-2.94

The highest average fixed cost during 1980 was reported by Group V, \$1.318 per A.M.U. followed by Group I firms with a cost of \$1.261. This pattern is similar to that found in 1978, with intermediate size markets incurring costs almost as high or higher than the smallest firms. The lowest cost reported by firms in 1980, \$0.254, was by auctions selling 54,000 or more A.M.U.'s annually (Group VII).

The composition of fixed costs may be examined to identify the large components (Table 3). For all auctions in 1978 and 1980 combined, insurance other than unemployment was the largest single fixed cost, representing 36 percent of average fixed cost. Taxes were the second-highest fixed cost, making up one-fourth of this cost category. These two cost items represent over two-thirds of average fixed cost. Because of the nature of fixed costs, these expenses do not vary with the level of output, but remain constant in the short run view of operation.

Table 3. Specific Average Fixed Cost Items for Tennessee Livestock Auction Markets, by Year, 1978 and 1980 (Actual Dollars per A.M.U.)

Year	Cost Category	Rank	% of Total	Mean	Standard Deviation
				dollars per A.M.U.	
1978	Other Insurance	1	37	.257	.151
	Taxes	2	20	.137	.111
	Depreciation	3	19	.134	.165
	Interest	4	15	.103	.148
	Legal Fees	5	7	.048	.099
	Licenses/Premiums	6	2	.021	.038
	Total			.701	.370
1980	Other Insurance	1	35	.345	.216
	Taxes	2	29	.283	.215
	Interest	3	15	.144	.236
	Depreciation	4	13	.128	.173
	Legal Fees	5	6	.060	.072
	Licenses/Premiums	6	2	.024	.072
Total				.908	.580

Variable Costs

Average variable costs per A.M.U. for markets during 1978 ranged from a low of \$2.883 for Group III, to a high of \$4.073 for Group V (Table 4). Group VII, the largest market size, reported the second-lowest variable cost, \$3.166, followed by Group VI with a cost of \$3.292. Thus, the two largest volume groups incurred the second and third lowest variable costs. This indicates that some size advantage is possible at the largest volume levels, but not at the intermediate size levels. The largest component of variable cost in 1978 was salaries, comprising 60 percent, followed by utilities at 7 percent (Table 5). The average variable cost for all firms in that year was \$3.460 per A.M.U.

During 1980, a similar cost-volume relationship was identified (Table 4). The largest average variable cost, \$7.350, was reported by the smallest volume group, Group I, followed by Group IV at \$5.098 per A.M.U. Group VII, the largest volume category, incurred the lowest unit variable cost of \$3.122, with Group III next at \$4.176 and Group V at \$4.189. Thus, the largest size markets realized lower average costs, but costs of small and intermediate size firms were not consistent with the notion of economies of size. The intermediate level markets (Groups IV and V) reported higher costs than markets either slightly smaller or larger. The largest component of variable costs in 1980 was, again, salaries, representing 59 percent of these expenses

Table 4. Average Variable Costs for Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980 (Actual Dollars Per A.M.U.)

Year	Size Group	Mean	Standard Deviation	Range
		----- dollars per A.M.U. -----		
1978	I	3.434	1.070	1.58- 5.00
	II	3.784	0.771	2.96- 5.48
	III	2.883	0.754	2.05- 4.61
	IV	3.984	1.061	2.84- 5.39
	V	4.073	0.873	3.03- 5.03
	VI	3.292	0.783	2.24- 4.60
	VII	3.166	0.891	2.58- 4.47
	All	3.460	0.902	1.58- 5.49
1980	I	7.350	3.433	3.17-16.25
	II	4.277	0.903	2.97- 6.10
	III	4.176	1.144	2.15- 4.90
	IV	5.098	0.924	3.95- 6.44
	V	4.189	0.481	3.85- 4.53
	VI	4.868	0.921	3.98- 5.82
	VII	3.122	0.821	2.53- 3.69
	All	5.293	2.443	2.15-16.25
1978 & 1980	All	4.294	1.992	1.58-16.25

(Table 5). The second-largest variable cost was utilities at 7 percent. The average variable cost for all firms in 1980 was \$5.290 per A.M.U.

Total Costs

Average fixed cost and average variable cost were combined to obtain average total cost. The resulting pattern was similar to that of average variable cost (Table 6). This presents a confused pattern of relationship between cost level and volume. The largest average total cost in 1978 was incurred by Group IV firms, \$4.933 per A.M.U. The lowest average cost was reported by Group III at \$3.412, followed by Group VII at \$3.514, and Group VI at \$3.874.

The 1980 results were similar. Group I incurred the largest cost of \$8.611 per A.M.U. Costs fell, and then alternately rose and declined between groups III and VII. Group VII, the largest volume category, reported the lowest cost, \$3.366, while Group II firms incurred the second lowest average cost. A significant cost advantage was thus realized by the largest group of markets. Groups V and VI, incurred costs lower than those reported by the smallest

Table 5. Specific Average Variable Cost Items for Tennessee Livestock Auction Markets, by Year, 1978 and 1980 (Actual Dollars per A.M.U.)

Year	Cost Category	Rank	% of Total	Mean	Standard Deviation
				dollars per A.M.U.	
1978	Salaries	1	60	2.064	0.669
	Utilities	2	7	0.226	0.125
	Bad Debt	3	6	0.218	0.491
	Miscellaneous	4	5	0.170	0.186
	Rent	5	5	0.161	0.345
	Supplies	6	4	0.153	0.118
	Maintenance	7	4	0.129	0.106
	Trucking	8	2	0.084	0.249
	Travel and Auto	9	2	0.070	0.125
	Advertising	10	2	0.063	0.063
	Unemployment Insurance	11	2	0.061	0.093
	Miscellaneous Labor	11	2	0.061	0.116
	Total			3.460	0.900
1980	Salaries	1	59	3.121	1.178
	Utilities	2	7	0.347	0.216
	Miscellaneous	3	6	0.328	0.322
	Rent	4	6	0.323	0.631
	Bad Debt	5	5	0.263	0.684
	Maintenance	6	4	0.219	0.298
	Supplies	7	3	0.184	0.236
	Trucking	8	3	0.167	0.400
	Miscellaneous Labor	9	2	0.124	0.212
	Advertising	10	2	0.101	0.119
	Travel and Auto	11	2	0.100	0.198
	Unemployment Insurance	12	1	0.016	0.050
	Total			5.290	2.440

market volumes, but did not achieve costs as low as those markets handling volumes between 9,000 and 17,999 A.M.U.'s.

The structure of average cost, shown in Table 7, indicates that salaries was the largest component of cost. Representing 50 percent of average total costs, this variable input comprises a much larger proportion of total costs than any other expense. During 1978 and 1980, the size group which reported the lowest average salaries expense also incurred the lowest average total cost. This may imply that utilizing labor more efficiently could significantly decrease costs for an auction market. As labor costs continue to rise, more efficient organization and utilization of labor may become increasingly important to livestock auction market profitability and survival.

Table 6. Average Total Costs for Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980 (Actual Dollars Per A.M.U.)

Year	Size Group	Mean	Standard Deviation	Range
		----- dollars per A.M.U. -----		
1978	I	4.553	1.218	2.32- 6.35
	II	4.592	0.876	3.46- 6.26
	III	3.412	0.840	2.35- 5.25
	IV	4.933	1.349	3.31- 6.47
	V	4.562	0.946	3.56- 5.82
	VI	3.874	0.885	2.52- 5.40
	VII	3.514	1.067	2.79 -5.10
	All	4.160	1.070	2.32- 6.47
1980	I	8.611	3.692	3.50-16.97
	II	5.099	1.024	3.48- 6.95
	III	5.339	1.559	2.75- 6.80
	IV	5.885	0.880	4.59- 6.95
	V	5.507	0.916	4.86- 6.16
	VI	5.679	0.895	4.79- 6.58
	VII	3.366	0.839	2.77- 3.96
	All	6.277	2.699	2.75-16.97
1978 & 1980	All	5.124	2.240	2.32-16.97

RETURNS TO LIVESTOCK AUCTION MARKET OPERATORS

Net returns per dollar of net worth and net returns per A.M.U. sold were calculated to allow comparison of returns or profitability of different sizes of auction market operations. Net returns are calculated by subtracting total costs from total revenues.

Net Returns per Dollar of Net Worth

Firms in Group VII yielded the largest net return per dollar of net worth in 1978, \$0.51, with Group V reporting the lowest value, \$0.21 (Table 8). However, Group II markets gave the largest value for 1980, \$1.00. Group I firms had the lowest net return to net worth in 1980, \$0.04. These results indicate that net returns per dollar of net worth vary considerably from year to year, with volume playing little role in the size of the net return. The two-year average net return per dollar of net worth for all firms was \$0.37.

Net Returns per A.M.U. Sold

There was no apparent relationship between volume and net returns per A.M.U. handled during either year (Table 8). During 1978, Group I had the highest return, \$1.12, while Group II reported the low value of \$0.09. In 1980,

Table 7. Specific Average Total Cost Items for Tennessee Livestock Auction Markets, 1978 and 1980 Combined (Actual Dollars Per A.M.U.)

Cost Category	Rank	Average Cost	Standard Deviation	% of Total Costs
		dollars per A.M.U.		
Salaries	1	2.546	1.071	49.7
Insurance	2	0.338	0.199	6.6
Utilities	3	0.281	0.182	5.5
Miscellaneous	4	0.242	0.267	4.7
Bad Debt	5	0.238	0.584	4.6
Rent	6	0.235	0.500	4.6
Taxes	7	0.204	0.181	4.0
Maintenance	8	0.170	0.219	3.3
Supplies	9	0.167	0.181	3.3
Depreciation	10	0.131	0.168	2.6
Interest	11	0.122	0.193	2.4
Trucking	12	0.122	0.327	2.4
Miscellaneous Labor	13	0.090	0.169	1.8
Travel and Auto	14	0.084	0.162	1.6
Advertising	15	0.080	0.094	1.6
Legal Fees	16	0.054	0.127	1.1
Licenses and Premiums	17	0.023	0.056	0.4
Total Costs		5.124		

Group VI firms returned the largest value, \$0.93, and the lowest return was from Group I, \$0.04. The net return per A.M.U. sold for 1978 and 1980 for all firms was \$0.49.

METHODS USED TO ESTIMATE THE LONG RUN AVERAGE TOTAL COST CURVE

The mathematical or graphical relationship between average total cost and volume of output for the firms in an industry may be represented by the long run average total cost (LRATC) curve. The LRATC curve shows how costs change as volume changes. Economic theory suggests that per unit costs should be high at very small volumes and should decline as volume increases. At very large volumes per unit costs may begin to increase again, although this is not observed in most studies of actual situations.

The data collected for 1978 and 1980 were combined to estimate the LRATC curve. The 1980 costs were deflated to 1978 dollars by the Index of Prices Paid by Farmers [6]. This adjusted for inflationary rises in prices which could make the data from the two years incomparable.

Table 8. Net Returns Per Dollar of Net Worth and Per A.M.U. Sold for Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980 (Actual Dollars)

Year	Size Group	Net Returns Per Dollar of Net Worth		Net Returns Per A.M.U. Sold	
		Mean	Standard Deviation	Mean	Standard Deviation
1978	I	0.426	0.695	1.124	0.813
	II	b		0.088	0.720
	III	0.306	0.393	0.923	0.995
	IV	0.223	0.324	0.517	0.832
	V	0.210	0.425	0.250	0.412
	VI	0.270	0.451	0.480	0.767
	VII	0.510	0.360	0.370	0.220
1980	I	0.042	0.894	0.041	2.173
	II	1.000	3.040	0.698	1.142
	III	b		0.621	1.355
	IV	0.090	0.225	0.470	0.658
	V	b		0.270	0.910
	VI	0.150	0.292	0.930	0.896
	VII	a	a	0.110	0.117
1978 & 1980	All	0.370		0.490	

^aGroup VII markets did not report net worth value during 1980.

^bThese firms reported negative net worth making net returns per dollar of net worth indeterminate.

Two methods were used to estimate a long run average total cost (LRATC) curve for the Tennessee livestock auction market industry, the ordinary least squares (OLS) method of regression and the frontier function method using linear programming techniques. The OLS approach uses cross-section data in a regression of average total cost against volume to estimate the LRATC function, while the frontier function method fits an envelope curve to the bottom of the point scatter of average total cost plotted against volume.

Since economic theory suggests a cost function which would decrease at a decreasing rate, the following four functional forms were postulated as potentially appropriate for the LRATC curve:

$$1) \text{ LRATC} = a + b_1V + b_2V^2$$

$$2) \text{ LRATC} = a + b_1\frac{1}{V}$$

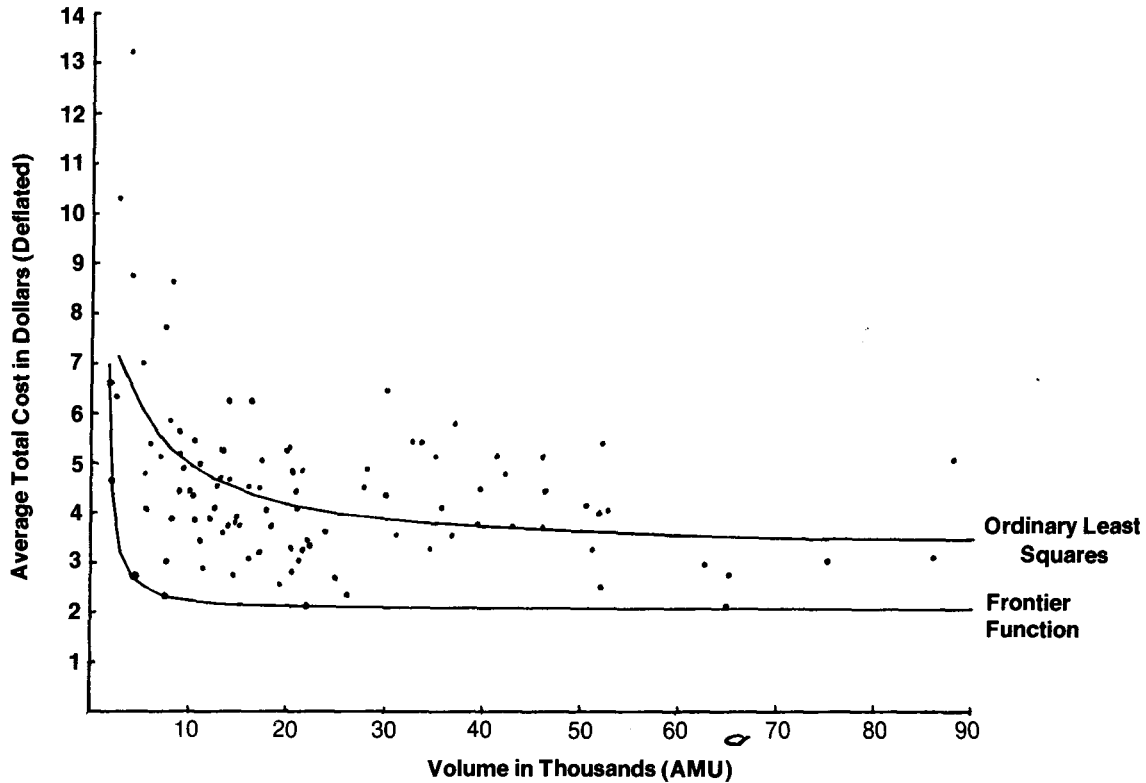


Figure 1. Long Run Average Total Cost Functions for the Tennessee Livestock Auction Market Industry Using Ordinary Least Squares and Frontier Function Methods for Model 4 (1978 and 1980 Data Combined).

COMPARISON OF OLS AND FRONTIER FUNCTION ESTIMATES

The OLS approach describes the mean cost conditions of Tennessee markets at one point in time for various volume levels. It yields a cost estimate of *expected* short run average total cost (SRATC) conditions over a range of volumes. It does not show the *minimal* operating costs which may be possible in long run operations.

The frontier function provides a more theoretically appealing LRATC estimate for the industry because it embodies the envelope concept to the various SRATC curves. In the long run, markets are free to enter and leave the industry, and existing firms can make long run adjustments in market operation such as capital improvements to alter capacity. The frontier function illustrates the minimal obtainable cost level for various volume levels in the long run, rather than reflecting expected short run cost conditions as the OLS method does.

The results of the OLS estimate indicate that economies of size do exist in Tennessee livestock auction markets, with the LRATC function declining throughout the range of observed volumes (Figure 1). However, very small markets have the greatest opportunity to reduce costs by increasing volume. The potential to increase efficiency by increasing volume declines as larger volumes are reached. Using the OLS estimate, markets handling 60,000 A.M.U.'s would achieve 90 percent of the potential economies of size (Table 9). According to the cost function elasticity shown in Table 9, a 10 percent increase in volume at 5,000 A.M.U.'s would result in a 3.12 percent reduction in average total cost. At 90,000 A.M.U.'s a 10 percent increase in volume would result in a reduction in average total cost of only 0.58 percent.

Results from the frontier function also show that economies of size exist in the industry. However, most cost economies are realized at very small volumes (Figure 1). Along the frontier function, 90 percent of the potential economies of size would be achieved by markets handling slightly less than 7,500 A.M.U.'s (Table 9). Cost saving to be realized by expanding volume beyond 30,000 A.M.U.'s is less than 1 percent. The cost function elasticity for the frontier function shows that a 10 percent increase in volume at 5,000 A.M.U.'s would result in a 3.02 percent decline in cost, but that a 10 percent increase in volume at 15,000 A.M.U.'s would result in only a 0.51 percent reduction in cost. Thus, the frontier function indicates that small markets can be relatively cost efficient while the OLS function indicates that much larger volumes are required to achieve the same level of efficiency.

Of the auctions included in this study, 72 percent handled less than 27,000 A.M.U.'s in 1980 (Table 1). Assuming the OLS function to be the appropriate estimate of the LRATC function, almost three-fourths of the existing industry captures less than 80 percent of the available economies of size. Most auctions could increase efficiency and substantially reduce operating costs per head by expanding volume. This economic pressure

Table 9. Comparison of Long Run Average Total Cost Functions Derived from Minimum Absolute Deviation Estimation of a Frontier Function and from Ordinary Least Squares for Model 4.

Volume	OLS			Frontier Function		
	Average total cost	Cost function elasticity ^a	% cost economies realized ^b	Average total cost	Cost function elasticity ^a	% cost economies realized ^b
(AMU)	(\$)		(%)	(\$)		(%)
5,000	6.118	-.312	8.4	2.547	-.302	86.0
7,500	5.381	-.312	32.3	2.327	-.158	92.9
10,000	4.936	-.286	46.8	2.244	-.099	95.6
15,000	4.441	-.234	62.9	2.179	-.051	97.6
20,000	4.175	-.196	71.5	2.153	-.033	98.4
30,000	3.896	-.147	80.6	2.132	-.018	99.1
40,000	3.751	-.117	85.3	2.123	-.012	99.4
50,000	3.663	-.097	88.2	2.118	-.009	99.5
60,000	3.604	-.083	90.1	2.115	-.007	99.6
70,000	3.561	-.072	91.5	2.113	-.006	99.7
90,000	3.503	-.058	93.4	2.111	-.004	99.7

^a Elasticity of average total cost with respect to volume was determined according to:

$$\text{Elasticity} = \frac{d\text{ATC}}{d\text{Vol}} \cdot \frac{\text{Vol}}{\text{ATC}}$$

^b Percent cost economies realized was defined as the difference between predicted average total cost (ATC) at the minimum observed volume and predicted ATC at the volume under consideration, divided by the difference between predicted ATC at the minimum observed volume and predicted ATC at the asymptotic minimum of the function

$$\frac{\text{ATC}_{\text{min. vol.}} - \text{ATC}_{\text{vol. } i}}{\text{ATC}_{\text{min. vol.}} - \text{ATC}_{\text{asympt. min.}}}$$

should lead to a trend toward larger markets over time if other factors do not offset the cost savings.

However, the percentage of markets handling less than 9,000 A.M.U.'s increased from 13 percent to 30 percent between 1978 and 1980 (Table 1). The number handling less than 18,000 A.M.U.'s increased from 40 to 61 percent while the number handling more than 27,000 A.M.U.'s declined from 36 to 28 percent. This apparent decline in the volume of markets was probably caused by a general decline in cattle marketings consistent with the cattle cycle. However, these data suggest that many small firms continue to exist.

This is contrary to the trend suggested by the OLS estimate of the LRATC function. Rather the data are more consistent with the frontier function estimate of long run average cost since it indicates that most of the available economies of size can be achieved at lower volumes and, thus, the incentive to expand the auction market operation beyond 10,000 or 15,000 A.M.U.'s per year may be small.

CONCLUSIONS

The results of this study indicate that economies of size exist in the Tennessee livestock auction market industry. While the results of the descriptive cost analysis leave the existence of general economies of size somewhat unclear, the estimation of the long run average total cost curve shows that markets handling larger volumes tend to experience lower costs per head handled.

For practical evaluation of Tennessee livestock auction market performance and efficiency in the short run, the ordinary least squares (OLS) estimate of average cost provides the needed descriptive information. Under current operating conditions, the average auction market would have to handle approximately 50,000 A.M.U.'s annually to achieve 90 percent of the potential economies of size. However, the OLS function may overestimate the volume needed to achieve most economies of size in the long run.

The frontier function estimate provides the theoretical envelope curve fitted to the lowest points of the scatter of average cost plotted against volume. This estimate, where 90 percent of the potential economies are realized at less than 7,500 A.M.U.'s, reflects Tennessee livestock auction market industry behavior more accurately than the OLS function. Despite previous research, the results of this study indicate that most of the available economies of size may be realized by auction markets with relatively small annual volume levels provided that the markets use the most efficient size plant for that level of volume.

Because several researchers in the past have estimated long run average cost functions for auction markets using the OLS approach, volumes necessary to achieve economies of size may have been exaggerated. The results of this study indicate that the level of volume required to achieve relatively cost-efficient operation may not be as large as once believed. The continued existence of many small markets in Tennessee tends to support this conclusion.

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APPENDIX

The following tables provide information which may be of interest to the Tennessee livestock auction market industry, but which is self explanatory.

Table 10. Number of A.M.U.'s Handled Through Market Support Activity by Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980.

Size Group	1978		1980	
	Mean	Standard Deviation	Mean	Standard Deviation
I	1,207	392	157	219
II	281	625	133	164
III	250	310	1,137	2,157
IV	87	173	164	199
V	3,226	3,925	813	1,150
VI	283	589	878	1,520
VII	1,198	1,877	1,131	1,599
All	585	1,514	375	885
1978 & 1980	489	1,265		

Table 11. Number of A.M.U.'s Handled Through Dealer Operations by Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980.

Size Group	1978		1980	
	Mean	Standard Deviation	Mean	Standard Deviation
I	290	675	735	2,171
II	852	2,838	10,945	35,077
III	10,014	32,211	2,131	4,681
IV	1,645	1,911	136	208
V	3,346	6,817	—	—
VI	598	912	5,562	8,634
VII	1,418	2,835	—	—
All	3,239	15,874	4,167	19,625
1978 & 1980	3,662	17,596		

Table 12. Average Number of Livestock Handled per Species by Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980

Year	Size Group	Cows	Calves	Hogs	Sheep	Horses
1978	I	3,499	2,141	406	121	9
	II	9,230	3,355	2,777	252	276
	III	11,554	6,300	10,581	204	216
	IV	19,961	9,010	6,698	104	15
	V	33,268	5,284	2,333	489	3
	VI	40,117	8,442	5,398	1,132	812
	VII	26,694	2,957	186,950	414	9
	All	17,217	5,090	14,656	358	233
1980	I	3,174	1,620	2,037	194	319
	II	8,383	3,189	4,421	259	5
	III	10,159	5,805	14,519	342	3
	IV	19,429	8,218	8,966	410	1,538
	V	36,188	1,940	4,532	2,143	537
	VI	28,106	16,149	14,775	482	79
	VII	13,331	1,289	165,036	284	0
	All	11,142	4,360	12,397	366	328
1978 & 1980		14,758	4,758	13,627	362	276

Table 13. Average Number of Sale Days Per Year for Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980.

Size Group	1978	1980
I	50	52
II	51	53
III	52	52
IV	52	72
V	62	91
VI	67	52
VII	102	128
All	58	60
1978 & 1980		59

Table 14. Average Gross Value of Livestock Sold by Tennessee Livestock Auction Markets, by Size Group, 1978 and 1980 (Actual Dollars)

Size Group	1978	1980
I	\$ 1,245,508	\$ 1,704,177
II	2,714,734	3,693,920
III	4,464,044	5,535,312
IV	7,237,633	9,868,664
V	8,748,713	12,184,315
VI	12,298,040	14,823,011
VII	13,407,570	10,398,238
All 1978 & 1980	5,816,051	5,480,349
	\$ 5,663,157	

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